AtkinsRéalis

Flood Consequences Assessment

Neath Port Talbot Council

April 2025

NE05_001-ATK-GEN-SWMWREC-RP-LW-000001

GRANDISON BROOK FLOOD ALLEVIATION SCHEME

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Contents

Figures

1. Introduction

1.1 Background

AtkinsRéalis has been commissioned by Neath Port Talbot Council (NPTC) to produce the detailed design for the proposed flood alleviation scheme to address flooding from the Grandison Brook in a residential area of Briton Ferry; the scheme is known as the Grandison Brook Flood Alleviation Scheme (herein referred to as 'the Scheme').

This report provides a Flood Consequences Assessment (FCA) for the Scheme which has been produced in accordance with Technical Advice Note 15 (TAN15)[1]. TAN15 relates to the siting and impact of new development and provides a framework within which flood risks can be assessed.

The Scheme is being designed to reduce flooding for the Pantyrheol, Cwrt Sart and Ynysymaerdy areas of Briton Ferry, Neath, Wales. The area has been subjected to periodic flooding over many years, resulting in internal flooding affecting residential and commercial properties. The cause of the flooding has been identified as the under-capacity of the Grandison Brook which is a culverted system for much of its length, forcing flows to the surface through surcharged culvert inlets and drainage connections. Overland flow paths develop as this water gravitates downhill, resulting in water collecting on the A474 before entering properties. The proposed scheme comprises modifications to an existing culvert inlet structure and an additional storm drainage culvert of minimum 1200mm diameter, thus increasing the overall capacity and reducing the risk of flooding to an expected 312 properties. At the lower end of the system box culverts are to be used to deal with the resulting increased flows. These culvert improvement works are proposed in combination with additional flood risk management solutions comprising an attenuation pond located in Jersey Park and a flood bund located in the northeast portion of the site.

1.2 Scheme Location

The Scheme is located entirely within the administrative boundary of NPTC. It is situated in the residential area of Briton Ferry, in Neath Port Talbot, which is approximately 8km northeast of Swansea and 3km south from Neath. Briton Ferry is centred around the A474 (Pantyrheol and Cwrt Sart) which acts as the district centre. The area is located east of the River Neath, which flows in a north-east to south-west direction.

As presented in Figure 1-2 the Scheme site area contains a large cemetery at Ynysymaerdy Road, the primary school Ysgol Carreg Hir and a number of recreational facilities including a park, a bowling green, rugby, cricket and football clubs, pitches and allotments. There is also undeveloped land within the site area at Penrhiwtyn which was formally industrial and is now classed as scrub land. Additionally, the site incorporates transport infrastructure, including the A474, and the South Wales mainline and freight railway lines. The southeast section of the proposed Scheme starts at an elevation of 64m AOD and as the Scheme runs northwest elevation falls to 6m AOD.

[1] https://www.gov.wales/sites/default/files/publications/2018-09/tan15-development-flood-risk.pdf

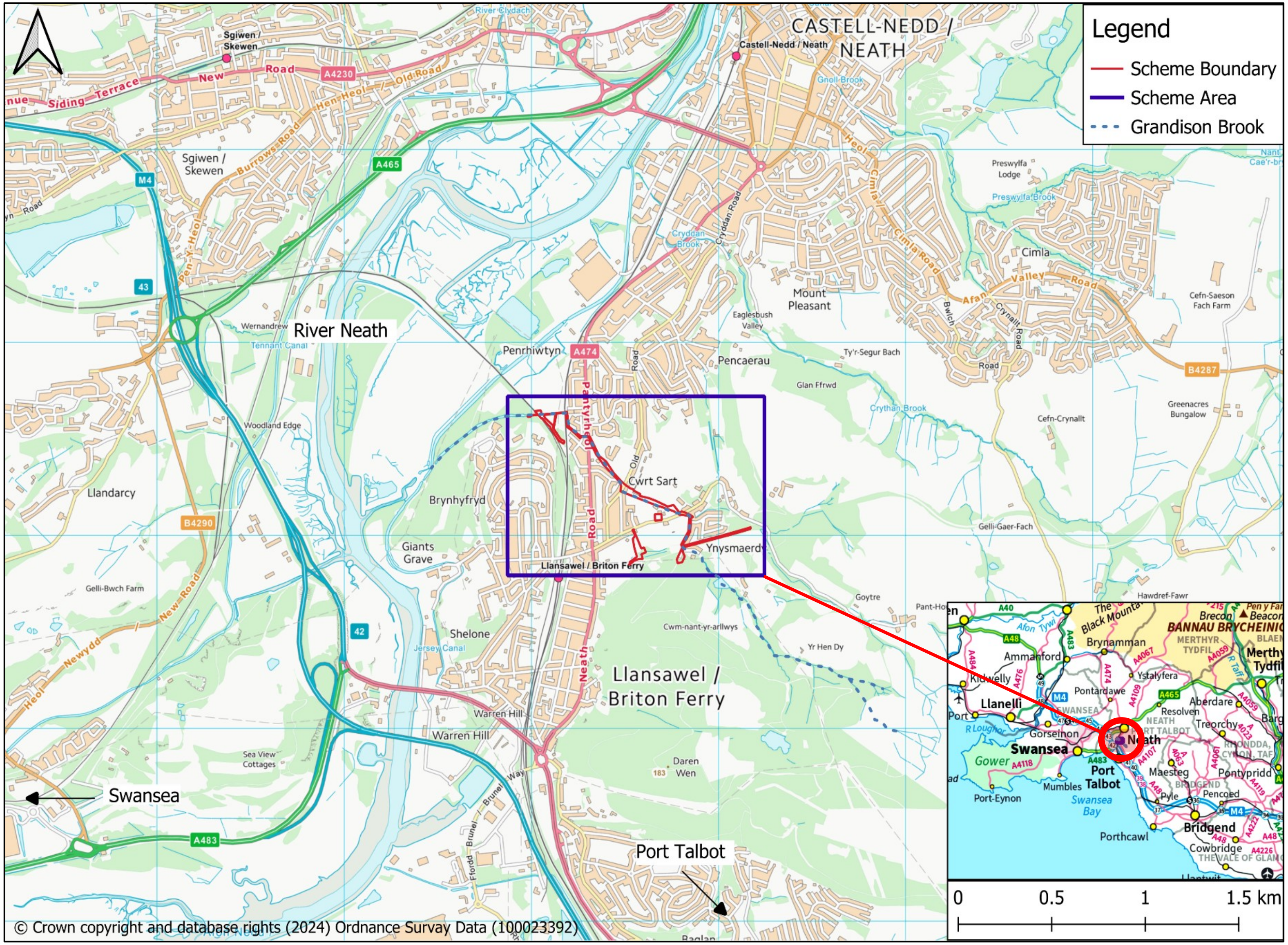

Figure 1-1 - Scheme Location Plan

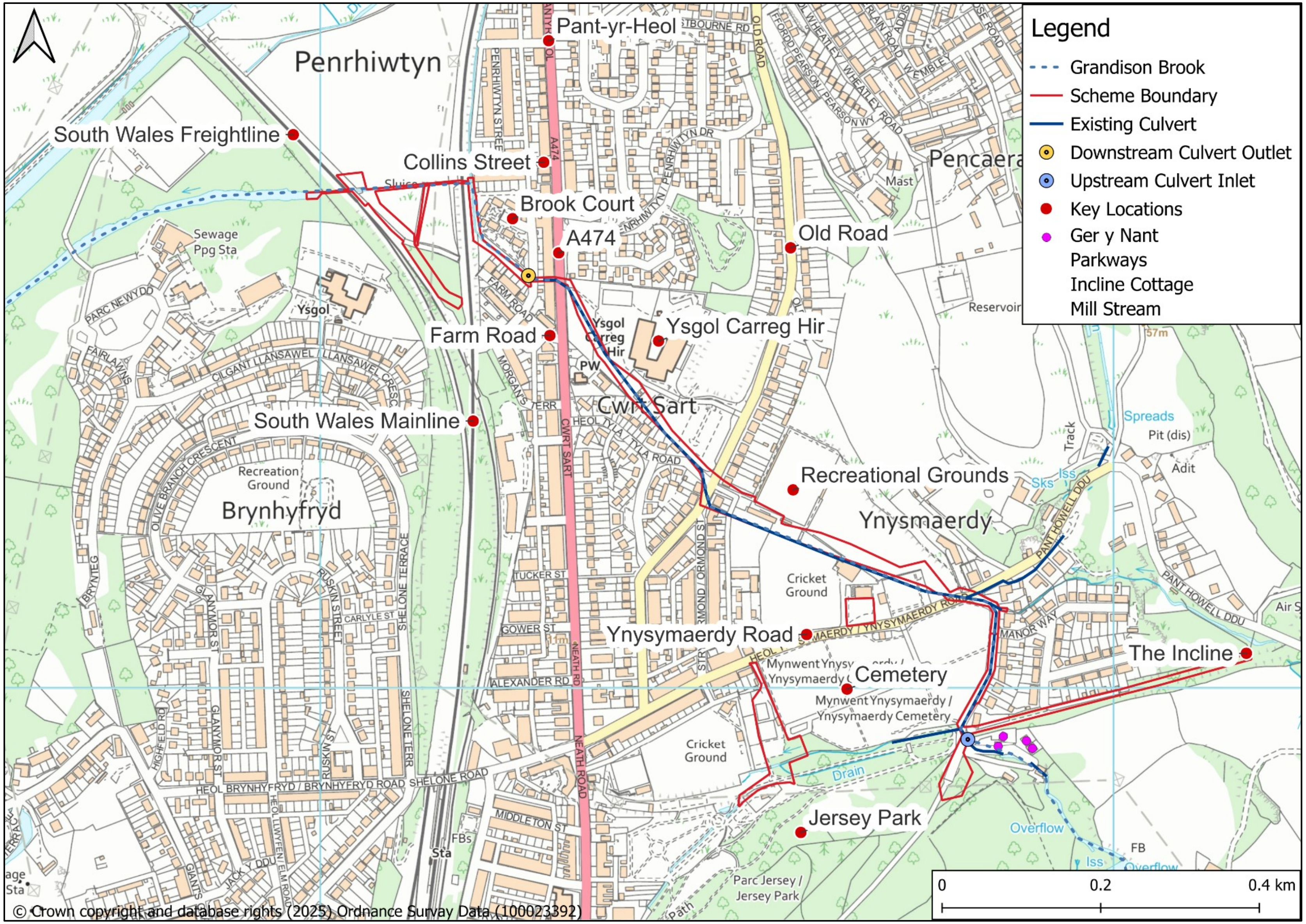

Figure 1-2 - Proposed Site Location

1.2.1 Grandison Brook

The watercourse of interest is the Grandison Brook which flows from its source at SS 75947 93993 down a steep valley side where it passes through semi natural woodland to the south of Ynysymaerdy Road. The watercourse is conveyed in an open channel before entering a culvert system at the inlet presented in Figure 1-2. The culvert has multiple diameter changes, ranging between 1.8m under the mainline railway at the scheme north-western extent and 375mm in diameter under the road at Ynysymaerdy as the schemes south-eastern extent. The existing culvert passes under the Ynysymaerdy Road, sports and recreational grounds, Old Road, school grounds, the A474 before returning to an open channel between residential properties at the downstream culvert outlet. The brook passes under the railway embankments in two existing culvert structures, returning downstream to a free open channel flow, and eventually it discharges to the River Neath approximately 1.1km further downstream. The scheme covers an approximate length of 1.5km of the watercourse.

