

Cardiff Coastal Defences – Flood Consequence Assessment

Version 1

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Purpose

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1 Introduction

1.1 Terms of reference

JBA Consulting (JBA) were commissioned by Cardiff Council to design a coastal defence scheme to improve and extend coastal and fluvial defences in an area of eastern Cardiff. The proposed coastal defence scheme is to be submitted for planning approval and this Flood Consequence Assessment has been prepared in support of the planning application.

1.2 FCA requirements

This FCA follows Welsh Government guidance on development and flood risk set out in the Technical Advice Note 15: Development and Flood Risk (TAN15). Where appropriate the following aspects of flood risk will be addressed in all planning applications over its expected lifetime in flood risk areas:

- The likely mechanisms of flooding
- The likely source of flooding
- The depths of flooding through the site
- The speed of inundation of the site
- The rate of rise of flood water through the site
- Velocities of floodwater across the site
- Overland flow routes
- The effect of access and egress and infrastructure, for example public sewer outfalls, combined sewer outflows, surface water sewers and effluent discharge pipes from wastewater treatment works
- The impacts of the development in terms of flood risk on neighbouring properties and elsewhere on the floodplain

2 Site description

2.1 Site extent and summary

The proposed coastal defences are located around the mouth of the Rhymney River, including the coastline along Rover Way, beginning at the eastern end of the privately owned Dŵr Cymru Welsh Water (DCWW) defences, extending along the coast and the western bank of the river as far as the railway line, approximately 1.3 km upstream. The proposed defence continues down the east bank of the river and along the coast around Lamby Way Landfill Site. Table 2-1 summarises the site characteristics and Figure 2-1 shows an overview the site location and extent.

Table 2-1 Site summary

Site name	Rhymney River Costal Defences
Site area	Approximately 40 hectares
Existing land use	Varied – see detailed description
Purpose of development	Coastal flood defence
OS NGR	ST 22113 77369
Local Planning Authorities	Cardiff Council
Lead Local Flood Authority	Cardiff Council



Figure 2-1 Proposed development site

2.2 Existing land use

The proposed coastal defences are located around the mouth of the Rhymney River, and the coastline adjacent to the Severn Estuary. The coastline in the study area is heavily modified by a legacy of urban development and industry along much of its extent. This includes the presence of extensive areas of Made Ground that are now used for a variety of industrial and recreation purposes, as well as significant transport and utilities infrastructure. Key features of the site and the surrounding area, as shown in Figure 2-2, include:

- Lamby Way and Rover Way form key road infrastructure for commuters and commercial traffic accessing the Cardiff Docks, city centre and south east Cardiff. Rover Way runs from Lamby Way roundabout behind the existing flood embankments parallel to the river before turning to run parallel along the coast towards the steel works. The Lamby Way road bridge crosses the river to the north of Lamby Way Landfill, to join Lamby Way roundabout, located immediately behind the existing defences on the west bank of the river.
- Decommissioned Frag Tip which contains unknown landfill materials. The dirt bike track, Cardiff Motocross Centre, is located on Frag Tip material.
- Traveller's site located directly off Rover Way, and adjacent the site, between the Rover Way and the coastline.
- Dŵr Cymru Welsh Water (DCWW) Waste Water Treatment Works (WwTW), located to the west of the site area. Adjacent to the Traveller's site is an electricity substation, which is thought to supply this WwTW.
- Industrial activities including metal salvage and recycling yards and vehicle repairers in Tremorfa Industrial Estate as well as steelworks and waste disposal associated with the Celsa Steelworks north and south of Rover Way.
- The land east of the Tremorfa Industrial Estate consists of a mix of green space, residential properties, and local amenities such as schools, leisure facilities and a large supermarket. There are also two allotment sites located close to the western bank of the Rhymney River towards the northern end of the project area.
- Lamby Way Landfill Site, east of the Rhymney River, until recently the principal waste disposal facility in Cardiff. Part of the site continues to operate as a municipal recycling facility, with the remainder of the site capped and landscaped. Much of the western portion of the site is currently being redeveloped into a solar farm. Along the coastline fronting the Lamby Way Landfill is a row of mains electricity pylons running parallel to the coast.
- The Wales Coast Path follows the coastline for much of the site area west of the Rhymney River. To the east of the river, the path diverts away from the coastline along Lamby Way highway, before diverting southwards along the eastern boundary of the landfill site back to the coastline.



Figure 2-2 Aerial imagery of the development site and surrounding area

2.3 Existing topography

A topographic survey was undertaken in December 2016 by Storm Geomatics Ltd, under the direction of JBA Consulting and is contained in Appendix A.

The site is a generally flat coastal region, forming the mouth and floodplain of the Rhymney River, with a general elevation of 7-9 m AOD. There are areas of infilling adjacent to the site extent, at Cardiff Motocross Centre, and Lamby Way Landfill Site, with elevations of up to 30m AOD.

Figure 2-3 contains 1m LiDAR elevations across the site, and adjacent areas, for clarity and for to provide context for the site area.

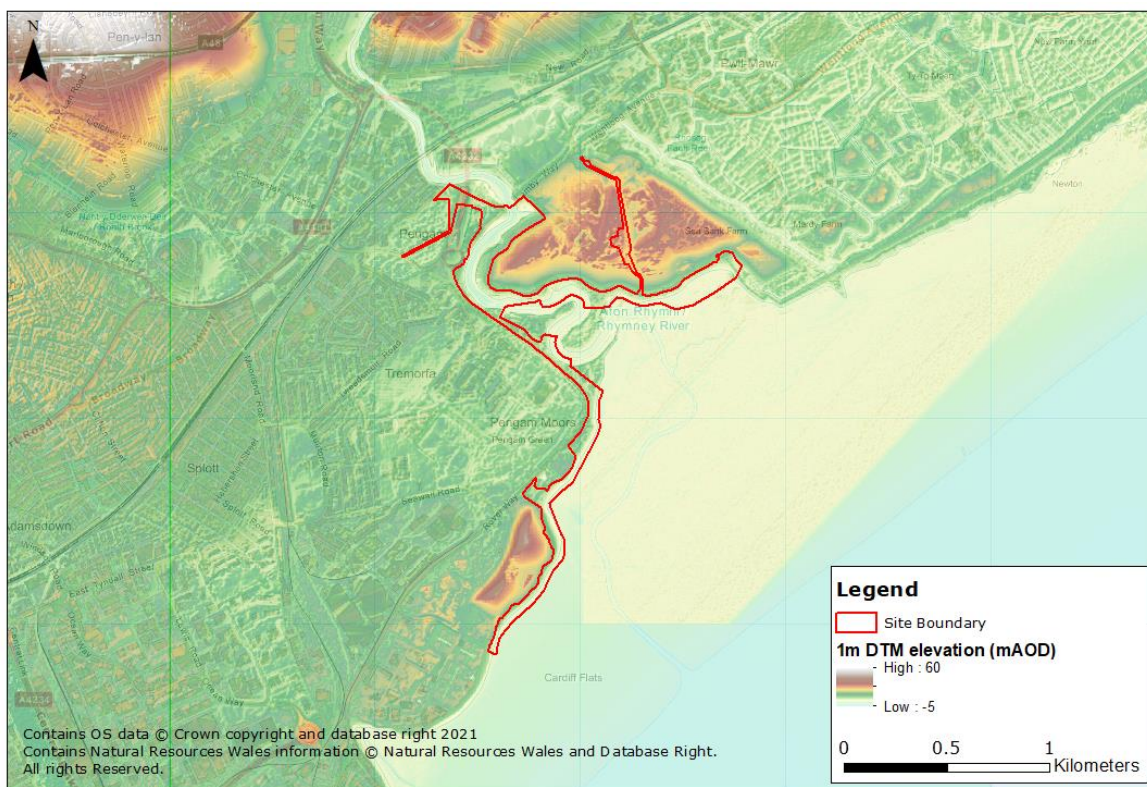


Figure 2-3 1m DTM LiDAR

2.4 Site geology

Ground investigations were scoped by JBA and undertaken by Quantum Geotechnic Limited (Quantum) (subcontracted by Alun Griffith Contractors (AGC)) between 02 March and 20 May 2020 and has been submitted to accompany the planning application.

The British Geological Survey (BGS) map shows that the majority of the site is underlain by Tidal Flat deposits (clay, silt and sand) over the Mercia Mudstone Group (mudstone). Much of the project area to the west of the Rhymney River comprises Made Ground, known locally as 'Frag Tip' which may contain waste materials from the metal working industry.

Thirty rotary open boreholes to maximum depth of 40.0mbgl, sixteen dynamic windowless sampling boreholes to a maximum depth of 20mbgl, fifteen dynamic windowless sampling boreholes to a maximum depth of 8.0mbgl and eleven cable percussive boreholes to a maximum depth of 20.0mbgl were undertaken as part of the ground investigation along with groundwater observation and monitoring records.

The boreholes were used to generate geological long sections of the study area which can be found in the accompanying Ground Investigation report. Broadly, however, the ground investigation corresponds with the BGS information for the area and indicated that ground conditions across most of the site are of Made Ground over Tidal flat deposits, over glacial fluvial deposits over weathered Mercia Mudstone and/or Mercia Mudstone Bedrock.

Ground conditions encountered within the 'Frag Tip' area consist of the Made Ground Landfill and/or Made Ground Slag over Tidal Flat Deposits.

2.5 Major watercourses

The site is located on the coast adjacent the Severn Estuary. Three NRW main rivers are located on or in close proximity to the site, as shown in **Figure 2-4**. The lower reaches of the Rhymney River, which are tidally dominated, runs through the application site.

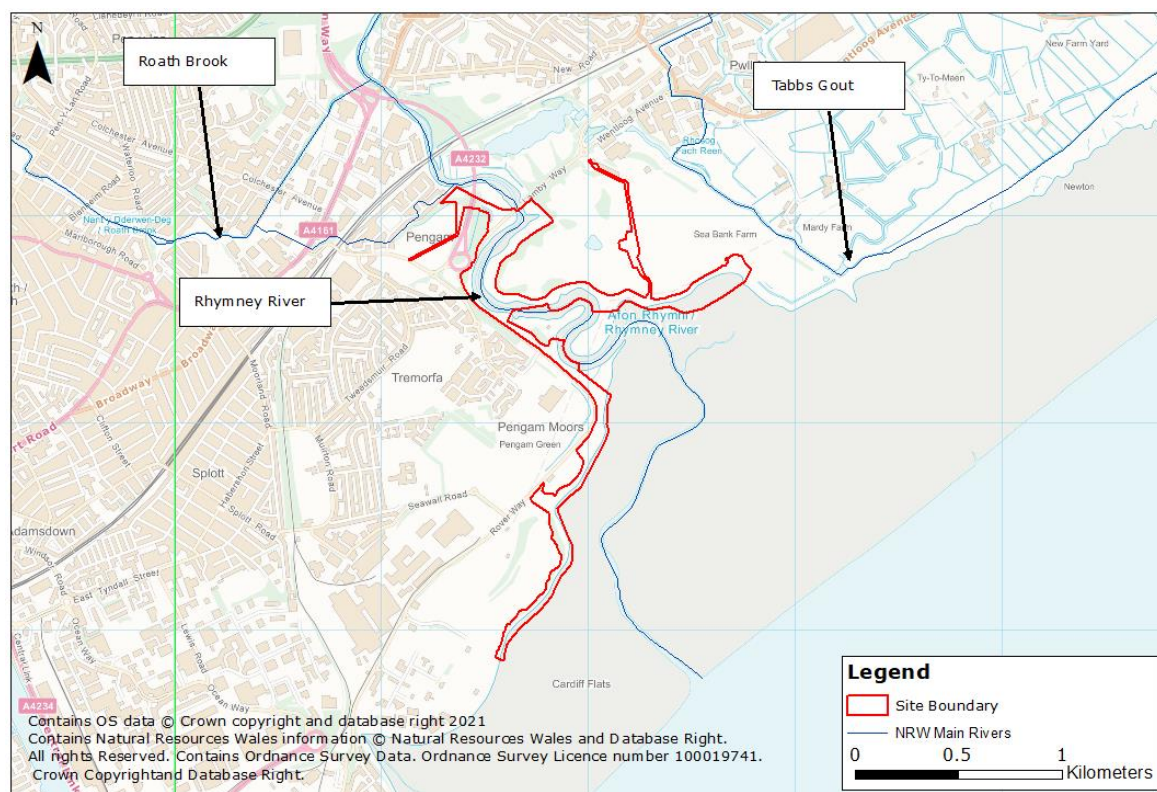


Figure 2-4 Watercourses around the site

2.6 Existing flood defences

Existing flood defences in this area comprise of the remnants of rock armour revetments along the Severn Estuary, a sheet-pile wall, earth embankment, and a section of severely eroded block stone defences along the western bank of the Rhymney River. Tidal and fluvial erosion of these defences and the associated coastline has taken place to the extent that extensive sections of defences have either been completely lost or are in very poor condition and are at significant risk of failure in the near future.

Existing flood defences in the scheme area, located along the Severn Estuary and the Rhymney River, have failed or are at significant risk of failing. Much of the coastline across the project area is eroding and with predicted sea level rise due to climate change, the flood and erosion risk will continue into the future.

The scheme comprises two main areas. The first of these is the flood cell to the west of the Rhymney River. The coastal defences along this section of the Severn Estuary are in very poor condition and erosion is taking place at a rapid rate. Landfill material is eroding into the Severn Estuary from the disused Frag Tip, whilst the Rover Way Traveller site is at risk of being lost to erosion and flooding. The coastal defences in this flood cell are already at risk of breach due to erosion, leading to flooding of the land behind. Along the west bank of the river, there are low sections of defence which will overtop as sea levels rise, increasing flood risk to people and property west of the river. Key areas of highway infrastructure are at risk of being undermined and lost to erosion within 20 years.

The second area is the flood cell to the east of the Rhymney River. The defences along the east bank of the river and the coastal defences to the east of the river mouth are also at risk of erosion. It is estimated that if no works are undertaken along the coast, erosion will continue to increase and will impact upon the disused Lamby Way landfill within 20 years, releasing landfill material into the Severn Estuary and having significant environmental impacts. Land elevations are higher on this side of the river leading to more limited flood risk but there is a risk of up to 50m of erosion along the coast within 20 years, and 270m by 2117.

The Severn Estuary Shoreline Management Plan (SMP) policy for these sections of the coastline is to 'Hold the Line' (HTL). This means that the flood defences should be maintained and upgraded or replaced in their current position. Therefore, substantial new flood defences are required to maintain and improve the level of protection currently provided.

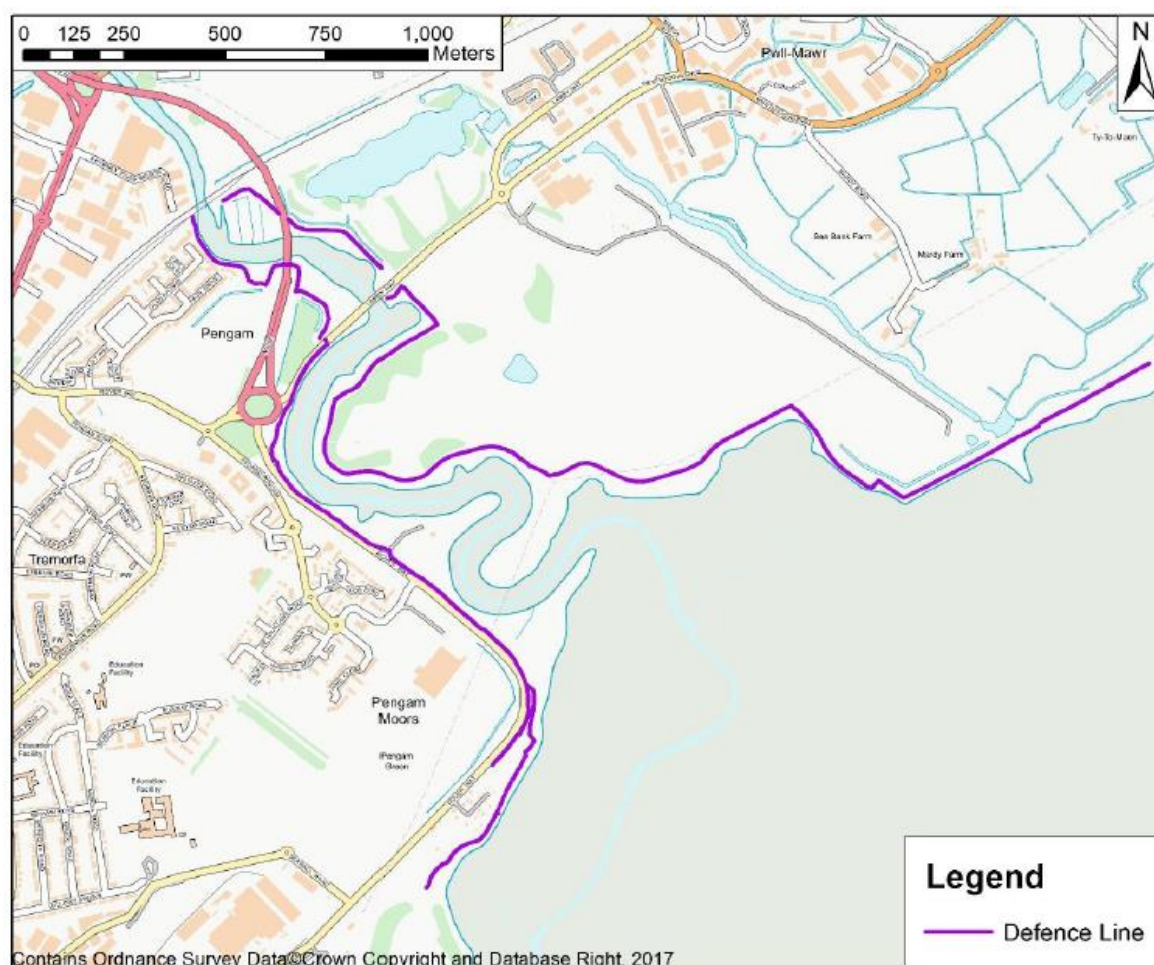


Figure 2-5 Existing Flood Defence Line

2.7 Development proposal – New flood defences

The proposed scheme will manage flood risk to 2,326 residential and 204 non-residential properties over 100 years, as well as preventing erosion of landfill material, key rail/road infrastructure and the Rover Way Travellers site.

The proposed development will provide increased flood protection for residents and critical infrastructure in the area and prevent further erosion of two landfill sites – the Lamby Way landfill site, operated and maintained by Cardiff Council, and the 'Frag Tip', an area of reclaimed land forming the coastline of the Severn Estuary to the west of the Rhymney River.

The proposed coastal defences include the coastline along Rover Way, beginning at the eastern end of the privately owned DCWW defences, extending along the coast and up the west bank of the river as far as the mainline railway crossing of the river near Parc Tredelerch. The proposed defences continue down the east bank of the river and along the coast around Lamby Way Landfill Site to the location of the recently constructed Natural Resources Wales (NRW) defences.

The flood defence comprises four main sections, shown in Figure 2-6 and outlined below:

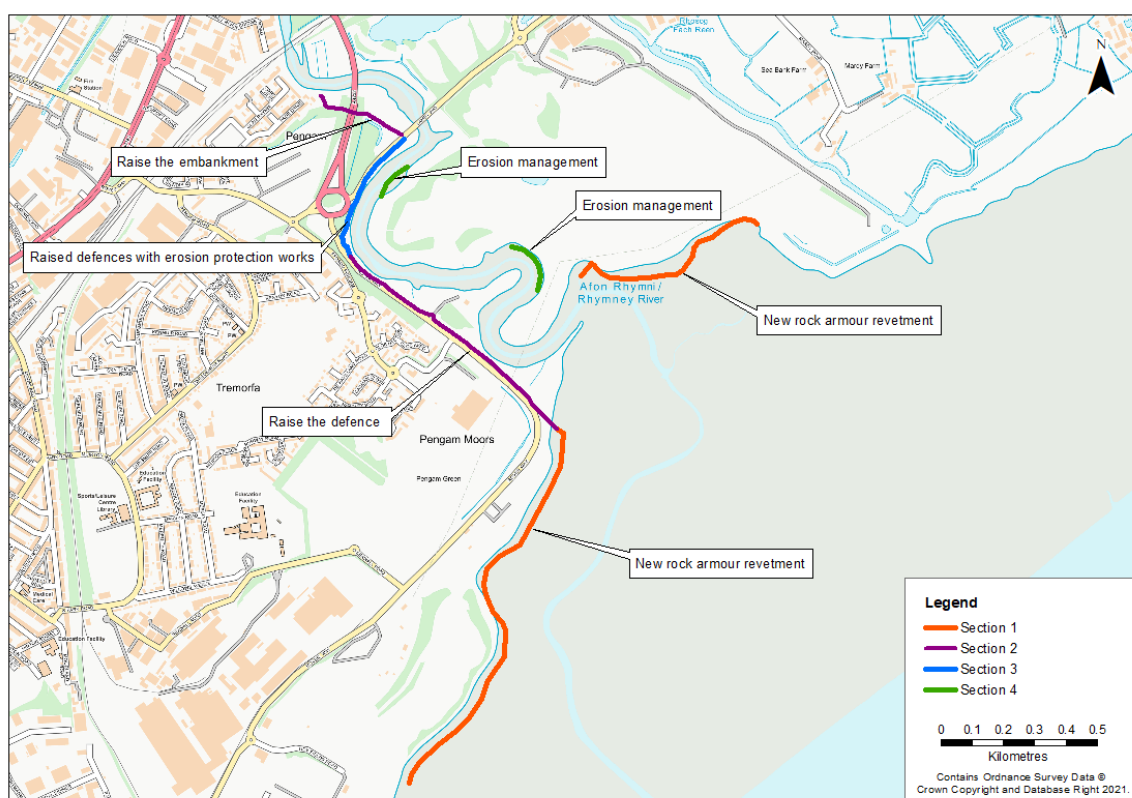


Figure 2-6 Proposed sections of flood and erosion defences

- **Section 1: Severn Estuary coastline east and west of the confluence with the Rhymney River**

The proposal along this section, extending either side of the Rhymney River, is to construct a sloping rock armour revetment along the coastline to manage coastal erosion of the Frag Tip, Lamby Way Landfill, and adjacent areas (including the Wales Coast Path), and tidal flood risk to infrastructure (Rover Way, electricity transmission, Wales Coast Path) and residential and commercial properties from wave overtopping. The design proposals for Section 1 comprise two sections of rock armour revetment, totalling approximately 2.1km in length, extending from high ground onto the estuary foreshore. The footprint of the revetment is approximately 20m in width.

- **Section 2: Severn Estuary west of the Rhymney River**

This section generally comprises of existing earth bunds. The proposed defence raises the existing bund (where present) to the required level to manage flood risk up to a 0.5% AEP SoP in 2119 continuing the existing bund slope face adjacent to Rover Way up to the new crest level. This will involve raising the defence by approximately one metre to 10.15m AOD. The flood defence will be achieved using

imported clay fill with a seeded topsoil finish. The crest of the embankment will house the Wales Coast Path alongside the River Rhymney.

The frontage includes a double flood gate installed within a concrete housing structure to provide access to the Rhymney River Motor Boat Sail & Angling Club. The Sailing Club is owned by CCC, and the gate will therefore be operated and maintained by CCC.

- **Section 3: Lamby Way Roundabout**

This section is generally a natural riverbank alongside Rover Way and Lamby Way although there are some old sheet piles present. There are signs of active erosion in the southern part of this section, and the sheet piles are at the end of their service life. However, the northern half of this section shows signs of accretion.

The design proposes that concrete erosion protection mats are installed on the riverbank where erosion is evident. The accreting sections will not require erosion protection. The toe of these mats will be buried into the riverbed below the low water line and secured by backfilling with rock armour units. On the lower portion of the bank, the mats will be exposed on the surface of the bank as required to manage scour action. The design proposes that at a suitable level, the erosion mats cut back into the bank and continue up under approximately 1m depth of natural mud material, in order to minimise impacts on the natural channel and associated biodiversity. At the transition point between buried and exposed erosion mats, wooden stakes and brushwood are proposed to facilitate establishment of the mud layer. Over the service life there is the possibility that the mud layer could be eroded and the erosion protection beneath may become exposed. However, this will not affect the functionality of the defence.

At the top of the bank, a sheet piled flood defence is proposed completed with concrete capping beam. This will approximately increase the embankment height by between 0.2 and 1 metre, providing the required defence level.

- **Section 4: Severn Estuary east of the Rhymney River**

This 350-metre-long section is generally a natural riverbank adjacent to a historic landfill. There are signs of active erosion. The design proposes that concrete erosion protection mats are installed on the riverbank. The toe of these mats will be buried into the riverbed below the low water line and secured by backfilling with rock armour units. On the lower portion of the bank, the mats will be exposed on the surface of the bank as required to manage scour action. The design proposes that at a suitable level, the erosion mats cut back into the bank and continue up under a depth of natural mud material. The risk of erosion of this mud layer is reduced, but over the service life there is the possibility that the erosion protection beneath may become exposed. At the transition point between buried and exposed erosion mats, wooden stakes and brushwood is proposed to facilitate establishment of the mud layer.

3 Planning Policy and flood risk

3.1 Planning context

TAN-15 was introduced in 2004 by the Welsh Assembly Government. TAN-15 contains technical guidance related to development planning and flood risk using a sequential characterisation of risk based on the Welsh Government's Development and Flood Risk Advice Map (DAM). The initial requirement is to identify the flood zones and vulnerability classification relevant to the proposed development, based on an assessment of current and future conditions.

3.2 Development Advice Map

The Development Advice Map shown in Figure 3-1 indicates that the site of the proposed coastal defence scheme is located largely within Zone C2 with small portions of the site within Zone B.

Zone C2 is defined as "areas of the floodplain without significant flood defence infrastructure". Zone B is defined as "areas known to have flooded in the past evidenced by sedimentary deposits".

Any proposed development located in Zones C2 must be supported by a Flood Consequence Assessment (FCA), prepared in line with TAN-15.

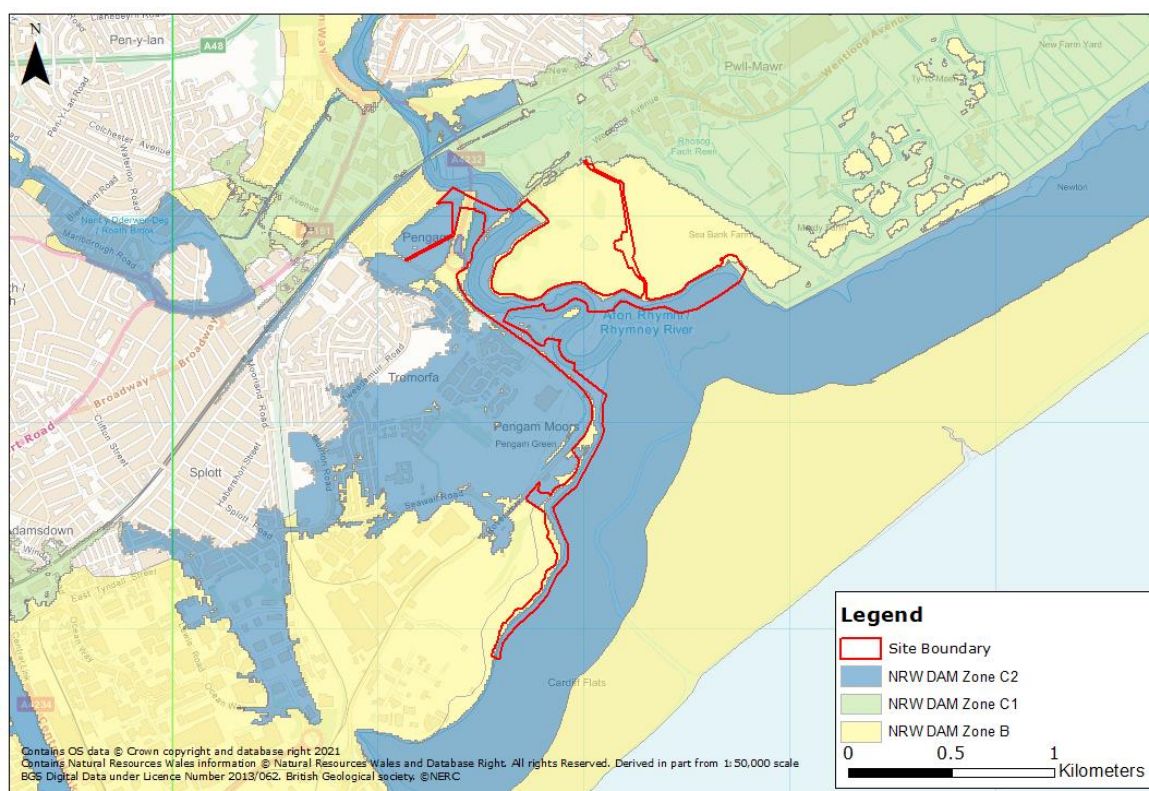


Figure 3-1 Development Advice Map

3.3 Development vulnerability

TAN-15 assigns one of three flood risk vulnerability classifications to developments. These are: emergency services, highly vulnerable development and less vulnerable development as shown in Table 3-1 below. TAN-15 typically addresses the development of property as reflected in the three vulnerability classifications.

Table 3-1: Development categories defined by TAN-15

Development category	Types
Emergency services	Hospitals, ambulance stations, fire stations, police stations, coastguard stations, command centres, emergency depots and buildings used to provide emergency shelter in time of flood.
Highly vulnerable development	All residential premises (including hotels and caravan parks), public buildings, (e.g. schools, libraries, leisure centres), especially vulnerable industrial development (e.g. power stations, chemical plants, incinerators), and waste disposal sites.
Less vulnerable development	General industrial, employment, commercial and retail development, transport and utilities infrastructure, car parks, mineral extraction sites and associated processing facilities, excluding waste disposal sites.

The aim of the proposed engineering works covered by this FCA are to provide flood mitigation to the wider Cardiff area. Therefore, the proposed engineering works do not fall into any of three stated vulnerability categories. Such a situation is recognised by paragraph 5.3 of TAN-15, which covers exceptions to the three vulnerability classifications, by virtue of their nature:

5.3 There are uses which are considered to be exceptions to the general rule, and have not been classified above, because they are required in a fluvial, tidal or coastal location by virtue of their nature. These include boatyards, marinas, essential works required at mooring basins, and development associated with canals. They will not be subject to the first part of the justification test in section 6 but will be subject to the acceptability of consequences part of the test as outlined in section 7 and the requirements of appendix 1. Further consideration is given to minor development in section 11.

The nature of defences for flooding and coastal erosion is such that they are required to be located in areas of flood risk, and therefore this FCA adopts the guidance of paragraph 5.3. Consequently, the Justification Test has not been applied to the scheme, but the 'acceptability of consequences' have been thoroughly considered in line with TAN-15.

4 Flood Risk Assessment

4.1 Assessment context

This section assesses the risk to the proposed development from all sources of flooding, the risk of increasing flooding to others, and how flood risks can be managed.

4.2 Review of existing flood risk

The latest available information of flood risk at the site, published by NRW, is summarised in Table 4-1

Table 4-1 Summary of flood risk

Source of Flooding	Onsite Presence	Description
Fluvial	✗	The site is at low risk of fluvial flooding
Tidal	✓	The site is located in an area at high risk of tidal flooding
Surface Water and small watercourses	✗	The site has a low risk of flooding from surface water and small watercourses
Groundwater	✗	The site has a low risk of flooding from groundwater.
Reservoirs	✓	The site is considered to be at risk of flooding from reservoirs.

4.3 Fluvial Flood Risk

NRW Flood Risk Assessment Wales (FRAW) data indicates that there is very low risk of fluvial flooding within the boundary of the site application area. With fluvial flood modelling only being available for stretches of the Rhymney River immediately upstream of the site.

The site includes portions of the lower catchment of the Rhymney River which is dominated by the tidal influence of the Severn Estuary. The risk of flooding to the site directly from fluvial sources is therefore considered low.

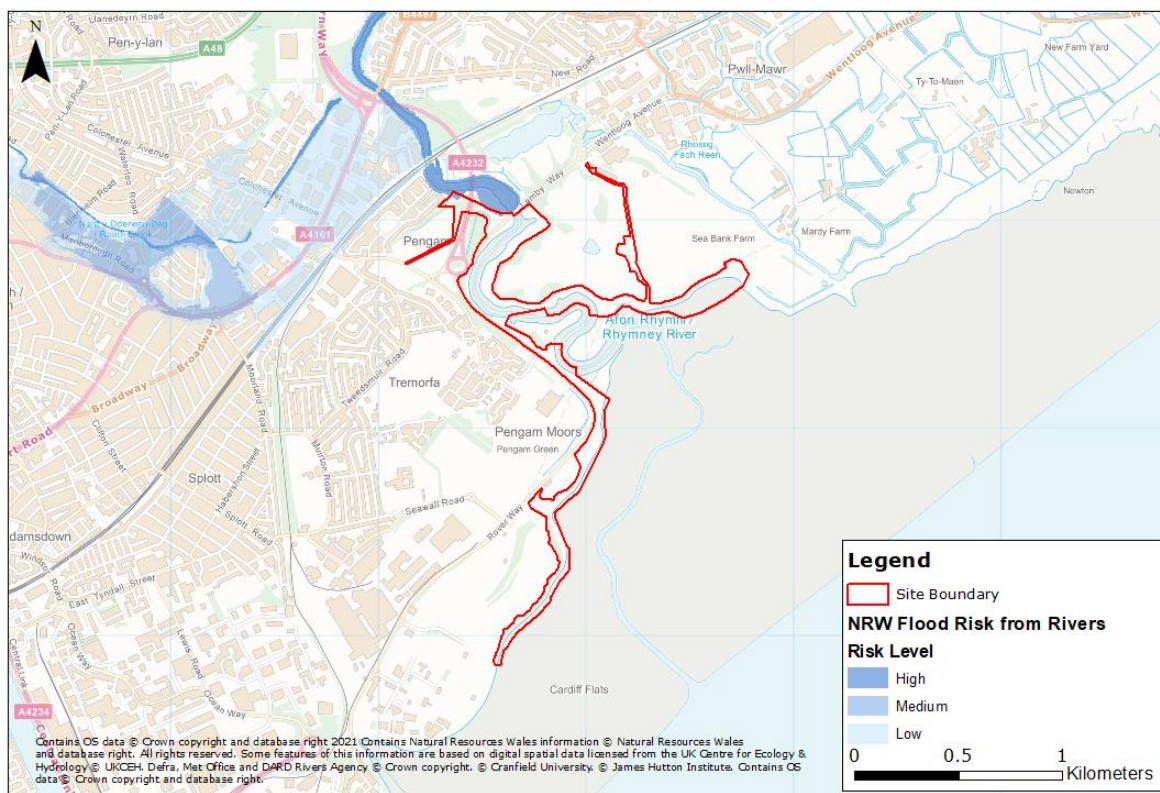


Figure 4-1 FRAW Flood Risk from Rivers

4.4 Tidal Flood Risk

NRW FRAW data indicates the site is at risk of tidal flooding during the High (1 in 30-year) flood risk scenario, as shown in Figure 4-2. The extent of the flooding is significant, covering a large part of the red line boundary area.