1.3 Proposed Works

The Scheme is required to reduce flooding to properties along the Grandison Brook in Briton Ferry. The proposed works will take place along a length of 1.5km of the Grandison Brook. The works will comprise the installation of a new 1200mm minimum diameter culvert to run alongside the existing culvert between Ynysymaerdy Road and the A474 Pantyrheol Road where the two culverts will converge under the road. Moreover, the culvert will outfall downstream of the first railway crossing at Penrhiwtyn whilst retaining a length of open channel section adjacent to Brook Court to deal with local surface water connections. The culvert will outfall to an existing open channel that flows through land at Penrhiwtyn and then on towards the existing rail culvert under the south Wales freightline. A new flood defence bund will be constructed to mitigate increased flood levels that would otherwise present an increased risk to the railway lines. An overview of the proposed development is shown in Drawings No. NE05_001-ATK-GEN-SWMWREC-DR-CD-000001 and NE05_001-ATK-GEN-SWMWREC-DR-CD-000002 in Appendix A.

In detail the Scheme comprises of the following elements:

- Localised raising of the existing bank along the Rhodfa Clarke walk (the 'Incline') to 0.5m high. An additional bund will be constructed to offer protection to the four properties south of the Incline (Ger y Nant, Parkways, Incline Cottage and Mill Stream) which are located towards the upper end of Ynysymaerdy Road.

- A new flood defence bund with a crest level at 6.5mAOD immediately east of the freight railway line at Penrhiwtyn, centred at grid reference 274121, 195539, will be constructed to protect the rail line from increased flood levels during extreme storm events;
    - As part of the proposed flood defence at this location, a 27m long section of concrete retaining wall at varying height of approximately 1.25m will be constructed above an existing culvert parapet wall; these works will also include removal of silt and weeds from the existing ditch between the mainline and freight line railways, as well as the removal of small trees and scrub.

- Repairs will be undertaken to the existing culvert and will include:

    - Repairing the culvert section under the mainline railway line: to ensure it is watertight. Cleaning of the culvert to remove debris along its base and any vegetation on the walls or the soffit of the culvert are to be removed. Two-stage grouting is required to ensure that the culvert can deal with the pressures as a result of the with scheme proposals. Pointing of all joints in masonry is required as well as filling of any cracks and rebedding of any loose masonry.

  - Existing culvert between the A474 through to Ynysymaerdy Road: These sections of the existing culvert will be lined, and pressure covers with concrete jacket surrounds will be added to existing manholes to protect against surcharge pressures. Manholes on the new culvert will be of similar construction.

- A new 1750 x 1000mm box culvert will be constructed between the mainline railway and A474 Pantyrheol following the alignment of the existing brook between Brook Court and Farm Road. Land to the north of Farm Road will be raised slightly over the route of the culvert to ensure that the culvert is fully below ground surface. Due to this raising of land, gabion baskets will be required to support the earthworks alongside the existing watercourse, part of which will be retained. A concrete chamber will be constructed where the new box culvert connects to the existing brick arch culvert and will be around 2m above the existing ground. The culvert will outfall to the existing ditch and flow towards the freight railway line further to the west.

- Construction of a buried surface water storage tank below the play area within Jersey Park including a new inlet structure, pipe inlet and a new section of watercourse.

- Refurbish the existing inlet structure of Ynysymaerdy Brook on Ynysymaerdy Road, replacement of an existing galvanised steel trash and security screen contained within a concrete structure with a new screen.

- Excavate and remove the existing culvert at Ynysymaerdy Road between the inlet and the playing fields and replace it with a new section of box culvert of 1200mm square dimension.

- Excavate for installation of a new 1200mm diameter culvert in open trench across the playing fields, and through allotments behind the Llansawel AFC grounds to Old Road and then continuing through the school grounds towards the A474 Pantyrheol Road.

- At the A474 Pantyrheol Road the culvert will change form from the 1200mm diameter pipe to twin 1250 x 750mm culverts. The culvert route will continue from Pantyrheol, through the existing gap between the houses, and continue towards the railway crossing. Part of the existing section of open channel which runs along the railway embankment will become culverted.

- Flap valves will be installed on surface water connections to prevent any water surcharging out from the culvert during periods of flooding.

1.4 Objectives of the FCA

The objectives of this assessment are to:

- Set out the planning policy context in terms of flood risk.
- Demonstrate the baseline flood outlines and overland flow paths in the area of the proposed Scheme and the locality.
- Specifically assess the with-scheme risk and compare this with the baseline flood extents.
- Define the flood consequences for the scheme.

- Identify the flood risk to the proposed scheme itself and the consequences of the proposed scheme on the existing flood risk in the locality.
- Highlight any measures required to mitigate potentially adverse impacts on the existing baseline flood risk which would otherwise arise from the Scheme.

2. Planning Policy Guidance - Flooding

2.1 Background

The Scheme has been made possible by the funding made available by the National Strategy on Flood and Coastal Erosion Risk Management (FCERM) for Wales initiative which sets out to reduce the risk of flooding to homes and businesses providing benefits are demonstrated in line with the Welsh Government's FCERM Business Case Guidance.

TAN15 seeks to provide technical guidance to the Local Planning Authority relating to national policy on development and flooding. The document provides advice on the risk and consequence of flooding to a number of development categories. These include Emergency Services (hospitals, fire stations, police stations, etc), highly vulnerable development (residential premises, hotels, caravan parks etc) and less vulnerable development (industrial, commercial and retail sites).

The Scheme at Briton Ferry falls outside the above categories. It is a flood defence scheme which by its nature will need to be built within the flood risk zone to provide improved flood protection to the existing community of Briton Ferry.

It has been subject to a rigorous project justification process in which the economic benefits of the scheme are compared against the economic losses resulting from flooding. It has also been subject to an Ecological Impact Assessment (EcIA) to identify potential impacts which the Scheme proposal has on habitats, species and ecosystems.

The consequences of the Scheme to the town of Briton Ferry are set out below:

- The scheme significantly reduces the flood risk to the area. Properties which currently flood significantly in a 50% (1 in 2) AEP event will benefit from protection up to and including a 1% (1 in 100) AEP.

- It will reduce the extent of flooding which will reduce the risk to life to people who live within the town.

- The scheme does not result in any detriment to third party properties.

The Scheme has been designed to have no adverse consequences to the local community and the local environment. It follows the underlying principles of TAN15;

- Uses government resources to reduce flood risk to existing communities.

- Manages the consequences of flooding.

- Makes provision for the increase in flood risk predicted to arise as a result of climate change.

Without the Scheme, the area will suffer an increase in the frequency and extent of flooding. This report will demonstrate that there will be significant improvement to flood risk if the proposed scheme is constructed with a potential 312 properties benefitting as a result of the proposals during a 1% AEP flood event.

2.2 TAN15

TAN15[2] advises that new development is initially directed away from areas that are considered to be at high risk of flooding. Where development in a high-risk area is essential or strategically important, TAN15 (Section 6) outlines the justification test that must be satisfied to support a positive decision for a development.

Where development in a flood risk area can be justified, the consequences of flooding of that development must be assessed against criteria laid out in TAN15. The overall objective of the assessment is to identify if the consequences can be managed down to a level which is acceptable for the nature/type of development proposed; including its effects on existing development.

New TAN15 Guidance was released together with NRW's Flood Map for Planning (FMfP) in 2021 but was subsequently suspended from 1 December 2021 until Winter 2024-2025. In line with Welsh Government advice up until the 1st April 2025 the assessment for this scheme has been carried out in accordance with the existing TAN15 guidance published in 2004. As the New Version of TAN15 was released in April 2025, the FCA will be updated accordingly prior to submission of the Planning Application.

Section 4 of TAN15 outlines the use of Development Advice Maps (DAM) for when flood risk issues need to be taken into account in planning future development. These maps have not been updated by NRW since 2020 and so have been left out of this assessment due to being determined to provide out of date information. In development of the revised TAN15 the Welsh Government has released the supporting FMfP which represents the most comprehensive information known on flood risk and includes predicted climate change over the next century, unlike the DAM. Therefore, this FCA will use the information provided by the FMfP in preference over the DAM.

2.3 Vulnerability of Development and Justification Test

Section 5 of TAN15 lists three classes of development and their vulnerability to flooding, denoted Emergency Services, Highly Vulnerable Development, and Less Vulnerable Development. This section further outlines the exceptions to this rule, notably infrastructure which, by virtue of its nature, is required to be in a fluvial, tidal or coastal location. As the proposed works for this Scheme fall within this category they are not subject to the first part of the Justification Test as detailed in Section 6 of TAN15.

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[2] TAN15 2004 is referenced for this assessment. A new revised TAN15 was published, effective from 31st March 2025 when this FCA was already substantially complete. This FCA will updated in line with the new TAN15 2025 for the planning application.

3. Existing Flood Information

3.1 Fluvial Flood Risk

The NRW fluvial FMfP (see Figure 3-1 below) indicates that the fluvial risks to Briton Ferry are predominantly associated with the River Neath (to the north) and the Cryddan Brook (to the east). It should be noted that not all ordinary watercourses are included in the NRW mapping therefore not all potential fluvial flood sources are represented in the figure below. The NRW FMfP indicates that areas of Briton Ferry have more than a 1% (1 in 100) chance of flooding from rivers in a given year, including the effects of climate change over the next century.

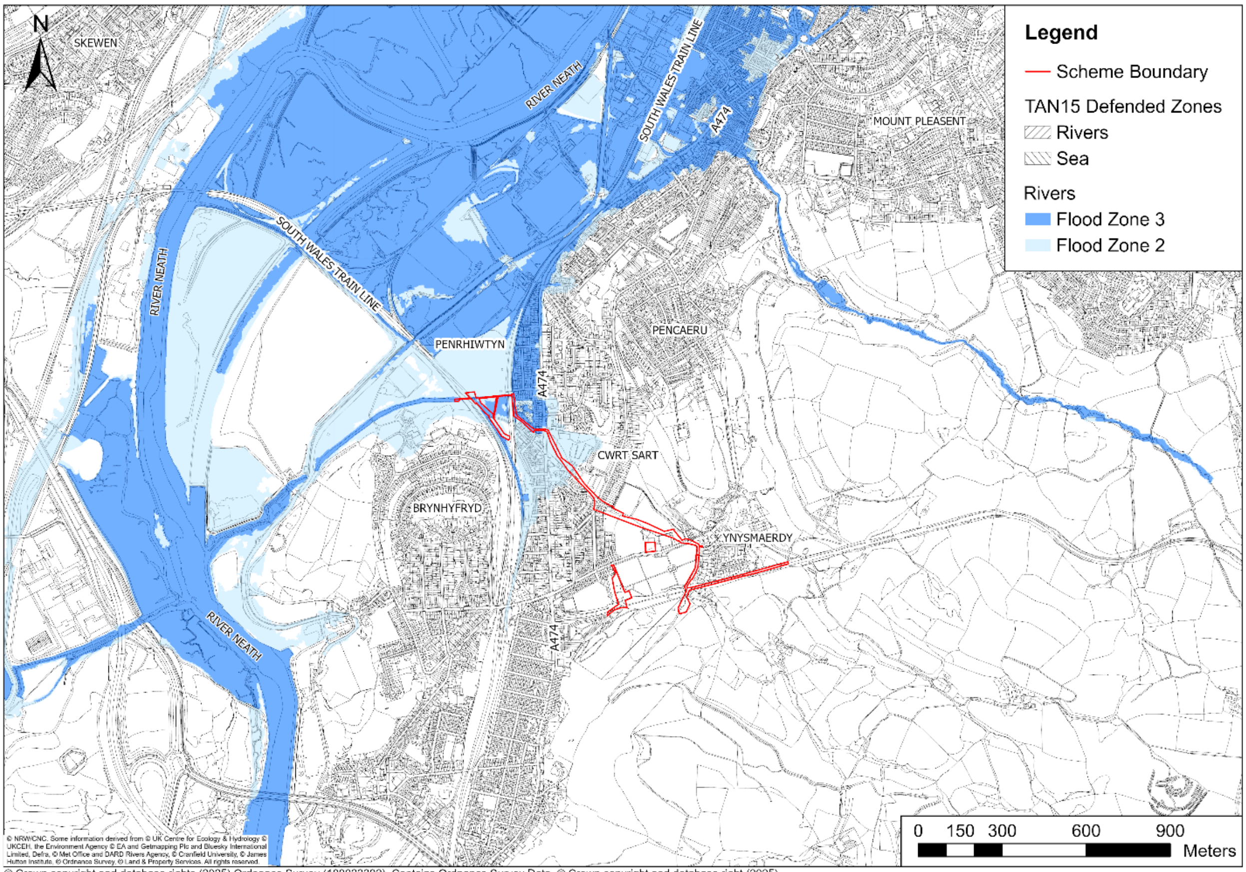

Figure 3-1 – Fluvial Flood Map for Planning for Briton Ferry

3.2 Surface Water and Small Watercourses Flood Risk

The NRW FMfP (shown in Fig**ure** 3**-**2 below) indicates that Briton Ferry is within an area with more than a 1% (1 in 100) chance of flooding from surface water and/or small watercourses in a given year, including the effects of climate change. The Grandison Brook is a source of flooding to a large area of Briton Ferry.

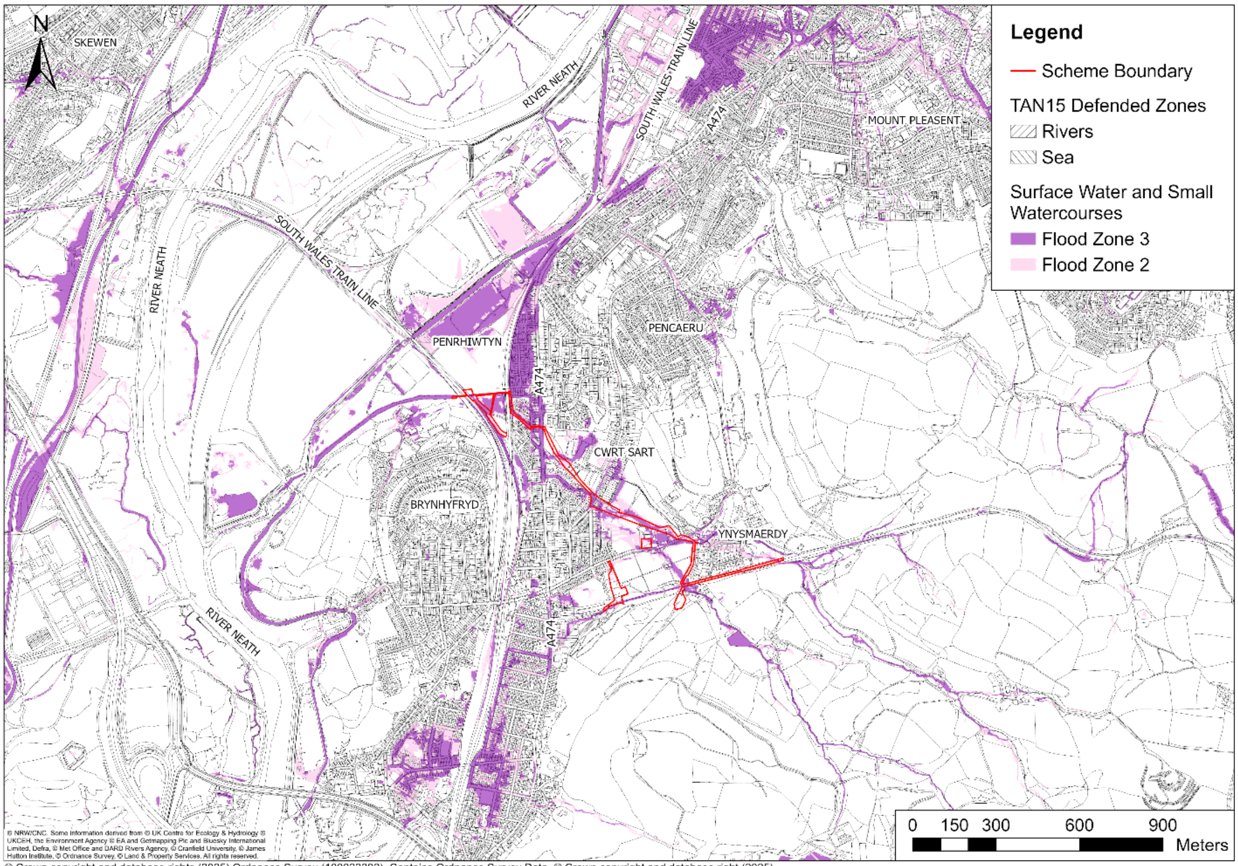

Figure 3-2 – Surface Water and Small Watercourses Flood Map for Planning for Briton Ferry

3.3 Tidal Flood Risk

The NRW FMfP (see Figure 3-3) indicates that Briton Ferry lies in an area with a chance of flooding from the sea greater than a 0.5% (1 in 200) in a given year, including the effects of climate change. This tidal risk is from the Neath estuary which is predicted to overtop the South Wales Mainline and inundate the low-lying areas of Briton Ferry.

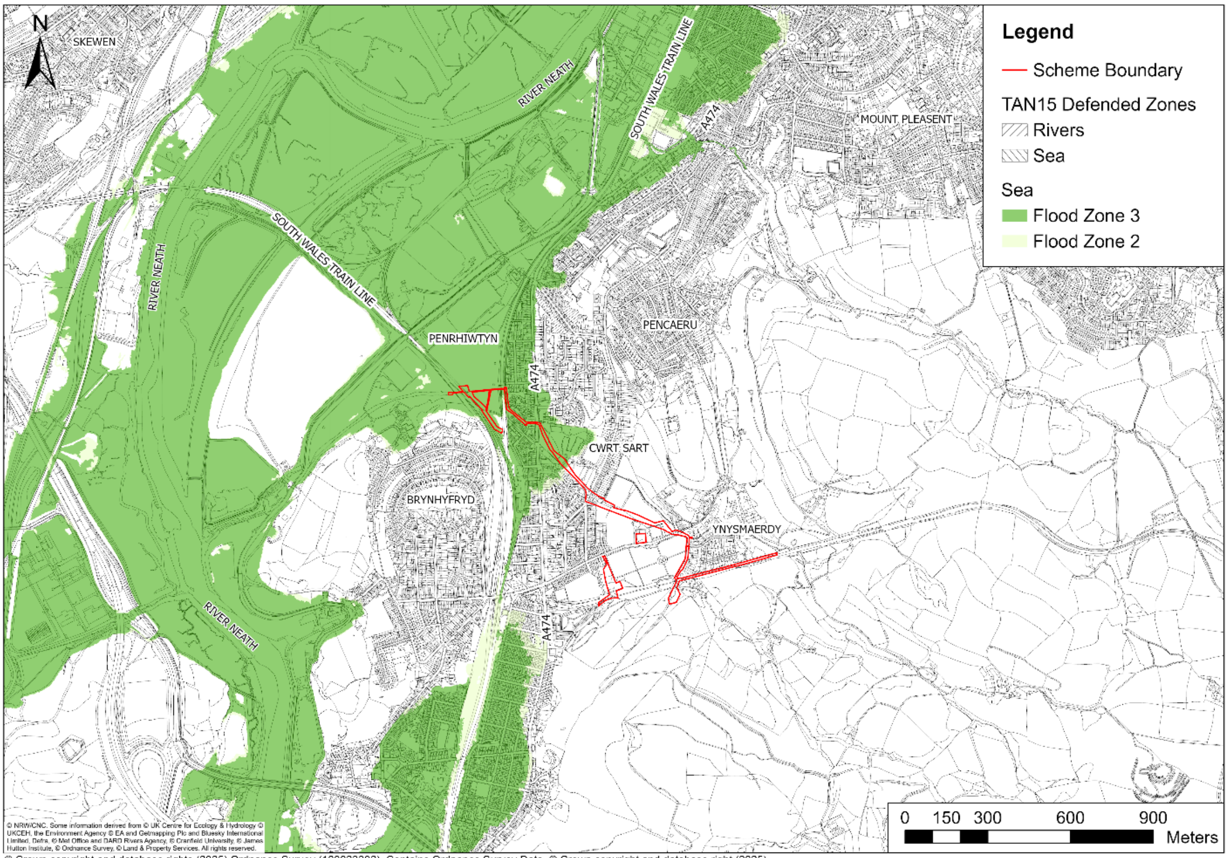

Figure 3-3 - Tidal Map for Planning for Briton Ferry

4. Flood Risk Assessment

4.1 Assessment of Fluvial Flood Risk

Fluvial modelling has been undertaken to assess the baseline flood risk impact and then to implement the scheme proposals so that the impacts of the proposed scheme could be fully understood.

4.1.1 Existing Information

A review indicated that the following hydraulic models were available to inform the study:

1. JBA TUFLOW model of the Grandison Brook. The model extends from where the Grandison Brook outfalls to the Neath estuary to upstream of Ynysmaerdy.
2. WSP TUFLOW model of the Cryddan Brook.

The JBA model has been used to inform the study with boundary conditions extracted from the WSP model as overland flow paths develop from the Cryddan Brook that contribute to flooding in the lower reaches of the Grandison Brook catchment.

The Grandison Brook model has been updated by AtkinsRéalis with additional topographic and drainage surveys at key locations as set out in the model report provided in Appendix B.

Boundary conditions for the hydraulic model have been updated with the fluvial boundaries based on the peak flows included in the hydrological calculation record provided in 0. The revised model was utilised to redefine the baseline risks. The model was then further updated to represent the proposed flood alleviation proposals to quantify the flood risk impacts of the Scheme.

4.1.2 Flood Events and Boundaries Tested

The following annual exceedance probabilities (AEP) have been tested in the model to inform the FCA:

- 1% AEP
- 1% AEP plus 30% climate change[3]
- 0.1% AEP

4.1.3 Hydraulic Modelling

The extent of the hydraulic model is shown in Figure 4-1 below:

[3] 30% increase on peak flows is the central estimate or change factor for the Western Wales River Basin District, as defined in Welsh Government advice on Climate Change Allowances for Planning (CL-03-16).