Large areas within the portion of Cardiff adjacent the Severn Estuary and Rhymney River, including both commercial and residential areas, have a low-high risk of tidal flooding.

To gain a better understanding of the risk associated with tidal flooding, and due to the nature of the development for proposed coastal defences, further assessment of tidal flood risk has been undertaken and is discussed within Section 5.

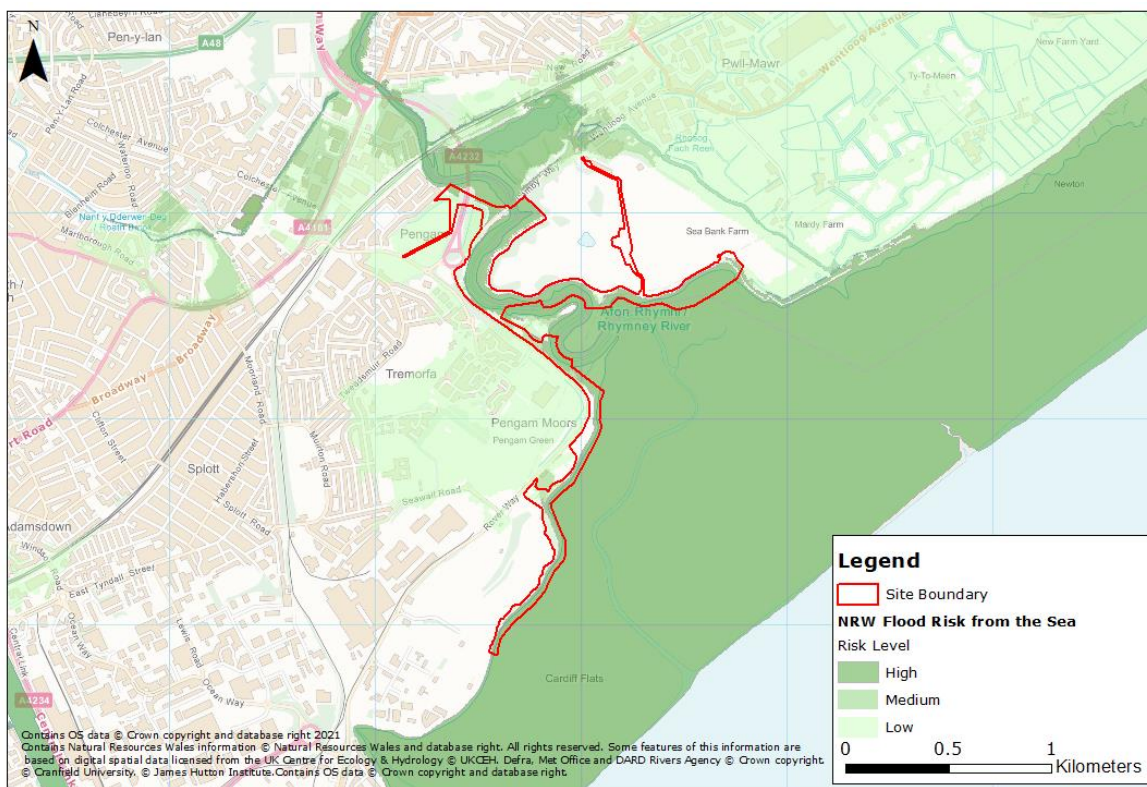


Figure 4-2 FRAW Flood Risk from Sea

4.5 Surface Water and Small Watercourse flood risk

NRW FRAW map for the risk of flooding from Surface Water and Small Watercourses, as shown in Figure 4-3, shows that the majority of the site is at very low risk of flooding from surface water and small watercourses (less than 0.1% chance of flooding each year).

It has therefore been concluded that the risk of surface water and small watercourse flooding at the site is very low.

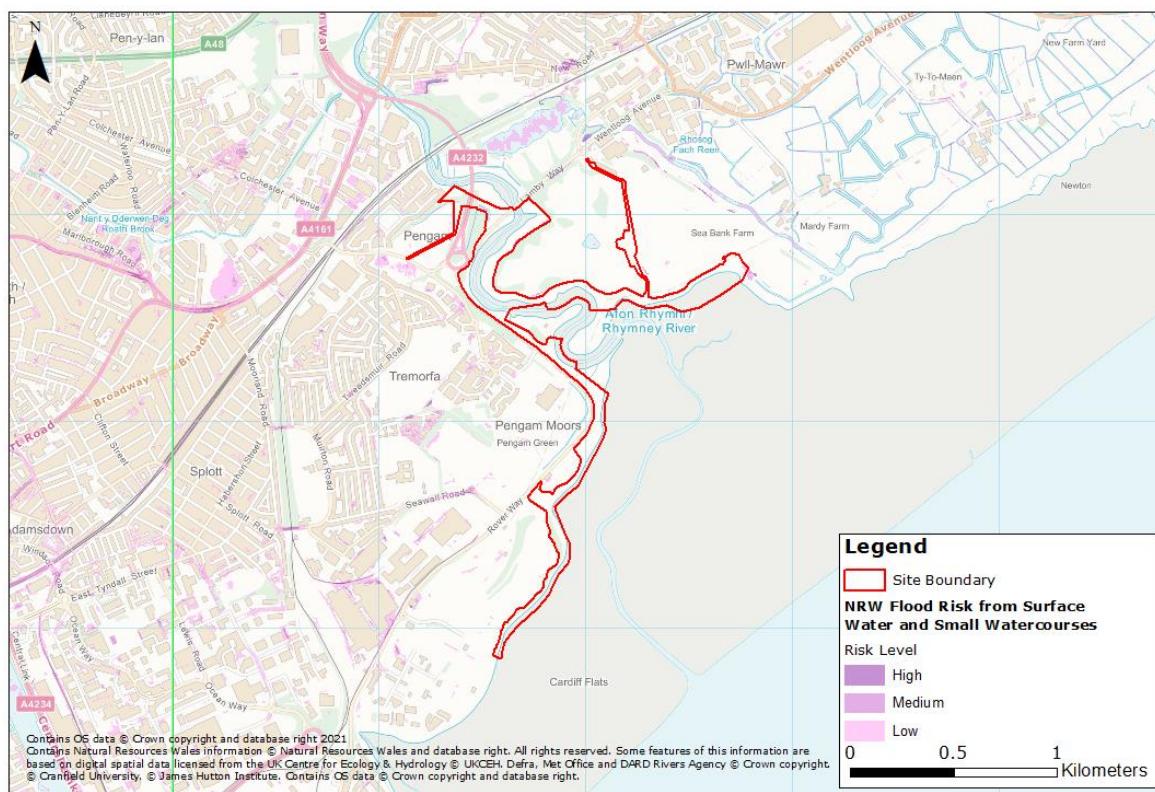


Figure 4-3 FRAW Flood Risk from Surface Water and Small Watercourses

4.6 Groundwater flood risk

Groundwater flooding is caused by unusually high groundwater levels. It occurs as excess water emerging at the ground surface, or within manmade structures such as basements. Groundwater flooding tends to be more persistent than surface water flooding, in some cases lasting for weeks or months. This risk of groundwater flooding depends on the nature of the geological strata underlying a site, as well as on the local topography.

A ground investigation was scoped by JBA Consulting (JBA) and undertaken by Quantum Geotechnic Limited (Quantum) (subcontracted by Alun Griffith Contractors (AGC)) between 02 March and 20 May 2020, as discussed in Section 2.4.

Groundwater observations and daily readings of depth to water in installations were made during the ground investigations and groundwater levels from monitoring wells were obtained between 05 May and 02 June. Groundwater seepage or slow inflow was encountered perched at the top of the tidal flat deposits and was unable to infiltrate due to low permeability. In addition, during the ground investigation there appeared to be a direct connection between fluvial water levels in the Rhymney River and the groundwater strikes encountered on advancement through the top of the glaciofluvial deposits. As the glaciofluvial deposits are largely confined above by the tidal flat deposits and below by the Mercia Mudstone, when the fluvial levels were higher than the top of the glaciofluvial deposit, sub-artesian conditions were observed.

Given the nature of the proposals, it is not envisaged that the proposed development would have a detrimental effect on groundwater levels in the area. It can therefore be concluded that the risk of groundwater flooding at the site is low.

4.7 Reservoir flood risk

NRW flood maps indicate that parts of the development site, and the wider area around the Rhymney River is at risk of flooding as a result of reservoir failure associated with the Llanishen and Lisvane reservoirs, as well as Roath Park Lake.

NRW consider reservoir flooding to be extremely unlikely to happen and there has been no loss of life in the UK from reservoir flooding since 1925. All large reservoirs must be inspected and supervised by reservoir panel engineers. NRW as the enforcement authority for the Reservoirs Act 1975 in Wales ensure that reservoirs are inspected regularly, and essential safety work is carried out. The risk of flooding from reservoirs is therefore considered low.

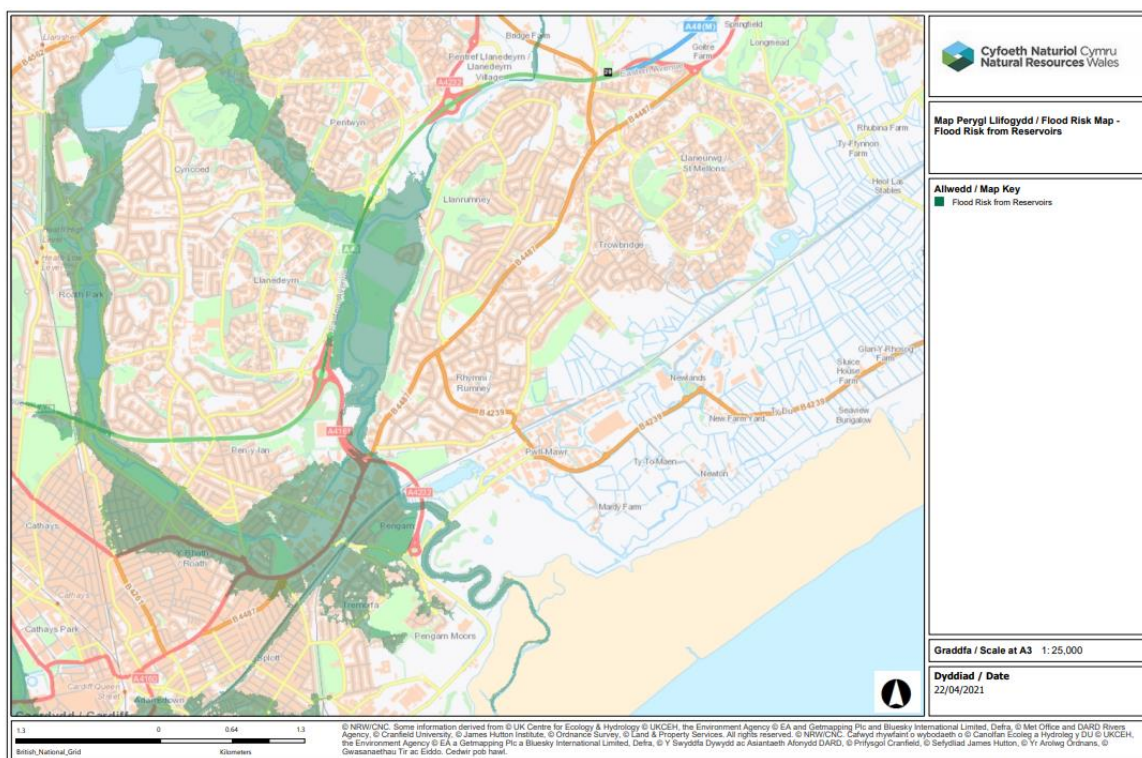


Figure 4-4 NRW Flood Risk from Reservoirs

5 Detailed Assessment of Tidal Flood Risk

5.1 Modelling undertaken

Tidal flood risk has been identified as the most significant source of flood risk to the site, and to the wider area of Cardiff around the site. Furthermore, managing tidal flood risk is the principal driver for the proposed scheme. In order to assess the risk of tidal flooding JBA Consulting have undertaken extensive modelling of the area in support of the coastal defence project.

There were no pre-existing models incorporating the Lamby Way and Rover Way areas of interest and a 2D tidal inundation model was therefore constructed utilising TUFLOW. The model domain extends from the Cardiff coast in the south to just beyond the tidal influence zone at the A48 Eastern Avenue Bridge over the Rhymney River and incorporates the Rhymney River and Roath Brook Watercourses. A 1D element was not required due to the lack of hydraulic structures within the model domain. The Rover Way and Lamby Way areas were combined as a single flood cell as they share similarities in site conditions and technical challenges. The modelling undertaken accounts for flood inundation through wave overtopping and extreme sea water levels. In order to fully represent the deteriorating condition of the existing flood defences and predicted coastal erosion, breaches were included in the baseline scenario. The post-development scenario does not include breaches as the flood defences are assumed to be adequately designed and maintained for a 100 year design life.

The 2D tidal inundation model was first constructed in 2016 for the Outline Business Case which considered the 2017 and 2117 climate change epochs. The Outline Business Case was reviewed and approved by Welsh Government in May 2017. Versions of this model have been utilised throughout the project lifetime from Outline Business Case to Final Design. Throughout the project lifetime, a number of updates have been undertaken to the model, the full details of which are contained within the associated model reports, contained in Appendix C. Most notably the model was updated in 2020 where the baseline scenario and climate change allowances were updated to the 2019 and 2119 scenarios respectively. The results of this modelling have been used to assess the present and future flood risk to and from the development. Full details of the hydraulic modelling undertaken, and any changes, are contained within the associated model reports, contained in Appendix C.

Model results have not been updated to 2021 due to the significant additional work that this would require for a negligible change.

5.2 Baseline flood risk

In the baseline scenario widespread flooding is predicted across Cardiff. Predicted flood depths for all design events are presented below.

Table 5-1 presents the number of properties affected by flooding during each of the design events. Up to 416 and 948 properties are affected in the present day 0.5% and 0.1% AEP events, respectively. This equates to £13,800,000 and £28,466,000 of damages for the same events, as detailed in Table 5-2.

During the 2119 0.5% and 0.15 AEP events, 2656 and 4758 properties are predicted to flood, respectively. This equates to damage totals of £127,099,000 during the 2119 0.5% AEP event, and £258,149,000 during the 0.1% AEP event.

Table 5-1 Properties affected

	Type	0.5%	0.1%
2019	Res	411	935
	Non-Res	5	13
	Total	416	948
2119	Res	2,656	4,758
	Non-Res	294	461
	Total	2,950	5,219

Table 5-2 Baseline Damages per modelled event

	Type	0.5% (£k)	0.1% (£k)
2019	Res	7,510	17,302
	Non-Res	6,290	11,164
	Total	13,800	28,466
2119	Res	64,039	129,522
	Non-Res	63,060	128,626
	Total	127,099	258,149

0.5% AEP Event (2019)

During the 2019 0.5% AEP event predicted flood depths within the development site boundary area generally exceed 1.2m. It should be noted that the development site boundary area is mostly confined to the Rhymney River channel.

In the wider Cardiff area, flood water is also mostly confined to the Rhymney River channel and associated functional floodplain, including Llanrumney sports fields where flood depths of up to 1.4m are predicted, small areas east of the A4232 where flood depths of up to 2.4m are predicted and Parc Tredelerch where flood depths of up to 0.85m are predicted.

Widespread flooding is predicted to the Tremorfa area of Cardiff, west of the Rhymney River, affecting a number of residential and commercial properties and Willows High School. Flood depths of over 1.2m are predicted to Pengam Moors and the Tesco retail unit on Rover Way. Across the residential area flood depths are generally predicted to be approximately 700mm, with maximum flood depths of 986mm predicted. At Willows High School, flood depths of up to 600mm are predicted.