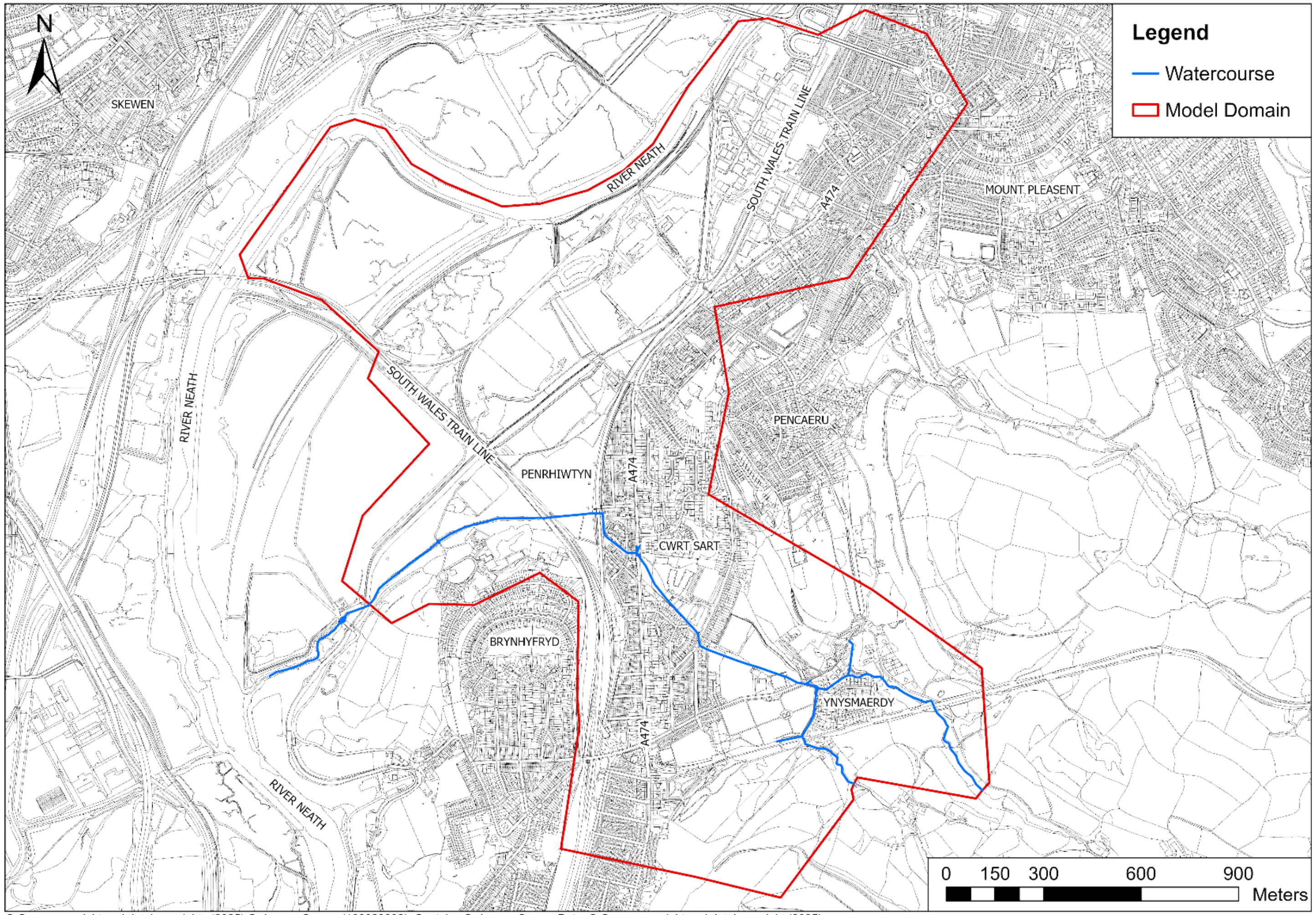

Figure 4-1 - Extent of hydraulic model

4.1.4 Hydrology

The hydrological inputs included in the existing hydraulic model were reviewed in order to ascertain if the estimates needed to be updated. The guidance[4] for undertaking hydrological assessments in Wales has been updated since the original model was developed by JBA. A copy of the hydrological calculation record is provided in 0.

5. Model Results and Flood Consequences

5.1 Fluvial Flood Risk

As described in 4.1.2 the model was run to test flood events for the (i) baseline (pre scheme) scenario and the (ii) proposed case with the alleviation scheme in place.

The results of the modelling for these two scenarios are described below for the three flood events tested. The consequences of the scheme are then described in Section 5.2.

1% (1 in 100) AEP flood event

The figures below compare the flood extents for the two scenarios which evidently shows that during a 1% (1 in 100) AEP event, there is a significant improvement as a result of the Scheme. Flows are contained and directed into the culverted system at Ynysymaerdy Road resulting in a significant reduction in the proposed flood extent during the 1% (1 in 100) AEP event.

The flooding that remains in the area around Pantyrheol immediately east of the South Wales Mainline in the proposed case originates from overland flow paths from the adjacent Cryddan Brook catchment (to the north). We understand a separate study into the risks associated with the flooding from the Cryddan Brook and to assess the business case to address these risks has been commissioned by NPTC; which may lead to a scheme to deal with this source of flooding.

A plot of the difference in the flood levels as a result of the Scheme compared to the baseline is presented in Figure 5-3 below. The results show that during a 1% AEP event, there is no negative impact/detriment to third party properties as a result of the proposed works. However, there are three areas (area between railway lines at Penrhiwtyn, along Ynysymaerdy Road and at the Incline where there is an increase in flood levels as a result of the proposals. No properties are adversely affected in these areas. This is discussed further in Section 5.2.

[4] NRW, GN 008 Flood estimation technical guidance

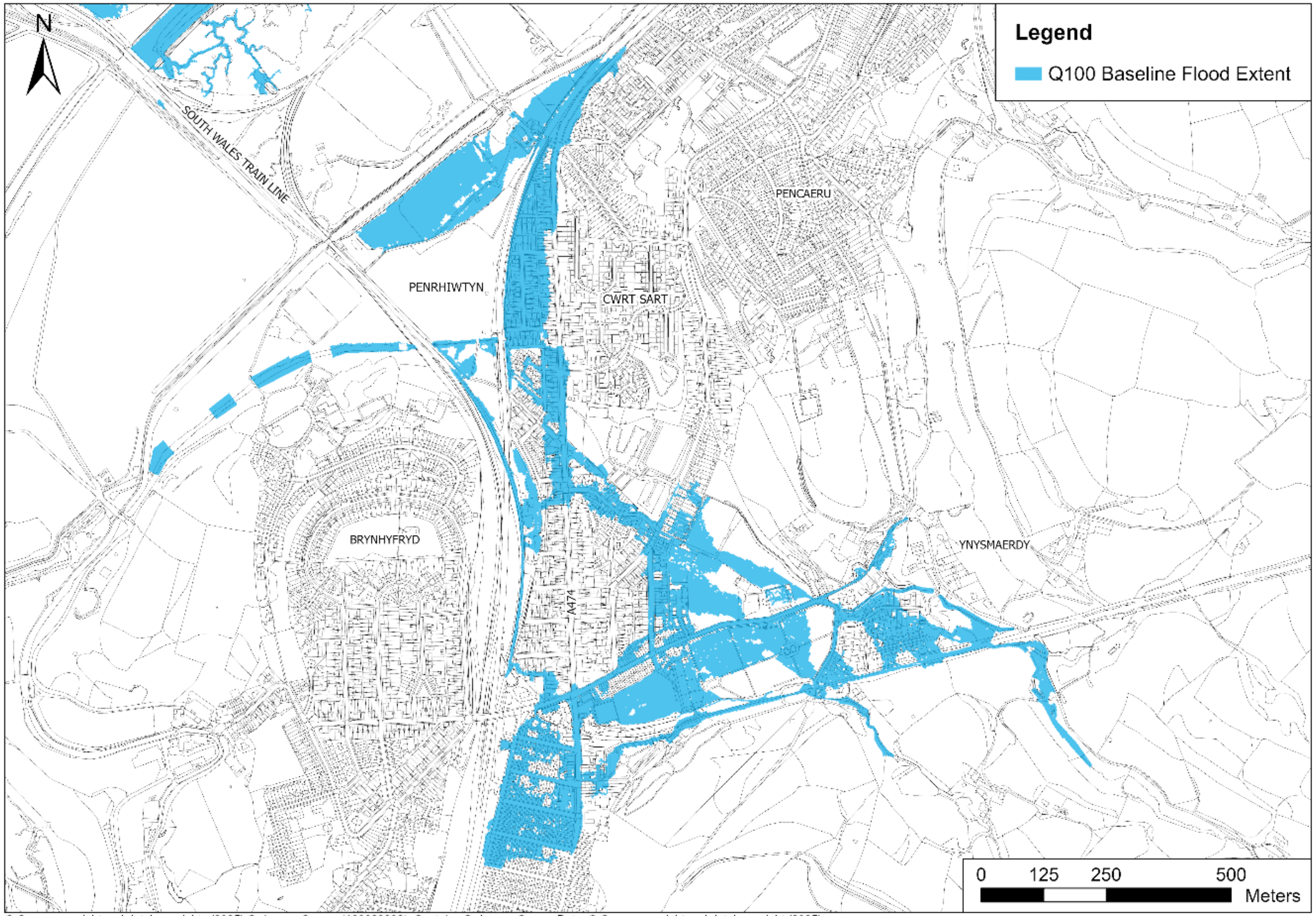

Figure 5-1 - 1% AEP flood extents - Baseline

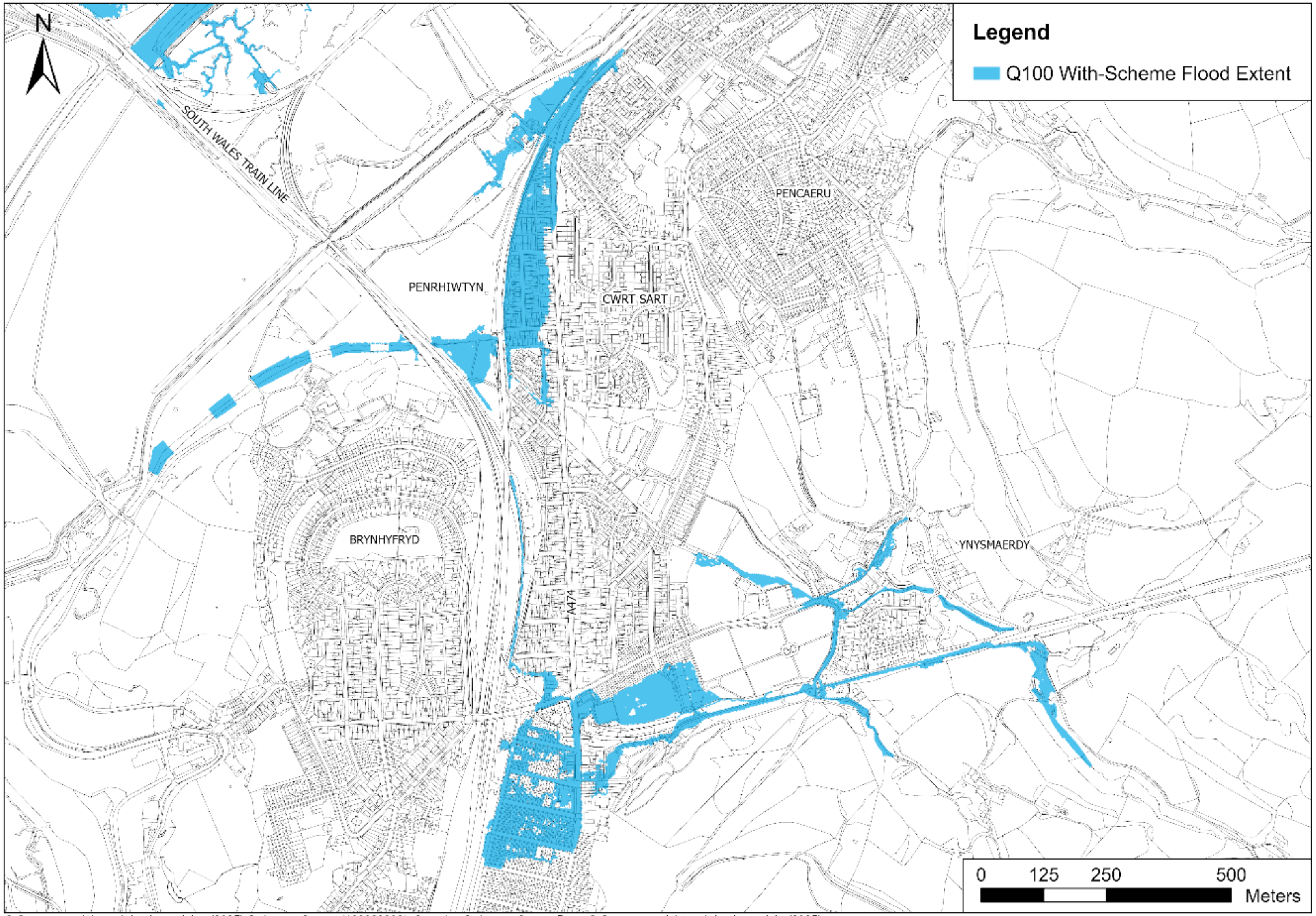

Figure 5-2 - 1% AEP flood extents - Proposed Scheme

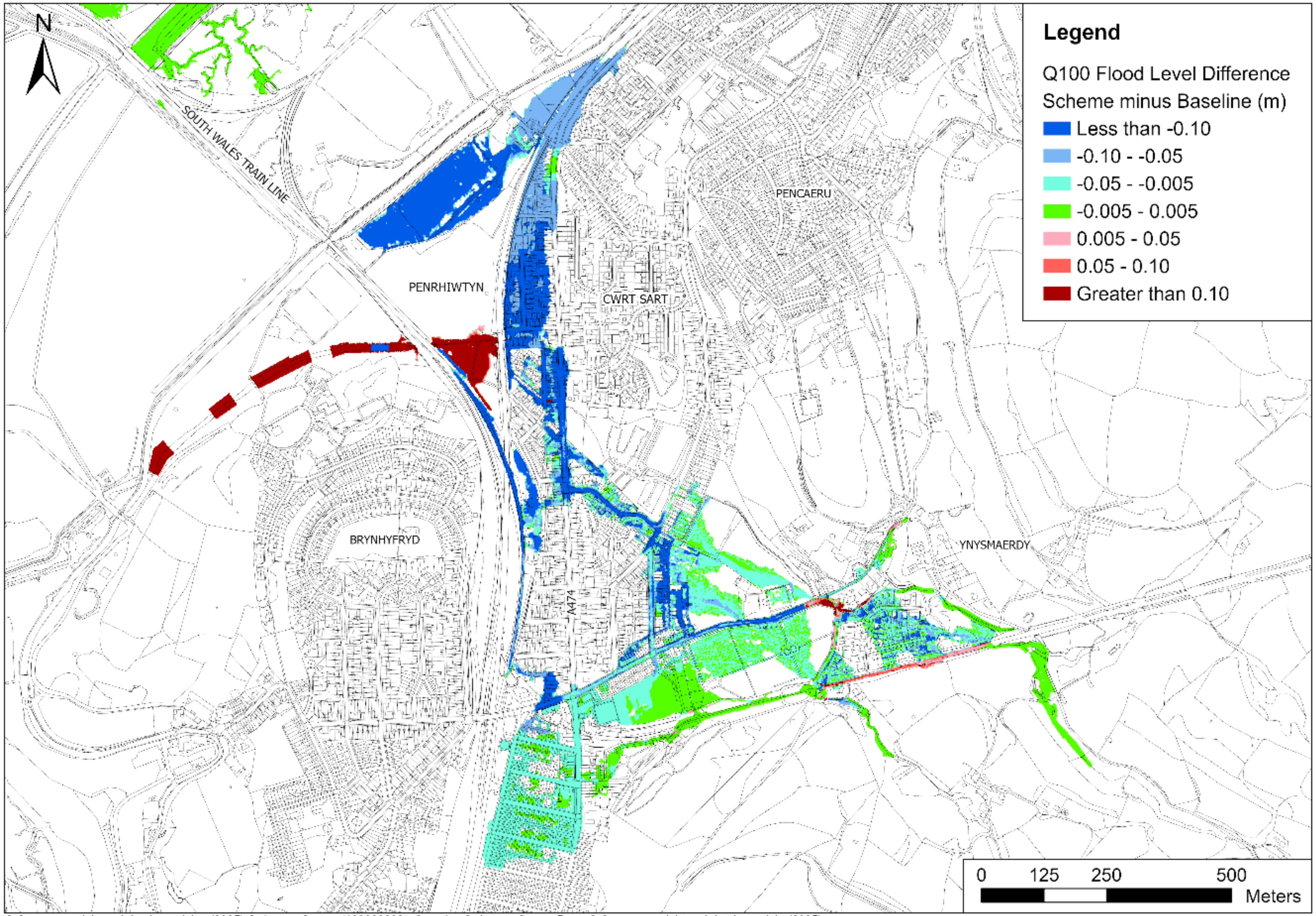

Figure 5-3 - Comparison of 1% AEP flood levels - Baseline and Proposed Scheme scenarios

1% (1 in 100) AEP flood event plus 30% climate change.

When the effects of climate change are factored in, the results for the 1% AEP fluvial event with climate change event show extensive flooding in the baseline case. With the proposed Scheme in place the flows are also not contained in channel. However, the flooding predicted for the proposed Scheme (see Figure 5-5), is less extensive than that predicted for the baseline case (Figure 5-4).

A comparison of the difference in the flood levels resulting with the Scheme in place compared to the baseline case is presented in Figure 5-6 below. The results show that during a 1% AEP flood event including climate change (in the Ordinary Watercourses), there is no negative impact to third parties with flood levels shown to be generally lower than the baseline. However, there are three areas (area between railway lines at Penrhiwtyn, along Ynysymaerdy Road and at the Incline where there is an increase in flood levels as a result of the proposals. No properties are adversely affected in these areas. This is discussed further in Section 5.2.