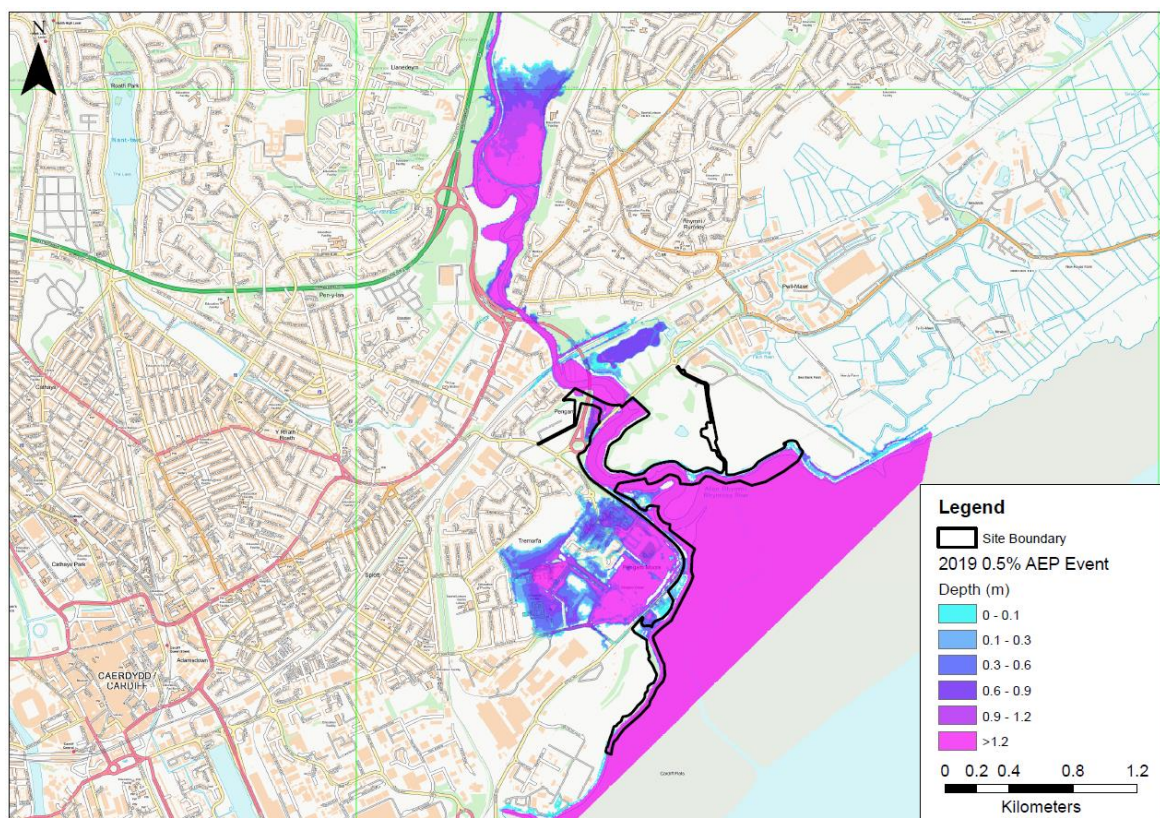


Figure 5-1 2019 0.5% AEP tidal flood event – flood depth

0.1% AEP Event (2019)

In the 2019 0.1% AEP event, the predicted flood extent is greater than that seen in the 2019 0.5% AEP event. During this event, predicted flood depths within the development site boundary area exceed 1.2m. It should be noted that the development site boundary area is mostly confined to the Rhymney River channel.

In the wider Cardiff area, Llanrumney sports fields is predicted to flood to depths of up to 2.5m, marginally encroaching onto the grounds of Ysgol Gymraeg Bro Eirwg, although the school building itself is predicted to remain flood free. Small areas east of the A4232 are predicted to flood to depths of up to 2.8m are predicted and Parc Tredelerch where flood depths of up to 2.2m are predicted within the lakes.

East of the A4232 and B4487, a number of residential properties along Dowlands Way are predicted to flood to depths generally exceeding 1.2m and a maximum flood depth of up to 1.97m. The flood extent also encroaches to residential properties along Brachdy Close and New Road with flood depths predicted of up to approximately 1.3m and 500mm, respectively. During this event, the railway line is also predicted to flood to depths of up to 600mm.

West of the A4232, large areas of Pengam are predicted to flood. Stargallot Community Garden is predicted to flood to depths exceeding 1.2m, and residential properties at Page Drive at predicted to flood to depths not exceeding 600mm. North of the railway line, a number of commercial properties in the Newport Road retail park area are predicted to flood to depths of up to 600mm.

Widespread flooding is predicted to the Tremorfa area of Cardiff, west of the Rhymney River, affecting a number of residential and commercial properties and Willows High School. Flood depths of over 1.2m are generally predicted across this area, with the flood extent reaching from the Rhymney River to north of Tweedsmuir Road.

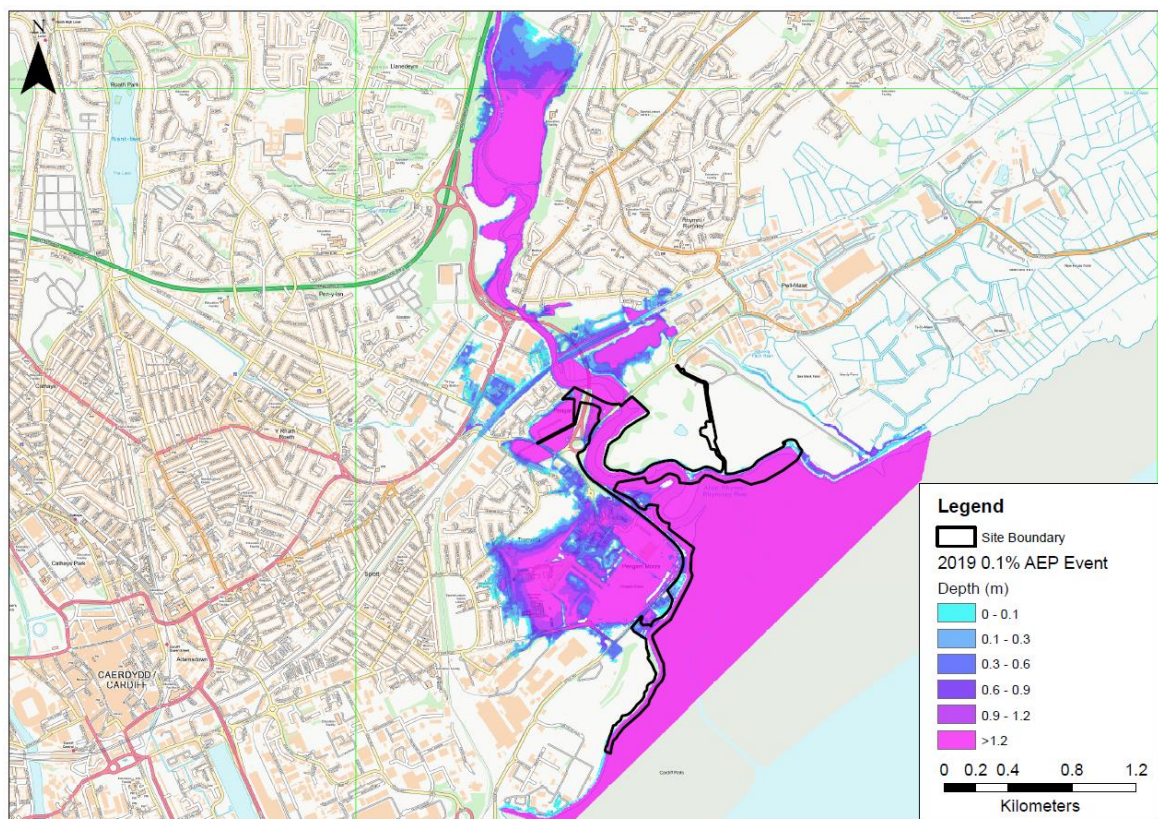


Figure 5-2 2019 0.1% AEP tidal flood event – flood depth

0.5% AEP Event (2119)

During the 2119 0.5% AEP event, flooding significantly increases across Eastern Cardiff compared to the 2019 design events. During this event, predicted flood depths within the development site boundary area exceed 1.2m. Although it should be noted that the development site boundary area is mostly confined to the Rhymney River channel.

Across Llanrumney Sports Fields the flood extent generally extends to residential properties at Mendip Road, with flood depths of up to 600mm predicted to these properties.

West of the A4232, the majority of commercial properties at the Newport Road Retail Park area are predicted to flood, with depths generally lower than 1m. However, there are isolated pockets where flood depths of up to 1.4m are predicted. South of the railway, a number of residential properties are predicted to flood to depths of up to 600mm.

East of the A4232, residential properties at Dowlands Way are predicted to flood to depths of up to 2.3m. At Brachdy Close, and New Road, flood depths of up to 400mm and 1.4m are predicted respectively.

During this event, the flood extent extends to the Pwll-Mawr area of eastern Cardiff, incorporating Capital Business Park and Wentlooge Corporate Park. This area is comprised of a series of reens which are predicted to flood to significant depths.

Widespread flooding is predicted to the Tremorfa area of Cardiff, west of the Rhymney River, affecting a number of residential and commercial properties and Willows High School. Flood depths of over 1.2m are generally predicted across this area, with the flood extent reaching from the Rhymney River to west of the railway to a number of residential properties in Splott and industrial properties in the East Moors area of Cardiff. To the west of the railway, flood depths of up to 1.5m are predicted.

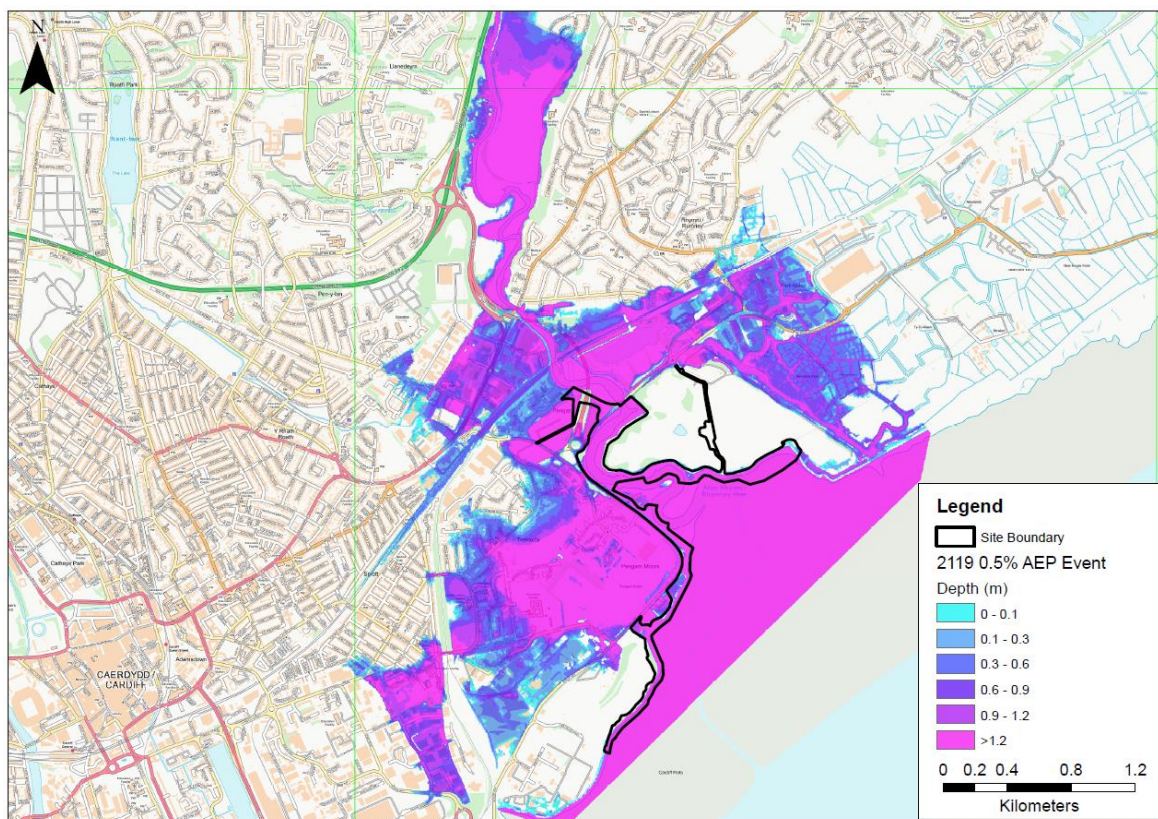


Figure 5-3 2119 0.5% AEP tidal flood event – flood depth

0.1% AEP Event (2119)

During the 2119 0.1% AEP event, the predicted flood extent remains largely unchanged east of the A4232, compared to the 2119 0.5% AEP event.

West of the A4232, the flood extent extends in a south-westerly direction. To the Splott and East Moors areas, the flood extent increases with more industrial and residential properties affected. Flood depths are generally predicted to exceed 1.2m.

In the Newport Road Retail Park area, the flood extent extends towards the north-west, with an increased number of residential properties affected, with depths of over 1.2m generally predicted.

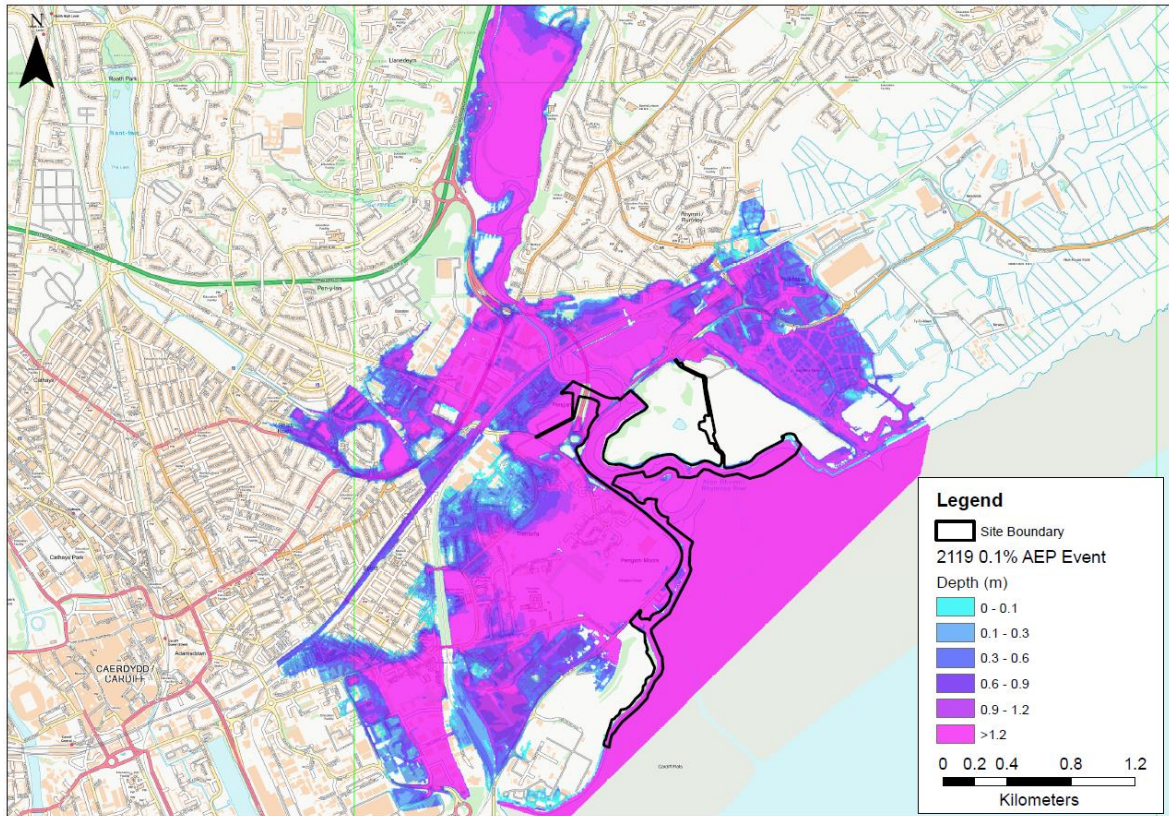


Figure 5-4 2119 0.1% AEP tidal flood event – flood depth

5.3 Post-development flood risk

The post-development scenario demonstrates that flood risk across Cardiff is significantly reduced as a result of the coastal defences.

The number of properties flooded, and the associated flood damages, are presented in Tables 5-3 and 5-4 below for the design events investigated. Overall, the number of properties experiencing flooding and the associated damages accrued are significantly reduced from the baseline scenario, as shown in Figure 5-9. This indicates that the proposed coastal defences offer substantial protection from flooding across the Cardiff area.

The proposed coastal defence is designed to mitigate the risk of tidal flooding to approximately 2,326 residential properties and 204 non-residential properties during the 2119 0.5% event. £70 million of Present Value damages are avoided as a result of the implementation of the scheme.

Table 5-3 Number of properties flooded for each modelled event during the post-development scenario

	Type	0.5%	0.1%
2019	Res	1	101
	Non-Res	1	4
	Total	2	105
2119	Res	330	2,859
	Non-Res	90	334
	Total	420	3,193

Table 5-4 Total damages incurred for each modelled event in the post-development scenario (£k)

	Type	0.5% (£k)	0.1% (£k)
2019	Res	1	981
	Non-Res	27	128
	Total	28	1,108
2119	Res	4,089	51,632
	Non-Res	28,500	79,040
	Total	32,590	130,672

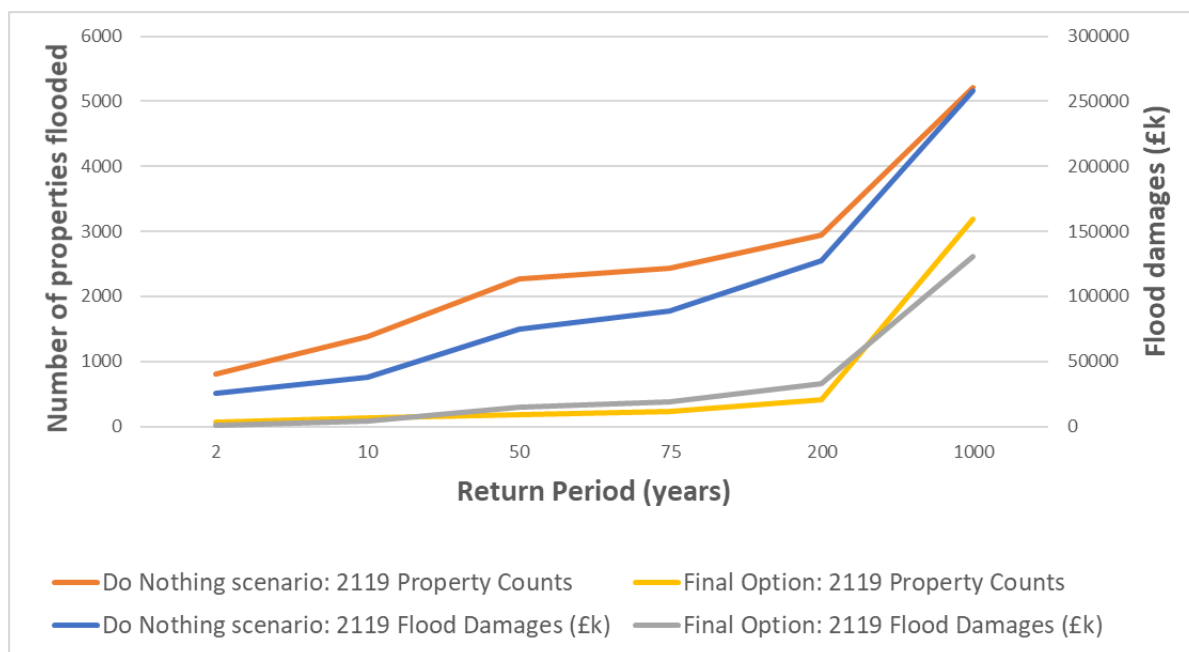


Figure 5-5 Total damages and number of properties flooded (2119), Do Nothing and Final Option scenarios

0.5% AEP Event (2019)

During the 2019 0.5% AEP event post-development scenario, predicted flood depths within the development site boundary area generally exceed 1.2m. Although, it should be noted that the development site boundary area is mostly confined to the Rhymney River channel.

The flood extent to the north of the railway line remains unchanged, with the predicted flood extent confined to the river channel and areas of functional floodplain at Llanrumney Sports Fields and Parc Tredelerch.

No areas to the east and west of the development site boundary area are predicted to flood in this event.

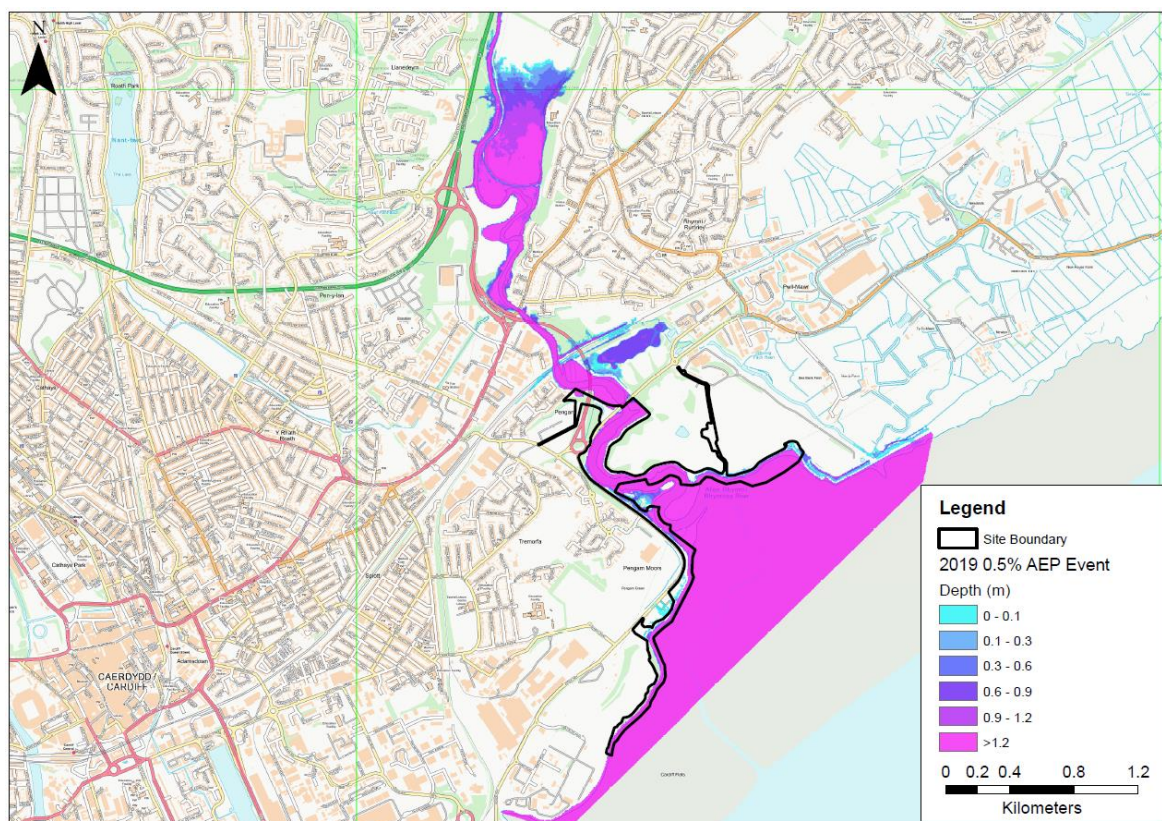


Figure 5-6 2019 0.5% AEP tidal flood event – flood depth

0.1% AEP Event (2019)

During the 2019 0.1% AEP event post-development scenario, predicted flood depths within the development site boundary area exceed 1.2m.

In the wider Cardiff area, north of the railway line, and to Parc Tredelerch, the flood extent remains unchanged compared to the baseline scenario.

South of the railway line and Parc Tredelerch, flooding is confined to the development site boundary area, and the areas of Pengam and Tremorfa are predicted to remain flood free.

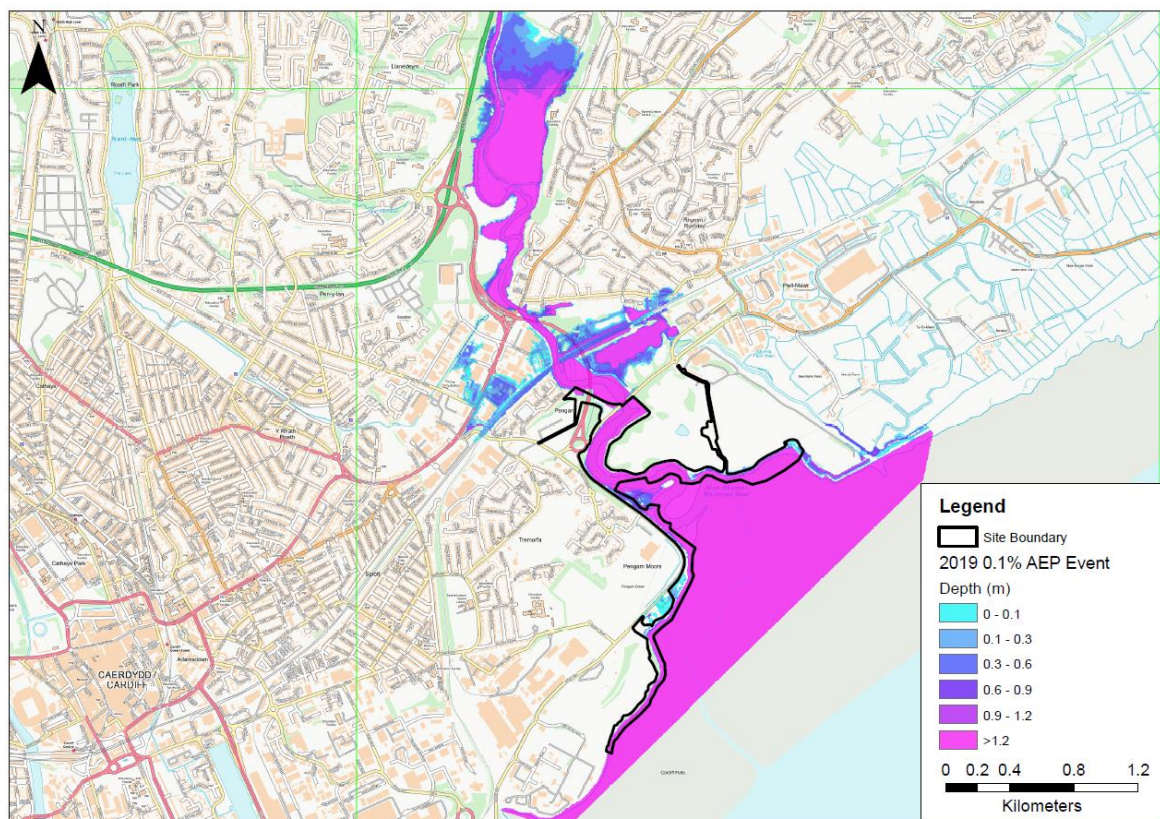


Figure 5-7 2019 0.1% AEP tidal flood event – flood depth

0.5% AEP Event (2119)

In the wider Cardiff area, north of the railway line, and to Parc Tredelerch, the flood extent largely remains unchanged compared to the baseline scenario. There is a small decrease to the flood extent to properties at Dominion Way and Ffordd Nowell, to the north-east of Newport Road Retail Park area, leaving a larger number of properties flood free during this event.

The predicted flood extent to the Pwll-Mawr area east of the Rhymney River is also predicted to remain unchanged.

South of the railway line and Parc Tredelerch, flooding is confined to the development site boundary area, and the areas of Pengam and Tremorfa are predicted to remain flood free.

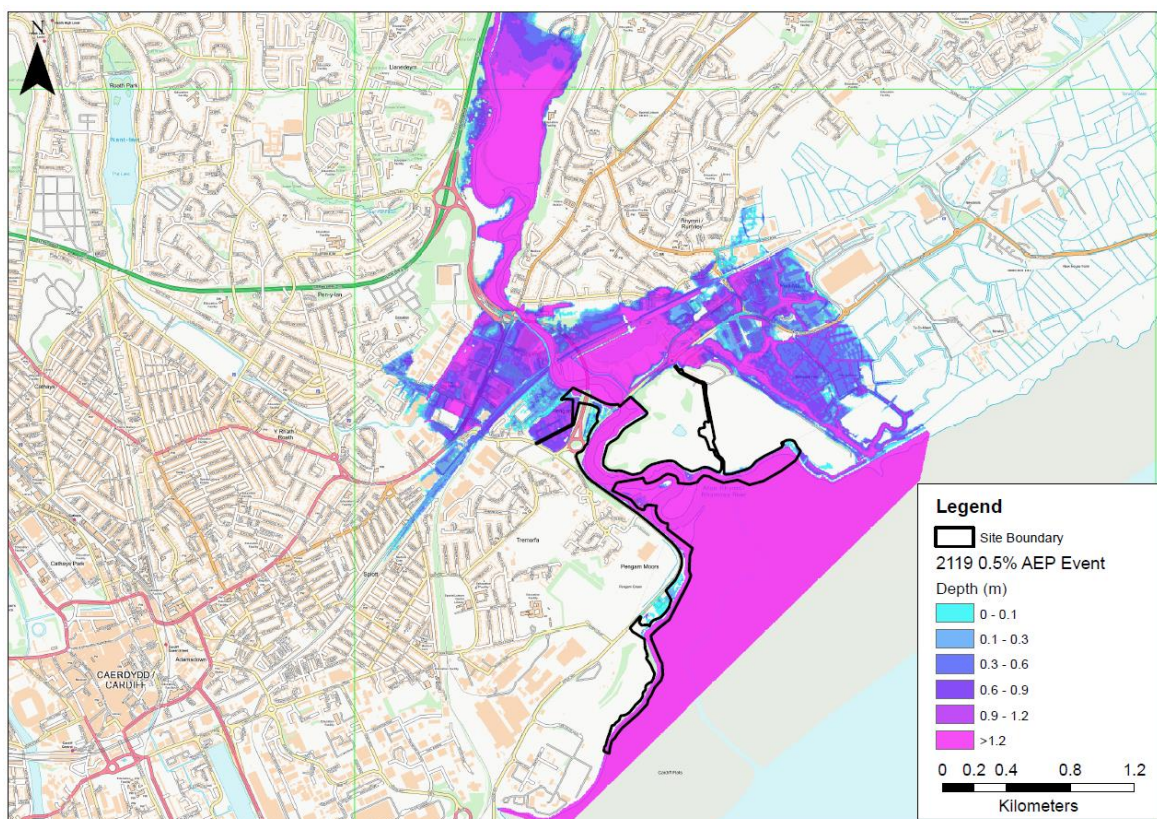


Figure 5-8 2119 0.5% AEP tidal flood event – flood depth

0.1% AEP Event (2119)

In the wider Cardiff area, north of the railway line, and to Parc Tredelerch, the flood extent largely remains unchanged compared to the baseline scenario. East of the development site, to the flood extent also remains largely unchanged across the Pwll-Mawr area. This area is comprised of a series of reens which are predicted to flood to significant depths.

North-west of the A4232, the Newport Road retail area is continued to be predicted to flood to significant depths of up to 1.7m. However, flood depths to residential and commercial properties in the Roath area of Trafalgar Road and Albany Road are predicted to flood to lower depths than those predicted during the baseline scenario.

West of the development site, the predicted flood extent is considerably reduced, with a large number of residential properties north of Tweedsmuir Road predicted to be flood free in the post-development scenario. A number of large industrial units north of Rover Way are also predicted to be flood free in the post-development scenario. Flood depths across Pengam Moors and Willow High School are predicted to be greater than 1.2m.

West of the railway line, the flood extent across Splott and East Moors is also considerably reduced compared to the baseline scenario, with the flood extent confined south of East Tyndell Street and east of Portmanmoor Road. Within this area, flood depths generally do not exceed 0.6m, with flood depths of up to 1.1m predicted at Moorland Primary School.

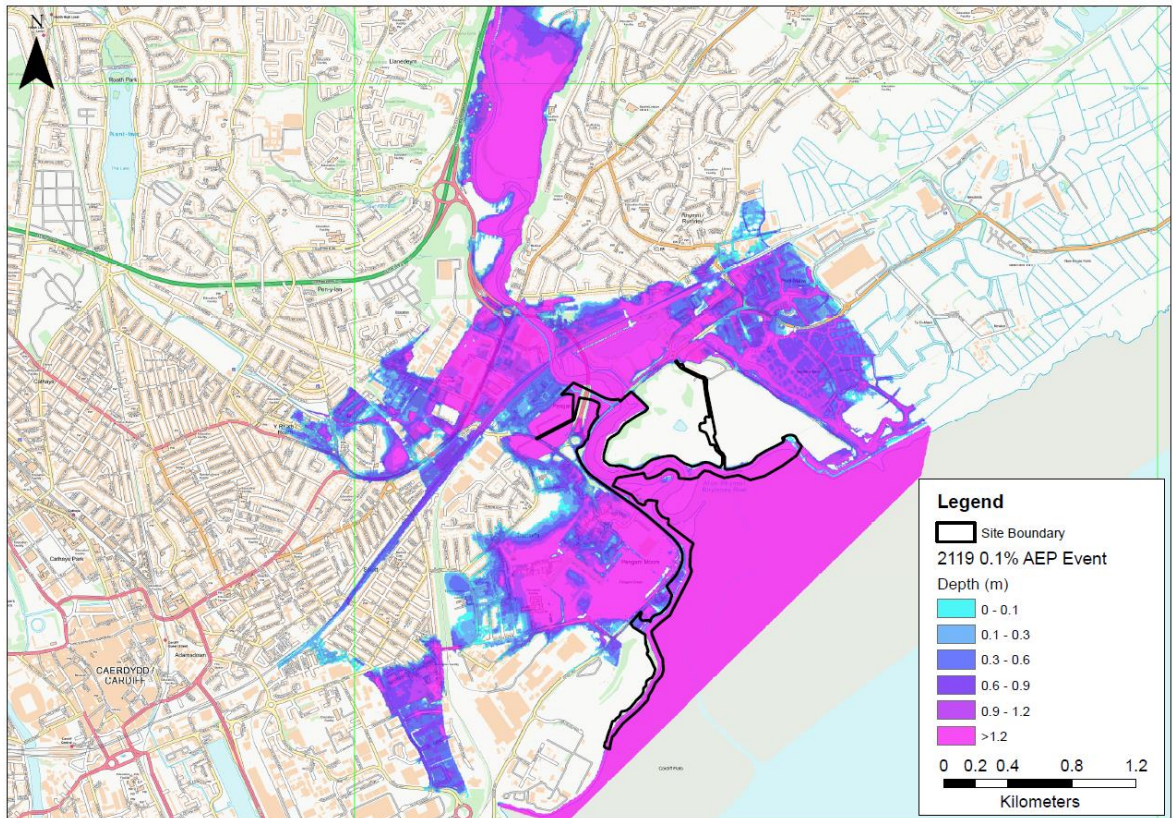


Figure 5-9 2119 0.1% AEP tidal flood event – flood depth

5.4 Third-party impacts

Section 7.3 of TAN-15 requires the demonstration that a proposed development will have minimal impact on flood risk generally (third parties). The construction of flood defences, whilst clearly for the benefit of the community, has the potential to disrupt flow paths, cause displacement of flood water, or a combination of both. Therefore, to assess this risk and determine the impact of predicted flood depths, comparisons of pre- and post-development water depths were undertaken in line with NRW guidance¹. This guidance requires the identification and consideration of any increases in flood depths greater than 5mm.