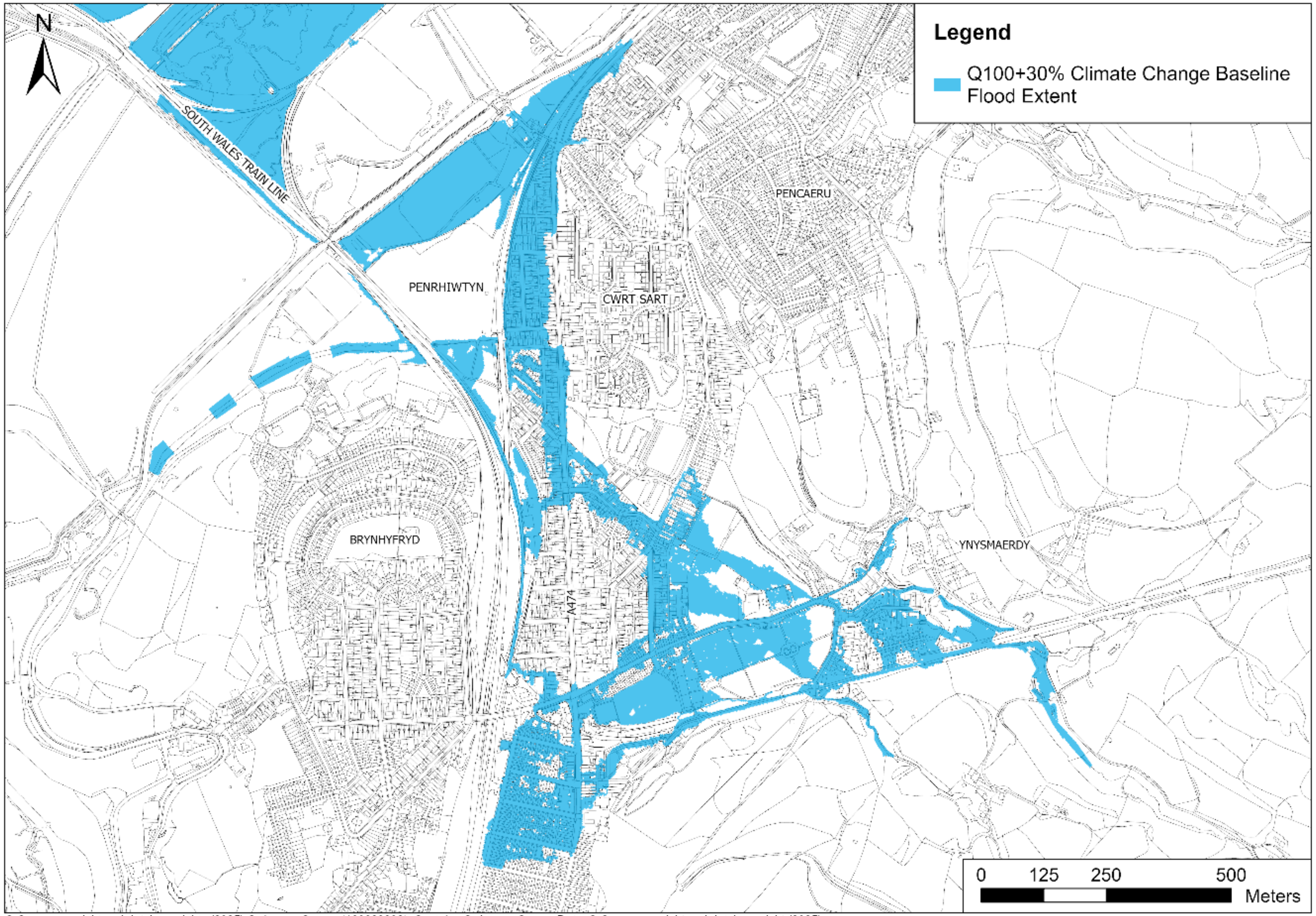

Figure 5-4 - 1% climate change AEP extents for the baseline scenario

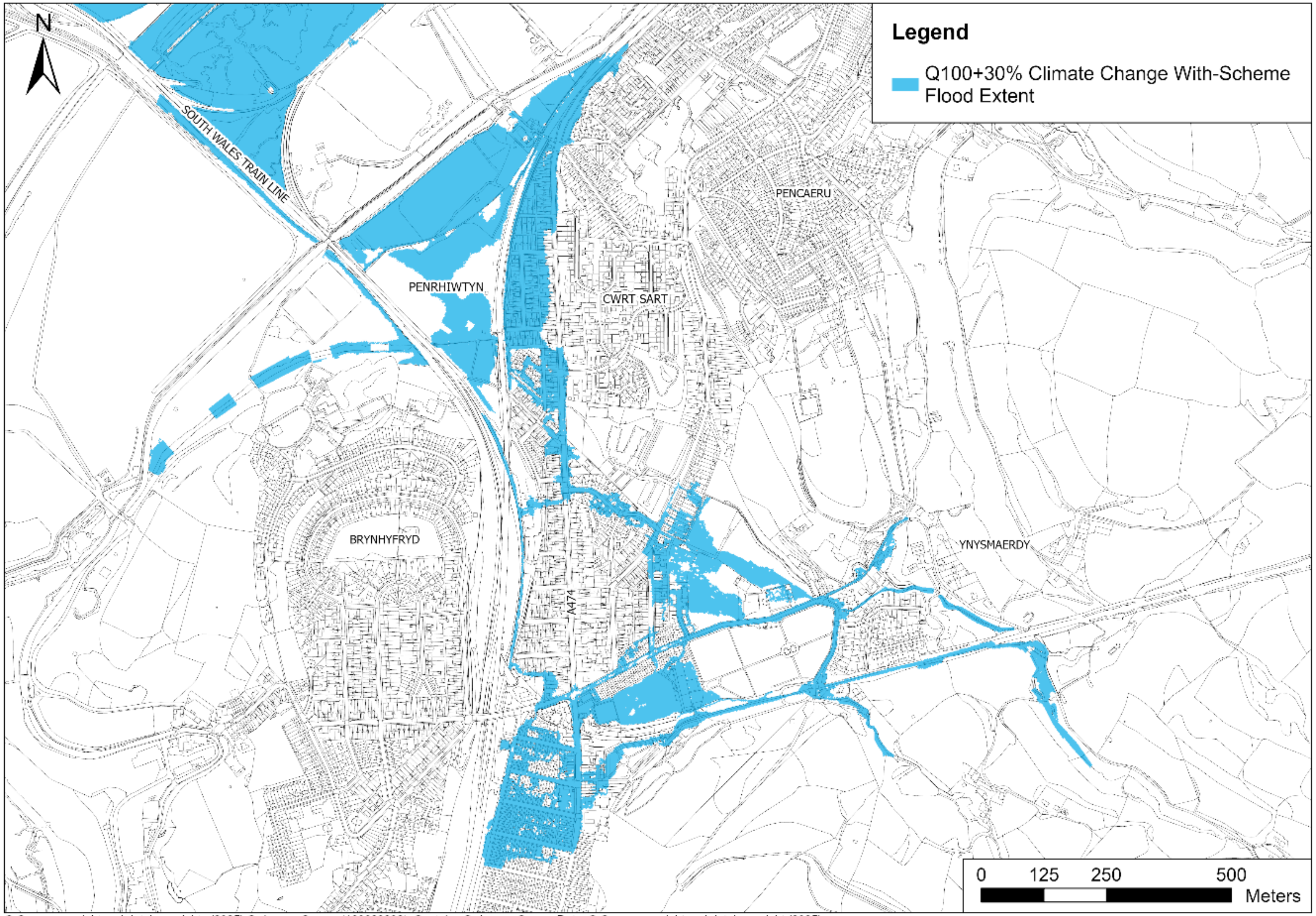

Figure 5-5 - 1% climate change AEP extents for proposed scenario

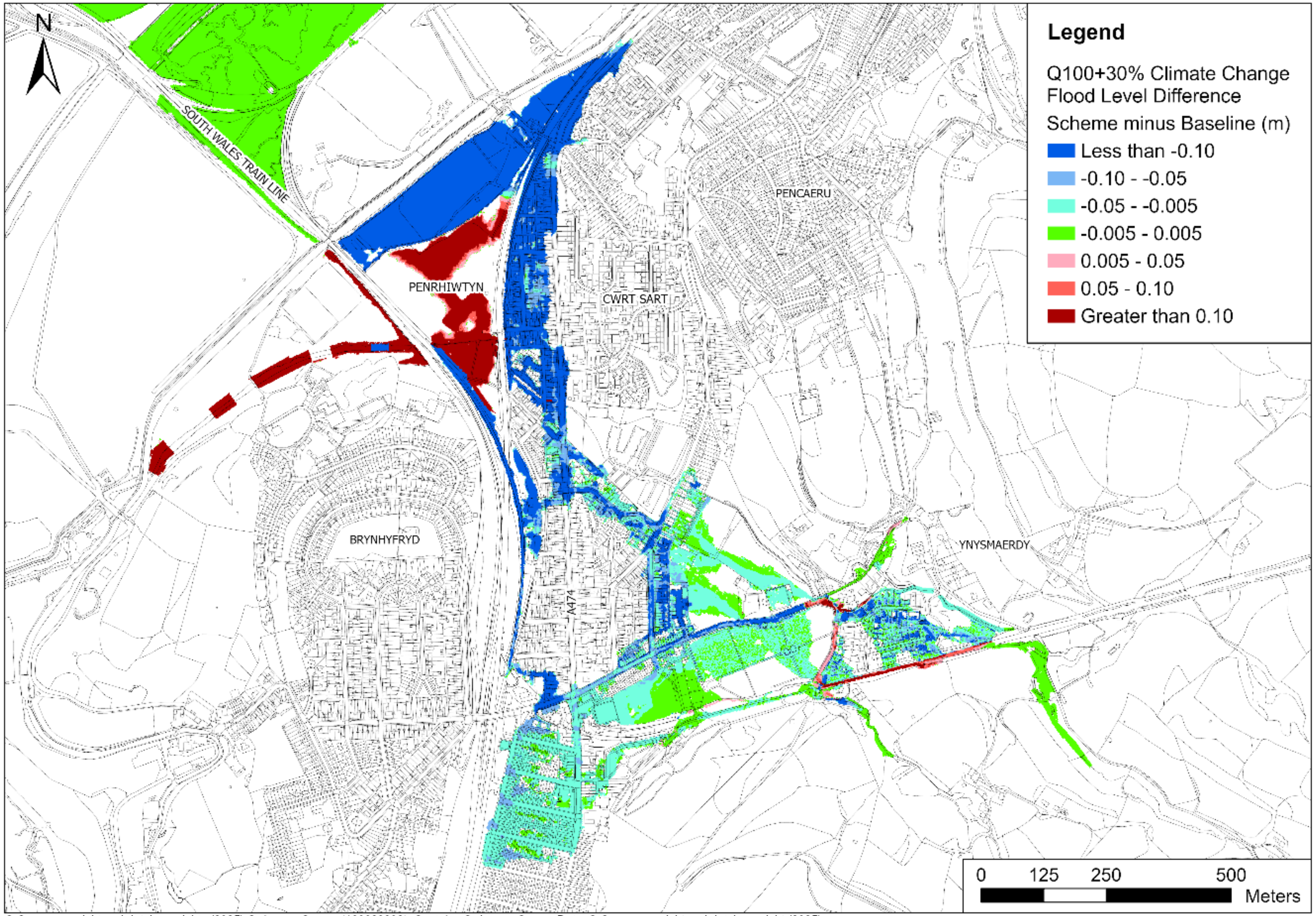

Figure 5-6 - Comparison of 1% AEP + CC Flood Levels for Baseline v Proposed Scheme

0.1% (1 in 1000) AEP flood event

The figures (Figure 5-7, Figure 5-8) below compare the flood extents for the two scenarios which evidently shows similar extents for a 0.1% AEP flood event with and without the proposed Scheme. In both these scenarios the 0.1% AEP flood overtops the banks of all the Ordinary Watercourses as the capacity of the streams and culverted system are exceeded. Although the flood extents for both scenarios are broadly similar, the proposed works ensure that the flood extents are less extensive than that if the current situation was maintained.

A plot of the difference in the flood levels as a result of the Scheme is presented in Figure 5.9 below. The results show that during a 0.1% annual chance flood there is a general lowering of flood levels as a result of the proposed works. There are areas of localised elevated levels where water is channelled along the incline footpath and the Ynysymaerdy Road along with the open channel downstream of the South Wales Mainline. These localised areas of elevated flood levels do not impact any third-party properties.