0.5% AEP Event (2019)

The implementation of the coastal defence scheme results in a noticeable change in the predicted flood extent for the 2019 0.5% AEP event, as shown in Figure 5-9. The proposed coastal defence results in a reduced flood extent, with no properties to the west of the development site predicted to flood in this event. The flood extent to the east and north of the site remains predominantly unchanged.

Figure 5-10 demonstrates the change in flood depth as a result of the proposed coastal defences. This demonstrates that during the 2019 0.5% AEP event, there is a predicted increase in flood depth within the site boundary as a result of the development. As the site boundary envelops the river channel, this increase in flood depth is considered acceptable.

Outside of the site boundary, areas of Cardiff are also shown to have an increase in flood depth as a result of the proposed defences. These relatively small areas are confined to the functional floodplain of the River Rhymney and consist of areas of public open space, including Parc Tredelerch where flood depths are predicted to increase by up to 6mm within the existing lake, and greenfield land between the Rhymney River Channel and the A4232 where flood depths are also predicted to increase by 6mm. Flood depths across Llanrumney sports fields are predicted to increase by 9mm.

¹ Modelling for Flood Consequences Guidance Note 028 November 2018: <https://cdn.naturalresources.wales/media/690050/gn-028-modelling-for-flood-consequence-assessments.pdf?mode=pad&rnd=132128585920000000>

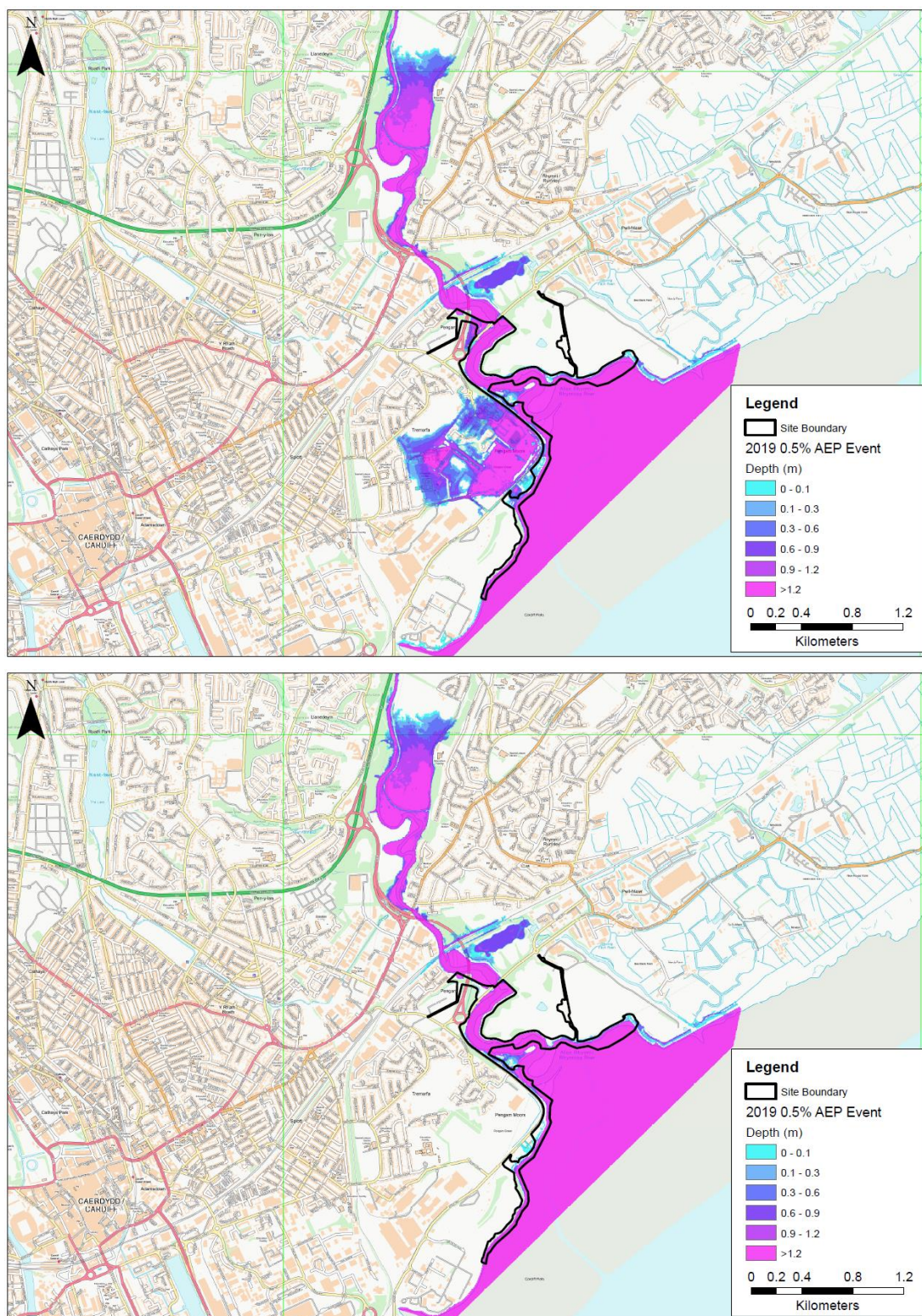


Figure 5-10 Comparison of flood extents for the 2019 0.5% AEP events

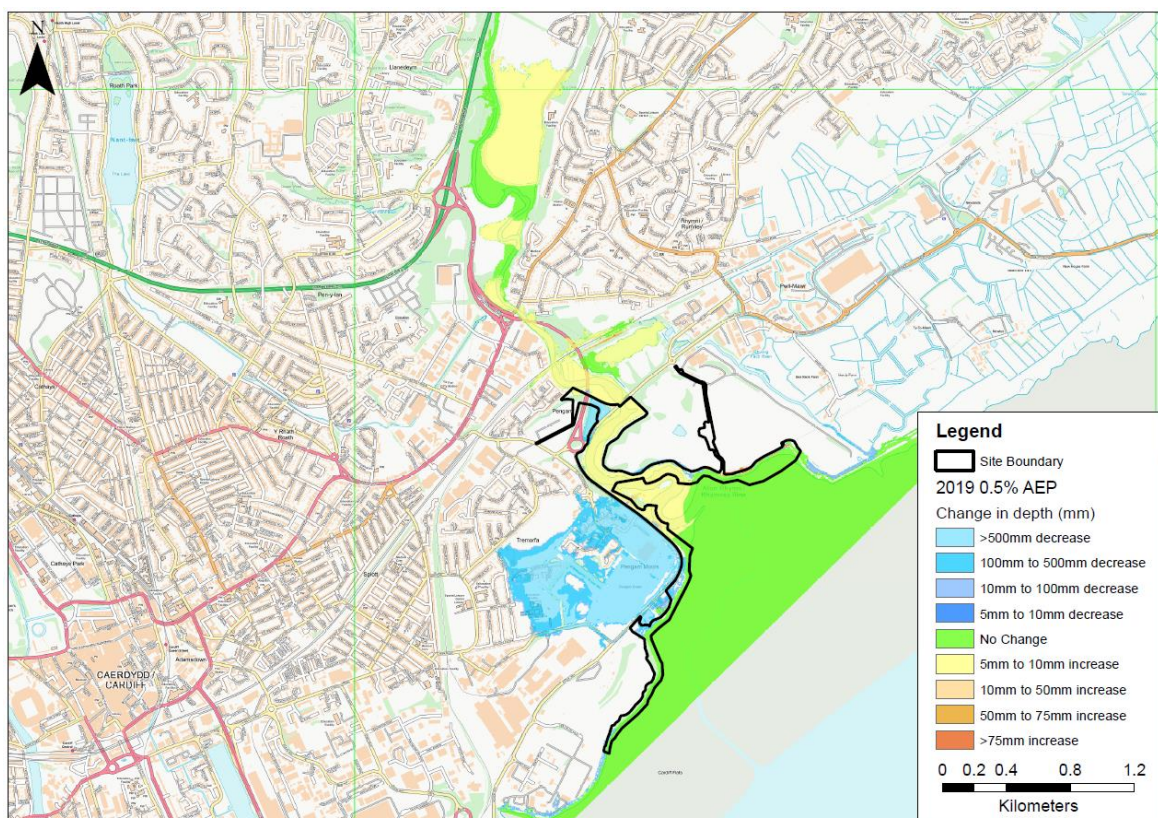


Figure 5-11 2019 0.5% AEP event - change in depth

0.1% AEP Event (2019)

As per the 2019 0.5% AEP event, the 2019 0.1% AEP event results in a significant change to the flood extent and frequency across the wider Cardiff area, as shown in Figure 5-11. The proposed coastal defence results in a reduced flood extent with properties across the Tremorfa area of Cardiff, west of the site boundary, predicted to be flood-free in the post-development scenario. The flood extent to the north and east of the site boundary remains unchanged in this event.

Figure 5-12 demonstrates the change in flood depth as a result of the proposed coastal defences. This demonstrates that during the 2019 0.1% AEP event, there is a predicted increase in flood depth to within the site boundary as a result of the development. As the site boundary envelops the river channel, this increase in flood depth is considered acceptable.

Outside of the site boundary, areas of Cardiff are also shown to have an increase in flood depth as a result of the proposed defences. These relatively small areas are mainly confined to the functional floodplain of the River Rhymney and constitute areas of public open space and greenfield land, including Llanrumney sports fields where flood depths are predicted to increase by 11mm and greenfield land between the Rhymney River Channel and the A4232 where flood depths are also predicted to increase by 15mm. Flood depths at Parc Tredelerch are predicted to increase by up to 62mm.

A small number of properties are also predicted to experience an increase in flood depth as a result of the proposed coastal defences. This includes residential properties at Dowlands Way, Brachdy Close, New Road and Mendip Road where flood depths are predicted to increase by 19mm, 8mm, 23mm and 8mm respectively. 1 property in the New Road area is predicted to experience an increase in flood depth of up to 53mm. Commercial properties at Newport Road retail park are predicted to experience an increase of flood depth of up to 10mm, with one property predicted to experience an increase of flood depth of up to 32mm.

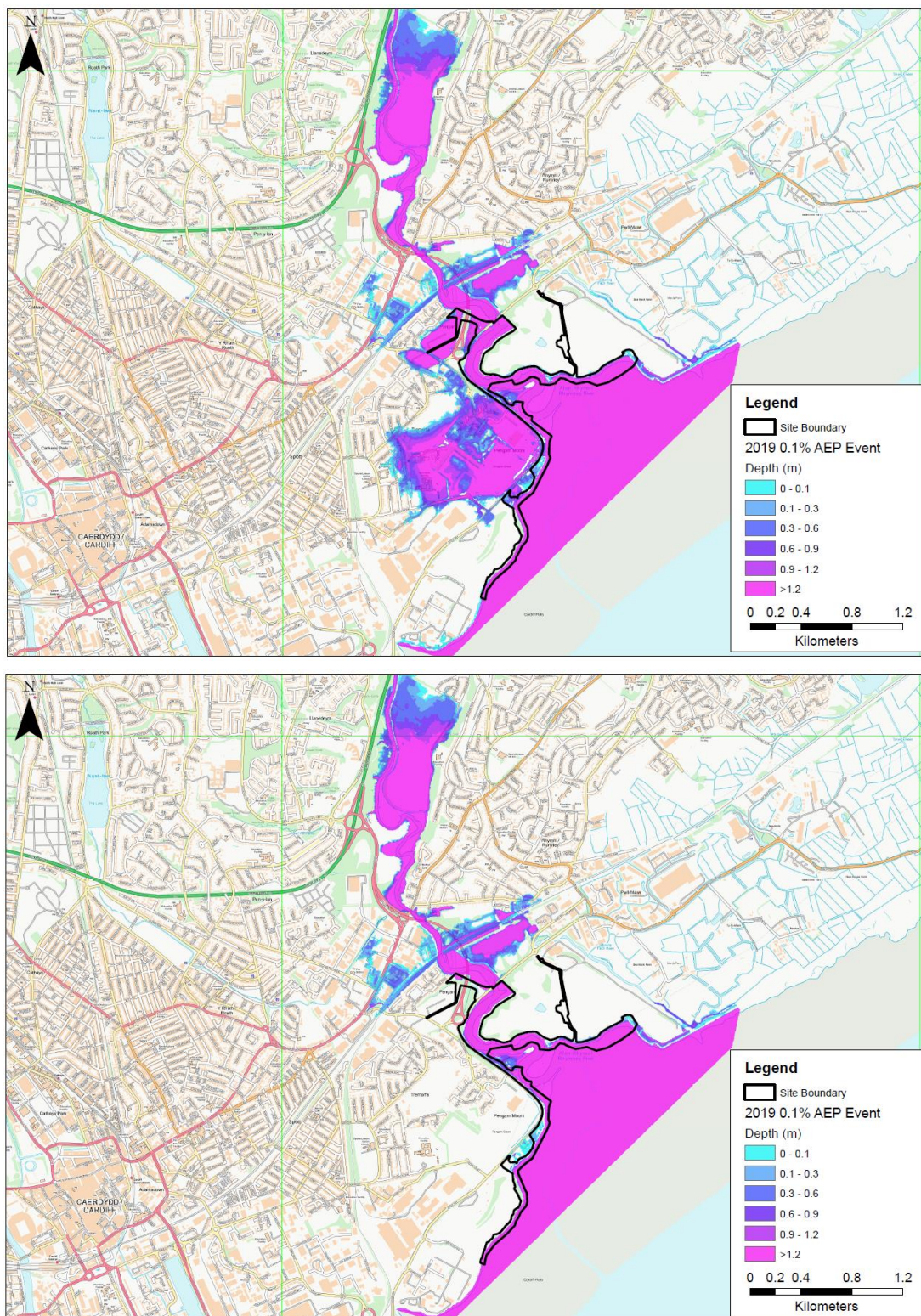


Figure 5-12 Comparison of flood extents for the 2019 0.1% AEP events

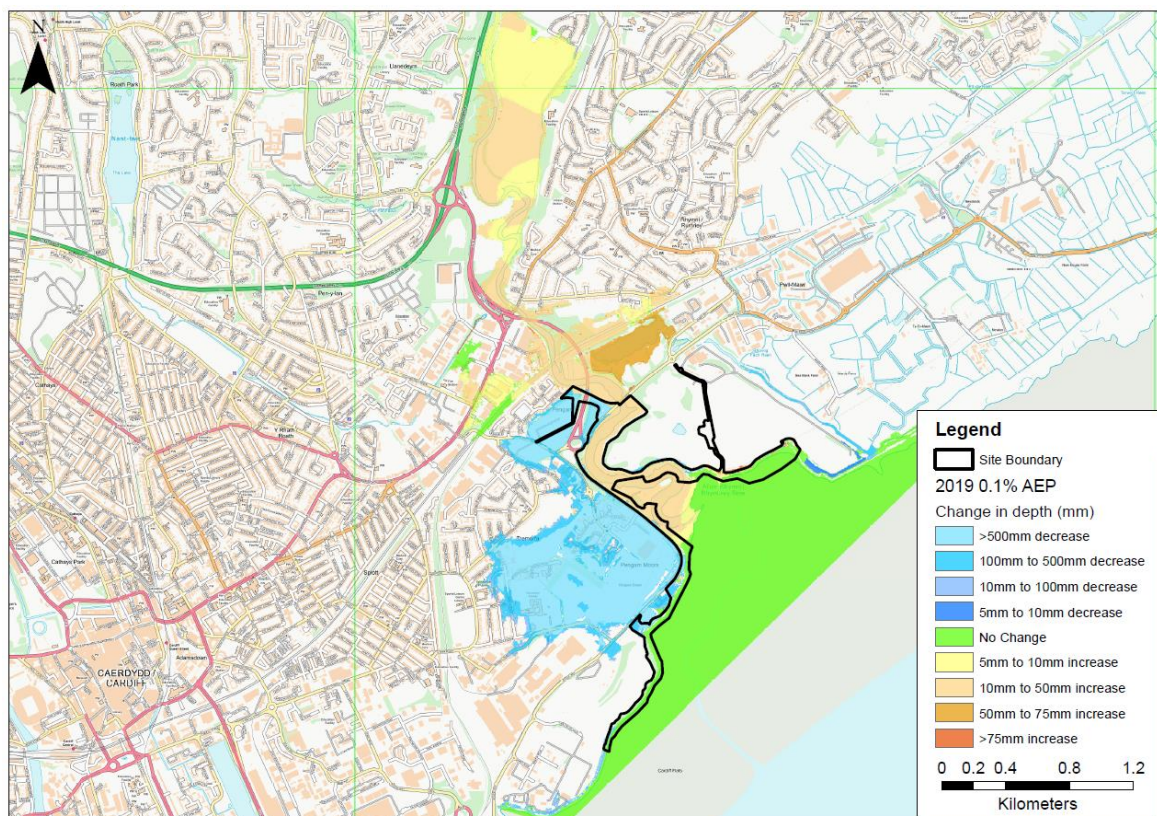


Figure 5-13 2019 0.1% AEP event - change in depth

0.5% AEP Event (2119)

The flood outlines produced for the post-development scenario demonstrate an appreciable change to the flood extent for the 2119 0.5% AEP event, as shown in Figure 5-13. The proposed coastal defence results in a reduced flood extent west of the River Rhymney with no residential, commercial or industrial properties south of the railway predicted to flood in

this event. There is no change to the flood extent to the north of the railway line or the east of the development site between the baseline and post-development scenarios.