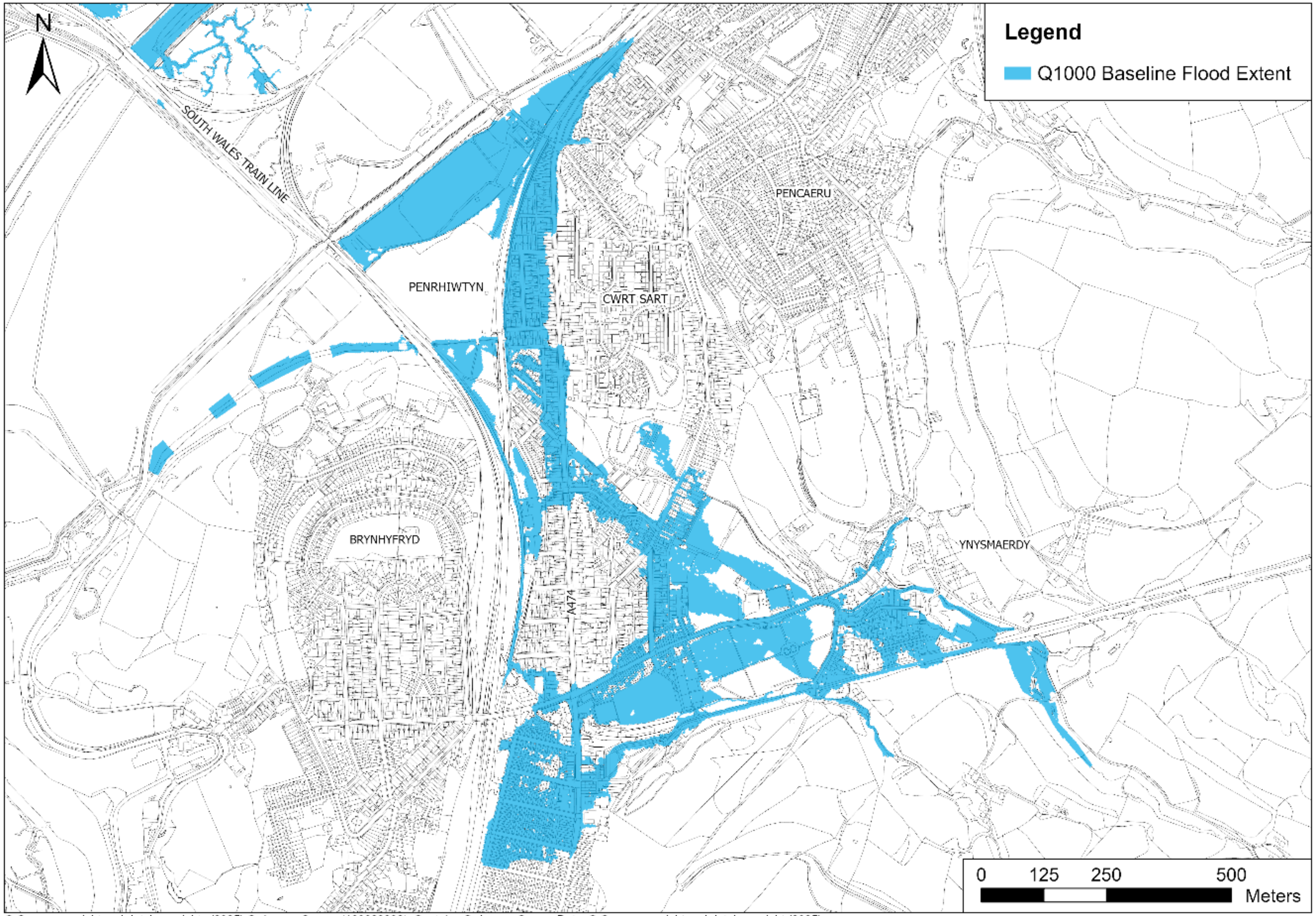

Figure 5-7 - 0.1% AEP flood extents - Baseline Scenario

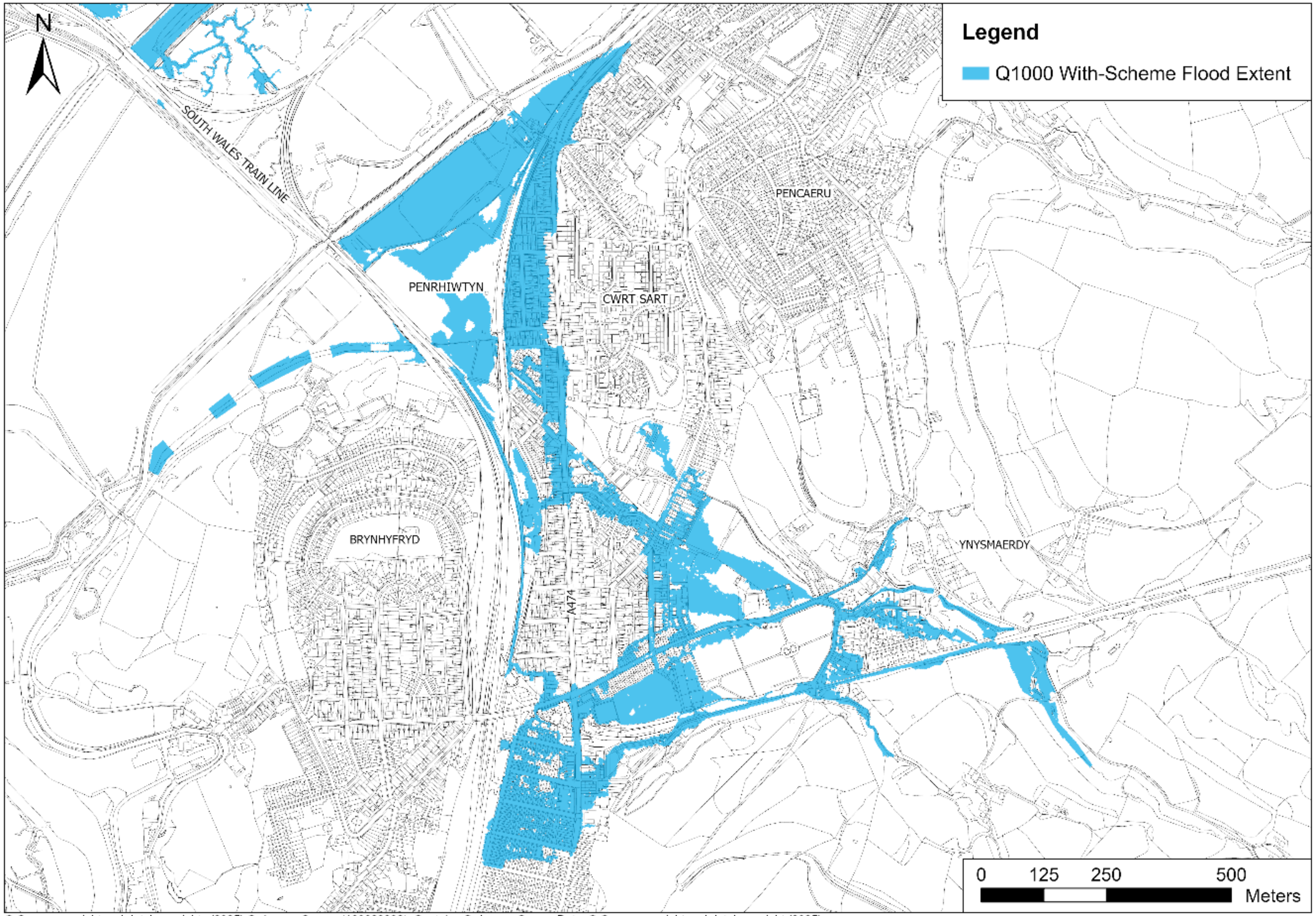

Figure 5-8 - 0.1% AEP flood extents for the proposed scenario

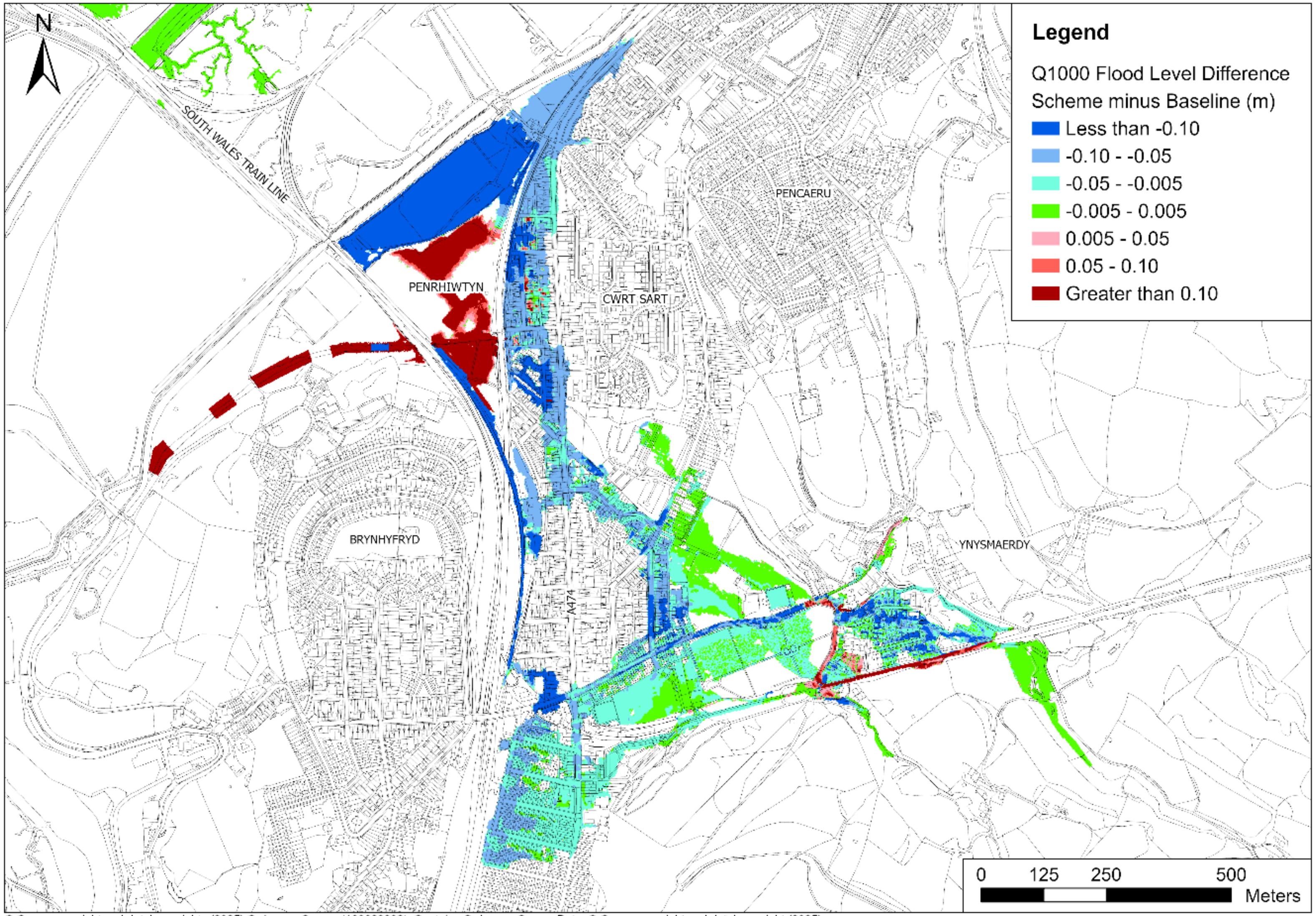

Figure 5-9 - Comparison of 0.1% AEP flood levels for baseline and proposed scenarios

5.2 With-Scheme Model Results and Flood Consequences.

This section considers the assessed consequences associated with the proposed flood alleviation scheme. TAN15 requires that the development should remain flood free during a 1% AEP fluvial event for the lifetime of the development. TAN15 also does not permit flood risk elsewhere to be increased as a result of developing a scheme.

The requirement for a 1% AEP fluvial event for the lifetime of the scheme should not apply to a flood alleviation scheme which by its nature it will flood for events exceeding its design standard of protection.

1% AEP Fluvial Flood Event

- There is reduction of flooding to the town, with the flows in the Grandison Brook and various other ordinary watercourses being diverted into the culverted system.
- There is residual flooding in the area between Pantyrheol and the South Wales Mainline which is less significant than in the baseline case. This residual flooding is from overland flow paths that develop from the neighbouring Cryddan Brook catchment.
- There are areas of localised elevated levels where water is channelled along the Incline footpath and Ynysymaerdy Road together with the open channel section immediately downstream of the South Wales Mainline. These localised areas of elevated flood levels do not impact any third party properties and have been discussed with NPTC and Network Rail who are responsible for the affected parcels of land. No detriment to the freight line is predicted due to the mitigation works proposed, namely the flood defence embankment and wall running parallel with the railway.

1 in 100 year (1% AEP) flood event plus 30% climate change

- There is flooding to Briton Ferry from the Grandison Brook in the proposed case during a 1% AEP plus climate change event although the depths are approximately 160mm lower than those predicted for the baseline case.
- There is no detriment or negative effects to fluvial flooding as a result of the scheme that would increase flood risk to any properties. There are areas of elevated water levels that are constrained to roads, footpaths and land operated by Network Rail that is already predicted to flood in the baseline case. The Scheme includes measures, in the form of a raised defence to ensure that there is no increase in risk to the rail lines.

0.1% AEP Fluvial Flood Event

- There is flooding to Briton Ferry from the Grandison Brook in the proposed case during a 0.1% AEP although the depths are approximately 90mm lower than those predicted for the baseline case.
- There is no detriment or negative effects to fluvial flooding as a result of the scheme that would increase flood risk to any properties. However, there are areas of elevated water levels that are constrained to roads, footpaths and land operated by Network Rail that is already predicted to flood in the baseline case.

5.3 Acceptability of Consequences

The structures proposed in this scheme, lying in the FMfP Flood Zone 3 for both Rivers and Sea along with the Surface Water and Small Watercourses extents. The area is known to flood, and the risks will need to be managed. Section 7 and Appendix 1 of TAN 15 describe the acceptability criteria of the consequences of flooding that should be considered. TAN 15 requires that for any new development, that there is:

- Minimal risk to life
- Minimal disruption to people living and working in the area
- Minimal potential damage to property
- Minimal impact of the proposed development on flood risk generally
- Minimal risk to natural heritage

These are discussed below.