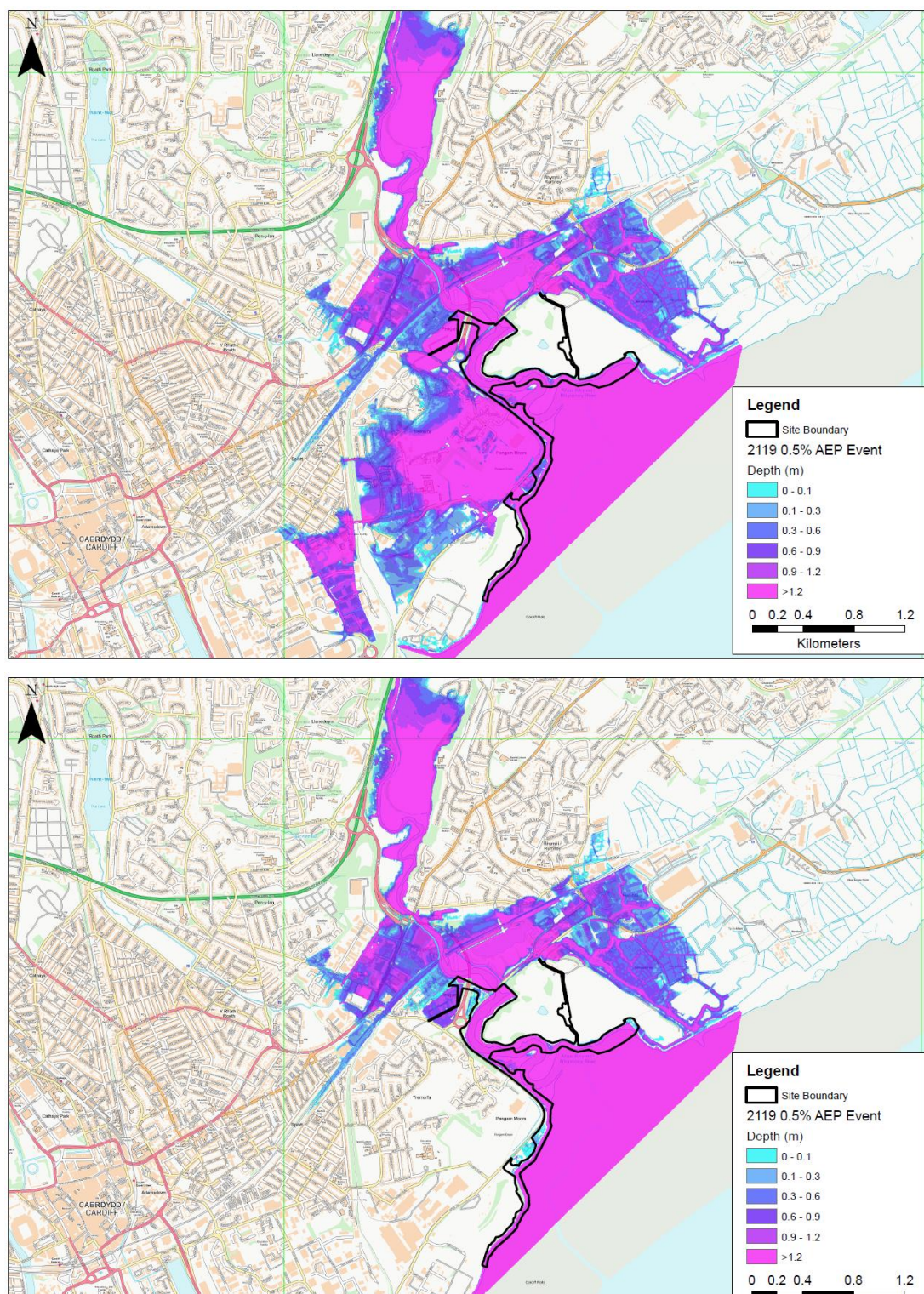


Figure 5-14 Comparison of flood extents for the 2119 0.5% AEP events

Figure 5-14 indicates the change in flood depths across the flood extent for the post-development scenario and demonstrates that as a result of the coastal defence scheme there is a significant reduction in flood depth across the majority of the flood extent.

There is a small area of slightly increased flood depth within the site boundary. As the development site development site encompasses the River Rhymney channel, this increase in flood depth is not considered to impact on third parties and is considered an acceptable consequence for the scheme.

There is no change in predicted flood depth across Llanrumney sports fields, whilst predicted flood depths to the Pwll-Mawr area are predicted to decrease by up to 39mm. At Parc Tredelerch, flood depths are predicted to decrease by up to 51mm, and the flood depth across residential properties at Brachdy Close and New Road are predicted to decrease by up to 46mm. At Dowlands Way, flood depths are predicted to decrease by up to 8mm.

At Newport Road retail park, flood depths are predicted to decrease by up to 73mm.

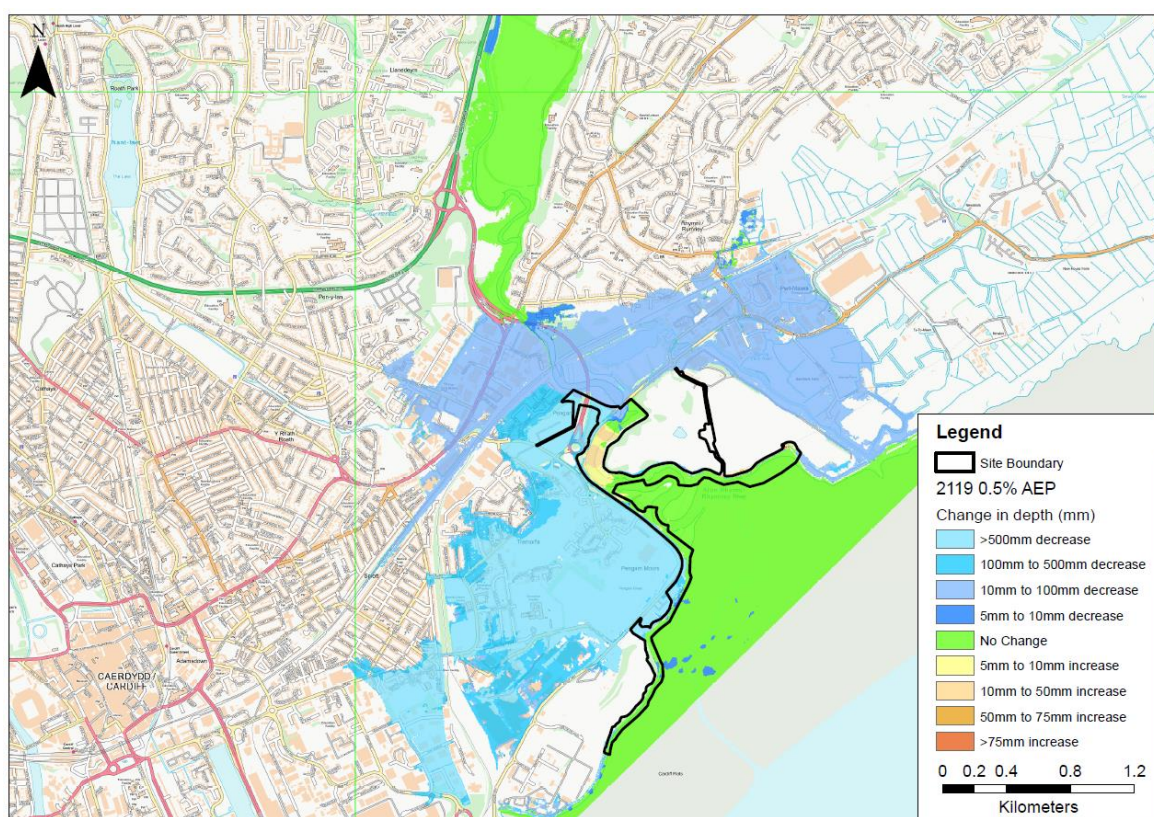


Figure 5-15 2119 0.5% AEP event - change in depth

0.1% AEP Event (2119)

The flood outlines produced for the post-development scenario demonstrate an appreciable change to the flood extent for the 2119 0.1% AEP event, as shown in Figure 5-15. A number of industrial units north of Rover Way, residential properties north of Tweedsmuir Road, and commercial and residential properties in Splott and East Moors are predicted to be flood free as a result of the proposed coastal defences.

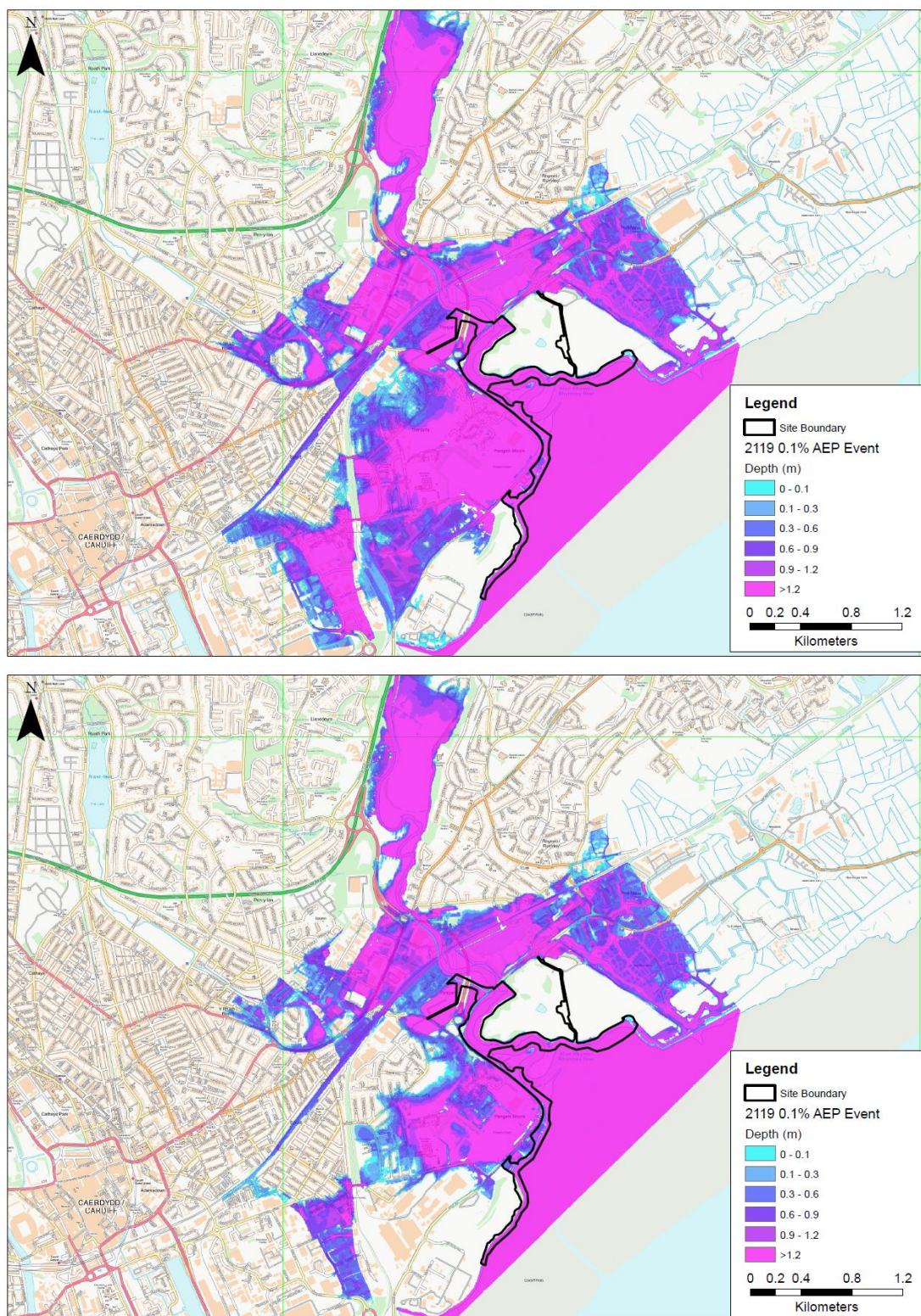


Figure 5-16 Comparison of flood extents for the 2119 0.5% AEP events

Whilst significant flood depths are still predicted in the post-development scenario to the Pwll-Mawr, Llanrumney Sports Field and Newport Road retail park area, a comparison of predicted flood depths, contained in Figure 5-16, demonstrates a predicted reduction of flood depths across the flood extent. Across the Tremorfa area, flood depths are predicted to reduce by up to 0.95m. Across the Newport Road retail park, flood depths are predicted to

decrease by up to 180mm, whilst residential and commercial properties in Roath are predicted to have a reduction in flood depth of up to 420mm. Across Parc Tredelerch, flood depths are predicted to decrease by up to 100mm, with residential properties at Dowlands Way and Brachdy Close predicted to have a decrease in flood level of up to 75mm and 100mm respectively.

Across the Pwll-Mawr area, flood depths are predicted to decrease by up to 52mm. Across Llanrumney Sports fields and the residential properties at Mendip Close, flood depths are predicted to decrease by up to 75mm.

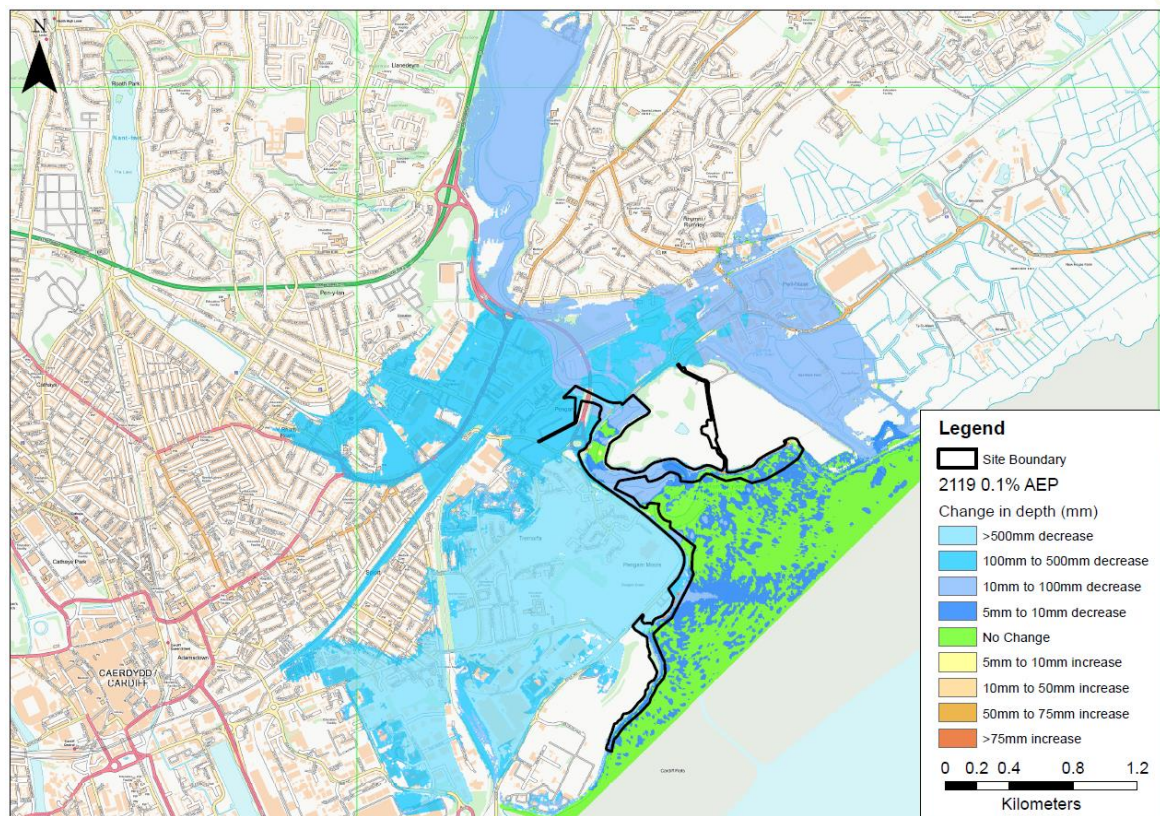


Figure 5-17 2119 0.1% AEP event - change in depth

5.4.1 Consideration of third-party impacts

Sections 5.3 and 5.4 demonstrate the clear positive impact that the proposed coastal defence shall have on the existing communities across Cardiff. As a result of the proposals, the present day predicted flood extent is retained behind the proposed coastal defences, mitigating the risk of flooding to all properties in the Tremorfa area of Cardiff. In the 2119 scenario, the flood extent beyond the coastal defences is significantly reduced, and flood depths to those properties still affected are significantly lower.

However, as a result of the proposed coastal defences, the model results demonstrate that there is a small degree of detriment in both the 2019 0.5% AEP event, and 2019 0.1% AEP events. No detriment is predicted during the 2119 0.5% and 0.1% AEP events.

Reasons for detriment

Following identification of detriment, the model data was analysed to assess the flood routes and identify the processes leading to the detriment. In this way adaptations to the scheme could be investigated with the aim of avoiding or reducing detriment, whilst continuing to provide flood risk benefits.

Network Rail's mainline railway crosses the study area from east to west. With the proposed scheme in place, the railway line forms a weak point in the defence as it lies at a lower level than the proposed defence heights for a 0.5% AEP standard of protection. 1 metre DTM resolution LiDAR indicates that the railway line adjacent to Windsor Village sits at around 8.1m AOD, while the surrounding land in this location is approximately 8.8m AOD. The railway line therefore acts as a flow route to convey floodwater towards the industrial units located along Newport Road to the west of the River Rhymney and also towards Dowlands Way. Due to the complexities and limitations involved in undertaking works to the railway line, it is not a feasible option at this time to include works to the railway as part of this local authority coastal risk management scheme. As such, the railway remains the weak point in the current and proposed line of defence.

During the design, development investigation of the model results indicated that a key cause of the detriment was the raising of the embankment on the left bank at Parc Tredelerch to the 0.5% AEP water level in 100 years. The increased defence height in this location prevented water entering the floodplain at Parc Tredelerch with water instead flowing westwards along the low point of the railway line increasing flood risk to residential and commercial properties in the Newport Road area. To minimise the risk of detriment, analysis was undertaken to understand the risk of flooding should the embankment not be fully raised until required in 50 years time. This change to the design mitigated the risk of detriment to properties in the Newport Road retail park area and reduced the detriment seen in both of the 2019 design events. As a result, the scheme was modified, and the scheme put forward within this FCA does not include the raising of the embankment at Parc Tredelerch, for the purpose of managing detriment to third parties.

Benefits Provided vs Detriment Caused

The proposed coastal defence is designed to mitigate the risk of tidal flooding to approximately 2,326 residential properties and 204 non-residential properties during the 2119 0.5% event. Table 5-1 demonstrates the number of properties at risk during the post-development scenario, compared to the baseline. £70 million of Present Value damages are avoided as a result of the implementation of the scheme.

Table 5-5 Table of properties at risk during the 2019 and 2119 0.5% AEP and 0.1% AEP events (number in brackets is change from baseline)

Property Type	2019 AEP 0.5%	2019 AEP 0.1%	2119 AEP 0.5%	2119 AEP 0.1%
Residential	1 (441)	101 (935)	330 (2,656)	2,859 (4,758)
Commercial	1 (5)	4 (13)	90 (294)	334 (461)

In the 2019 0.5% AEP event, there is an overall reduction in the number of properties at risk of flooding, whilst areas that are predicted to experience an increase in flood depth as a result of the development are confined to areas of public open space and greenfield land. Flood depths in these areas are predicted to increase by 6-9mm. Given the small increase in flood depth to these areas of functional floodplain, the increase in risk in the 2019 0.5% AEP event is considered negligible.

In the 2019 0.1% AEP event, whilst there is an overall reduction in the number of properties at risk of flooding, some properties remain at risk, and a small number of properties suffer increased flooding in this extreme event. Table 5-2 provides the number of properties predicted to experience detriment as a result of the proposed defences during the 2019 0.1% AEP event.

A property level assessment of detriment has been undertaken to identify properties predicted to be at detriment. The areas predicted to experience detriment includes 4 properties which did not previously flood. However, the depth of flooding in the 2019 0.1% AEP event is only around the curtilage of the property, which results in there being no increase in the number of properties that flood internally as a result of the proposals. All other properties predicted to experience an increase in flood depth during this event, are also predicted to flood during the baseline scenario. It is worth noting, that none of these properties are predicted to experience an increase in flood risk during the climate change scenarios.

Table 5-6 Number of properties affected by the proposed coastal defences against increase of depth predicted.

Increased Flooding Depth	Number of properties affected
>50mm	1
40-50mm	0
30-40mm	1
20-30mm	25
10-20mm	45
5-10mm	49
Total:	121

It is therefore concluded that the proposed coastal defences create significant betterment in protecting properties during high-risk flood events and that is of overwhelming public interest compared to the very low levels of detriment predicted to be experienced by a very small number of properties. Furthermore, it is worth noting, that there is no detriment to third parties as a result of the proposed coastal defences during the 2119 0.5% AEP and 0.1% AEP events.

Detriment and Flood Risk Management

We have taken a risk-based approach to flooding, betterment and detriment to assess the viability of the flood risk management scheme, in accordance with the provisions of the Water Resources Act 1991 (as amended by the Flood and Water Management Act 2010) and NRW guidance.

TAN-15 states in Section 7.3 that development must have 'minimal impact of the proposed development on flood risk generally'. Appendix 1 of TAN15 provides additional guidance on assessing flooding consequences. Section A1.12 states that development should result in 'no flooding elsewhere'.

Although the current TAN15 is clear that development should not negatively impact others, it is not clear on how this should be assessed and there is no guidance on the consideration of detriment and the limits to acceptability. In keeping with other potentially negative impacts of development (e.g. noise, visual, pollution), it is not always possible to have no impact. However, the significance of impacts should be carefully assessed to inform the application of planning balance as has taken place in the above assessment.

The draft update to TAN-15, which is currently being considered and is due to be implemented later in 2021, has also be reviewed to inform this assessment. The draft TAN-15 'Development, flooding and coastal erosion' was released for public consultation on 10th October 2019, with consultation closing on 17th January 2020. Although the draft planning policy carries no material weight for local planning development purposes, it is helpful in

clarifying Welsh Government's thinking on the development of new flood defences and their potential to impact negatively on the flood risk of others.

Sections 3.6 to 3.10 of the consultation version of TAN 15 sets out considerations for 'new or improved flood defence infrastructure'. Within this, sections 13.7 to 13.9 advise on the consideration of detriment, and includes the following key points:

"full and careful consideration of the benefits and detrimental impacts, both on and off site, must be undertaken when new or improved flood defence infrastructure is proposed.

Planning authorities should be satisfied the benefits to the protected areas clearly outweigh any negative effects elsewhere...

the provision of compensatory floodplain is an effective way of avoiding detrimental impacts elsewhere, but is not always a feasible option.

Increasing the risk or severity of flooding elsewhere may be acceptable where the impact is on undeveloped or unoccupied land...

Where flood defence infrastructure would lead to an increase in risk to residential properties already at risk of flooding the flood consequences assessment should inform the planning authority's decision. Planning authorities should carefully consider whether the increased risk under different flood scenarios is reasonable and tolerable"

It remains for the LPA to determine whether to approve schemes through the planning process based on the information provided within the FCA submitted as part of the application. This FCA aims to demonstrate that every effort has been made to minimise the impacts to third parties as a result of the proposals, along with a clear demonstration of the potential benefits of the scheme should it be constructed.

JBA as the design designers have thoroughly analysed the impacts arising elsewhere from the scheme and sought, where possible and practical to do so, to minimise detriment. Mitigation options have been considered and dismissed for various reasons. Some alterations have been carried through the final scheme, with a 50 year delay applied to the construction of some flood defence improvements to minimise potential detriment.

Entirely avoiding detriment in an urbanised flood risk location can be very difficult to achieve and consequently risk-based decisions have to be made. Other mitigation measures tested in the model were less effective at reducing flooding more generally or were found to be impractical. The railway remains a weak line in the defence due to its ground level compared to surrounding ground levels and it is not feasible at this time to construct additional defences to mitigate the detriment this facilitates.

Summary

When analysing the effect of the proposed coastal scheme for the lifetime of its construction on all third parties, it is considered that the benefits of the scheme to the wider community greatly outweigh the potential present-day detriment to a small number of properties.

6 Acceptability of the consequences

The development is not subject to the Justification Test due to its nature. However, it is still subject to the acceptability of consequences (acceptability criteria). Consequently, an assessment of flood risk has been carried out for the site and has been discussed in Sections 4 and 5. Table 6-1 below assesses the proposals against the acceptability criteria set out in TAN-15.

Table 6-1 Acceptability Criteria for TAN 15

TAN-15 Acceptability Criteria	Comments	Assessment
Flood defences must be shown by the developer to be structurally adequate particularly under extreme overtopping conditions (i.e. that flood with a probability of occurrence of 0.1%)	The proposed flood defences will mitigate the risk of flooding to a large number of properties across Cardiff up to the 0.1% 2119 climate change scenario	✓
The cost of future maintenance for all new/approved flood mitigation measures, including defences must be accepted by the developer and agreed with NRW.	The proposed flood defence scheme shall be maintained by Cardiff City Council as Lead Local Flood Authority to ensure no significant deterioration occurs and that adequate protection will be provided for the 100 year design life of the scheme.	✓
The developer must ensure that future occupiers of development are aware of the flooding risks and consequences	N/A - There are no occupants of the development and the development will take place largely within in the River Rhymney channel and along the open coast.	✓
Effective flood warnings are provided at the site	N/A - The proposed development is not a flood risk receptor and will take place largely within in the River Rhymney channel and long the open coast However, the site and surrounding areas along the Cardiff Coast and adjacent the River Rhymney are covered by the 'Coast from Aberthaw to Severn Bridge' flood alert area. The east bank of the River Rhymney and the area to the north of the mainline railway bridge is covered by	✓

	the 'Tidal Rhymney at Industrial Area near Rhymney Bridge, inc Roath' and the 'Coast at the Wentlooge Levels in the Cardiff Area' flood warning areas.	
Escape/evacuation routes are shown by the developer to be operational under all conditions	Given the nature of the site, escape/evacuation routes are not required.	N/A
Flood emergency plans and procedures produced by the developer must be in place	Given the nature of the development site, flood emergency plans shall not be required.	N/A
The development is designed by the developer to allow the occupier the facility for rapid movement of goods/possessions to areas away from the floodwaters	The rapid movement of goods and possessions will not be required given the nature of the development site.	✓
Development is designed to minimise structural damage during a flooding event and is flood proofed to enable it to be returned to its prime use quickly in the aftermath of the flood	The proposed flood defence will be built to withstand the velocities and potential damage from a coastal storm.	✓
No flooding elsewhere	The proposed development will have an overwhelmingly positive effect in reducing flood risk to a significant number of homes and properties. There is detriment which increases flood risk at a small number of properties during the 2019 0.1% AEP event, whilst all 2119 design events demonstrate a betterment across the flood extent. Detriment has been mitigated where practicable and will have an almost undetectable impact. .	✓
The development should be designed to be flood free during the 0.5% tidal flood	N/A - The nature of the proposed development as a coastal defence means that the red line boundary envelops the River Rhymney Channel.	N/A
The development should be designed so that in an extreme (1 in 1000 chance) event there	N/A - The nature of the proposed development as a coastal defence means that	N/A

would be less than 600mm of water on access roads and within the property	the red line boundary envelops the River Rhymney Channel.	
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7

Conclusions

- JBA Consulting (JBA) were commissioned by Cardiff Council to design a coastal defence scheme to improve and extend coastal and fluvial defences in an area of eastern Cardiff. The proposed coastal defence scheme is to be submitted for planning approval and this Flood Consequence Assessment has been prepared in support of the planning application as required by TAN15: Development and Flood Risk.
- The proposed coastal defences are located around the mouth of the Rhymney River, including the coastline along Rover Way, beginning at the eastern end of the privately owned Dŵr Cymru Welsh Water (DCWW) defences, extending along the coast and the western bank of the river as far as the railway line, approximately 1.3 km upstream. The proposed defence continues down the east bank of the river and along the coast around Lamby Way Landfill Site to the location of the recently constructed Natural Resources Wales (NRW) defences.
- The proposed development will provide increased flood protection for residents and critical infrastructure in the area and prevent further erosion of two landfill sites – the Lamby Way landfill site, operated and maintained by Cardiff Council, and the 'Frag Tip', an area of reclaimed land forming the coastline of the Severn Estuary to the west of the Rhymney River. The coastal defences are comprised of a combination of rock armour revetments, raising of existing embankments, sheet piling and scour protection.
- The proposed scheme will manage flood risk to 2576 residential and 204 non-residential properties over 100 years, as well as preventing erosion of landfill material, key rail/road infrastructure and the Rover Way Travellers site. £70 million of Present Value damages are avoided as a result of the implementation of the scheme.
- The proposed development site is located within Zone C2 of the Development Advice Map (DAM).
- The aim of the proposed engineering works is to provide flood mitigation to the wider Cardiff area. Therefore, the proposed works do not fall into any of three stated vulnerability categories within TAN-15. TAN-15 provides exceptions to these classes, where developments are required to be located in areas of flood risk, and therefore this FCA adopts the guidance of paragraph 5.3 of TAN-15. Consequently, the Justification Test has not been applied to the scheme, but the 'acceptability of consequences' have been thoroughly considered in line with TAN-15.
- The site has a low risk of flooding from fluvial, surface water, groundwater and reservoir sources
- Tidal flood risk has been identified as the most significant source of flood risk to the site, and to the wider area of Cardiff around the site. In order to assess the risk of tidal flooding JBA Consulting have undertaken extensive modelling of the area in support of the coastal defence project. The 2D tidal inundation model was first constructed in 2016 for the Outline Business Case which considered the 2017 and 2117 scenarios, among others, and has been utilised throughout the project lifetime from Outline Business Case to Final Design. The model was updated in 2020 where the baseline scenario and climate change allowances were updated to the 2019 and 2119 scenarios respectively.
- In the baseline scenario, large areas of Cardiff are predicted to flood to significant depths during all design events.

- In the post-development scenario, the present day predicted flood extent is retained behind the proposed coastal defences, mitigating the risk of flooding to all properties in the Tremorfa area of Cardiff.
- In the 2119 post-development scenario, the flood extent beyond the coastal defences is significantly reduced, and flood depths to those properties still affected are significantly lower.
- As a result of the proposed coastal defences, the model results demonstrate that there is a small degree of detriment in both the 2019 0.5% AEP event, and 2019 0.1% AEP events. In the 2019 0.5% AEP event, there is an overall reduction in the number of properties at risk of flooding, whilst areas that are predicted to experience an increase in flood depth as a result of the development are confined to areas of public open space and greenfield land. In the 2019 0.1% AEP event, whilst there is an overall reduction in the number of properties at risk of flooding, some properties remain at risk, and 121 properties suffer increased flooding in this extreme event. This is in contrast to the 950 properties defended from flooding during this event.
- No detriment is predicted during the 2119 0.5% and 0.1% AEP events.
- When analysing the effect of the proposed coastal scheme for the lifetime of its construction on all third parties, it is considered that the benefits of the scheme to the wider community greatly outweigh the potential present-day detriment to a small number of properties.
- It is therefore concluded that on the grounds of flood risk, the proposed development meets the principles and requirements set out in TAN-15 and Planning Policy Wales.

Appendix A – Topographic Survey

Appendix B – Geotechnical Report

Appendix C – Model User Reports

Offices at

Coleshill
Doncaster
Dublin
Edinburgh
Exeter
Haywards Heath
Isle of Man
Limerick
Newcastle upon Tyne
Newport
Peterborough
Saltaire
Skipton
Tadcaster
Thirsk
Wallingford
Warrington

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