Flood protection

The project reduces the impact of flooding to 312 properties from the predicted 1% (1 in 100) AEP flood extent and in comparison to the Do Minimum (Business as Usual) scenario provides a very high level of economic flood benefits.

Minimal risk to life

The proposed scheme reduces flood risk at Briton Ferry to the 1% (1 in 100) AEP event, and therefore reduces the risk to life.

Minimal disruption to people living and working in the area

By minimising the flood risk at Briton Ferry, disruption to residents, workers and visitors will be reduced.

Minimal potential damage to property

The proposed scheme will reduce the expected damages to residential and commercial properties.

Minimal impact of the proposed development on flood risk generally

Flood risk has been shown to reduce at Briton Ferry with no detriment to any third parties being predicted as a result of the with scheme proposals.

Minimal disruption to natural heritage

There will be minimal disruption to natural heritage as a result of the scheme. There are no **designated** sites within the Scheme extent. There is one designated site within 2km of the site. which is Earlswood Road Cutting and Ferryboat Inn Quarries Site of Special Scientific Interest (SSSI). This is located approximately 1.5km south-west of the site and designated for geological features and ancient river systems.

The following four **locally designated** sites are located within 1km of the site: Eaglebush Valley local nature reserve; The River Neath Sites of Importance for Nature Conservation (SINC); Ancient semi-natural woodland to the south; and a restored ancient woodland located within the vicinity of Jersey Park to the south.

There are five SINCs within 1kmof the site: Neath Canal; Giant's Grave; Shelone Woods; Garth Mor; and the Waun, Cimla.

6. Conclusions

This assessment has demonstrated that the consequences of flooding associated with the proposed scheme are understood, are acceptable and that the flood risk can be managed. Crucially, the scheme will reduce the flood risk to the people and properties of Briton Ferry.

- The proposed works have been shown to provide a 1% (1 in 100) AEP standard of service.
- A total of 312 properties benefit from flood reduction from the 1% (1 in 100) AEP flood extents.
- The 0.1% AEP fluvial events have been tested in the hydraulic model for the current day pre-scheme (Baseline), and With-scheme situations.
- A 100-year development lifetime has been assumed. Climate change effects on fluvial flows up to a 1% AEP event have been applied.
- There is no detriment or negative effects to fluvial flooding as a result of the scheme that would increase flood risk affecting any third-party property.
- There are some areas where elevated flood levels are predicted to result as a consequence of the proposed flood alleviation scheme. These areas are limited to footpaths, roads and land adjacent to the railway lines. The proposals have been discussed at length with both NPTC and Network Rail who are responsible for these areas of land. Both bodies have confirmed in principle that they accept the consequences of the scheme proposals.

APPENDICES

Appendix A. Proposed Scheme Overview

Low

DO NOT SCALE

SAFETY, HEALTH AND ENVIRONMENTAL INFORMATION

In addition to the hazards/risks normally associated with the types of work detailed on this drawing, note the following significant residual risks (Reference shall also be made to the design hazard log).

Construction
- Requirement for services diversions in advance of works to install new culvert
- Potential for encountering unplotted services or private underground services
- access to be maintained to residential and commercial properties
- Presence of asbestos containing materials at Carreg Hir
- Presence of contaminated soils in areas of former industrial use (land at Penrhiwtin)
- Maintaining of existing surface water flows
- Sudden increase in flows

Maintenance / Cleaning
- Trash screen will require regular inspection and clearance
- Trash screen and outfall to be inspected after storm events
- Attenuation tanks to be cleaned by high flow jetting
- Silt/rock traps to be emptied to prevent culvert blockage

Use
- Trash screen will require regular inspection and clearance
- Trash screen and outfall to be inspected after storm events
- Attenuation tanks to be cleaned by high flow jetting
- Silt/rock traps to be emptied to prevent culvert blockage

Decommissioning / Demolition
- Requirement for services diversions in advance of works to install new culvert
- Potential for encountering unplotted services or private underground services
- access to be maintained to residential and commercial properties
- Presence of asbestos containing materials at Carreg Hir
- Presence of contaminated soils in areas of former industrial use (land at Penrhiwtin)
- Maintaining of existing surface water flows
- Sudden increase in flows

NOTES

1. ALL DIMENSIONS ARE IN MILLIMETRES UNLESS OTHERWISE NOTED.
2. ALL LEVELS ARE IN METRES ABOVE ORDNANCE DATUM UNLESS OTHERWISE NOTED.

DRAINAGE SERVICES LEGEND
- Neath Port Talbot Borough Council - Drainage
- Neath Port Talbot Borough Council - Gully
- Dwr Cymru Welsh Water - Sewerage
- Dwr Cymru Welsh Water - Water

KEY

PLANNING BOUNDARY, BASED ON SITE ACCESS ROUTES AND SITE COMPOUND

Status	Revision	Drawn	Checked	Reviewed	Authorised	Issue Date
S0	P01.3	ME	---	---	---	07/04/25

Drawing Suitability: WORK IN PROGRESS — Status: S0

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Client: NEATH PORT TALBOT COUNTY BOROUGH COUNCIL

Project Title: GRANDISON BROOK

Drawing Title: PROPOSED SCHEME OVERVIEW SHEET 1 OF 2

Drawing Number: NE05_001 - ATK - GEN - SWMWREC - DR - CD - 000001

Original Size: A1 | Scale: 1:1250 | Project Ref. No: 5192793 | Sheet: 1 of 2 | Rev: P01.3

This Drawing is saved on ProjectWise. Plotted:

DO NOT SCALE

Millimetres 0 10 100

SAFETY, HEALTH AND ENVIRONMENTAL INFORMATION

In addition to the hazards/risks normally associated with the types of work detailed on this drawing, note the following significant residual risks (Reference shall also be made to the design hazard log).

Construction
- Requirement for services diversions in advance of works to install new culvert
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- Maintaining of existing surface water flows
- Sudden increase in flows

PLAN

1:1250

NOTES

1. ALL DIMENSIONS ARE IN MILLIMETRES UNLESS OTHERWISE NOTED.
2. ALL LEVELS ARE IN METRES ABOVE ORDNANCE DATUM UNLESS OTHERWISE NOTED.

DRAINAGE SERVICES LEGEND
- Neath Port Talbot Borough Council - Drainage
- Neath Port Talbot Borough Council - Gully
- Dwr Cymru Welsh Water - Sewerage
- Dwr Cymru Welsh Water - Water

KEY

PLANNING BOUNDARY, BASED ON SITE ACCESS ROUTES AND SITE COMPOUND

Status	Revision	Drawn	Checked	Reviewed	Authorised	Issue Date
Description						
S0	P01.3	ME	---	---	---	07/04/25

Drawing Suitability: WORK IN PROGRESS

Status: S0

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Client: NEATH PORT TALBOT COUNTY BOROUGH COUNCIL

Project Title: GRANDISON BROOK

Drawing Title: PROPOSED SCHEME OVERVIEW SHEET 2 OF 2

Drawing Number: NE05_001 - ATK - GEN - SWMWREC - DR - CD - 000002

Original Size: A1 | Scale: 1:2500 | Project Ref. No: 5192793 | Sheet: 2 of 2 | Rev: P01.3

This Drawing is saved on ProjectWise. Plotted:

Appendix B. Hydraulic Model Report

Hydrology Calculation Record

Cyfoeth Naturiol Cymru
Natural Resources Wales

Flood estimation – calculation record

Site/project name: Grandison Brook FAS

Date: April 2025

Introduction

This document is a supporting document to the Natural Resources Wales Flood Estimation Technical Guidance Note V3. It provides a template for recording calculations and decisions made during flood estimation. It will often be complemented by more general hydrological information given in a project report. The information given here should be enough to enable the work to be reproduced in the future.

Note 1: Table, content or page layout can be adapted to best present relevant information. Additional rows should be added to, or removed from tables as appropriate.

Note 2: Probability of flood occurrence is traditionally expressed within Hydrology as a Return Period, this is the average time between years with at least one larger flood. It can also be expressed as Annual Exceedance Probability (AEP), and this is often more appropriate to use when communicating with non-hydrologists. Return Period has been retained within this document but can be replaced with AEP if wished.

Contents

mailto:guidance.development@cyfoethnaturiolcymru.gov.uk?subject=Issue%20or%20problem%20with%20guidance

Approval

	Name	Qualifications	Competence level
Calculations prepared by:	CB	Charlie Bleasdale BSc, MCIWEM, C.WEM	3
Calculations checked by:	TA	Tracey Ashworth, BSc (Hons), MSc, MCWIWEM, CWEM, C. Sci	3
Calculations approved by:	DW	Dyfan Walters, MSc FRGS CGeog	3

Competence levels:

level 1 – hydrologist with minimum approved experience in flood estimation

level 2 – senior hydrologist

level 3 – senior hydrologist with extensive experience of flood estimation

Abbreviations

AEP	Annual exceedance probability
AMAX	Annual maximum flow
AREA	Catchment area (km^2)
BFI	Base flow index
BFIHOST	Base flow index derived using the HOST soil classification
BFIHOST19	Base flow index derived using the revised (2019) HOST soil classification
DPLBAR	Mean drainage path length (km)
DPSBAR	Mean drainage path slope (m/km)
FARL	FEH index of flood attenuation due to reservoirs and lakes
FEH	Flood Estimation Handbook
FPEXT	Floodplain extent

HOST	Hydrology of soil types soil classification
NRFA	National river flow archive
POT	Peaks over a threshold
QMED	Median annual maximum flow (with Annual Exceedance Probability of 50% / return period 2 years)
ReFH	Revitalised flood hydrograph method – used for rainfall runoff method
SAAR	Standard average annual rainfall (mm)
SPR	Standard percentage run-off
Tp	Time to peak
URBEXT2000	Index of urban extent in the year 2000
WINFAP	Windows Frequency Analysis Package – can be used for FEH statistical peak flow method

1. Method statement

1.1 Overview of requirements for flood estimates

Item	Comments
	AtkinsRéalis has been commissioned by Neath Port Talbot Council (NPTC) to produce the detailed design for the proposed flood alleviation scheme to address flooding from the Grandison Brook in a residential area of Briton Ferry in Neath Port Talbot, which is approximately 8km northeast of Swansea and 3km south of Neath. The Pantyrheol, Cwrt Sart and Ynysymaerdy areas of Briton Ferry, Neath, Wales, have been subjected to periodic flooding over many years, resulting in internal property flooding affecting residential and commercial properties. Flooding has been experienced many times after intense sustained periods of rainfall. The cause of the flooding has been identified as the under-capacity of the Grandison Brook culvert, forcing flows to the surface through surcharged culvert inlets and drainage connections. Overland flow paths develop as this water gravitates downhill, resulting in water collecting on the A474 before entering properties. The proposed scheme comprises modifications to an existing culvert inlet structure and an additional storm drainage culvert of minimum 1200mm diameter, thus increasing the overall capacity and reducing the risk of flooding to properties. At the lower end of the system larger box culverts are to be used to deal with the resulting increased flows. This works in combination with additional flood risk management solutions including an attenuation pond located in Jersey Park and a flood bund located in the northeast portion of the site. Flow hydrographs for the 2, 5, 10, 25, 30, 50, 75, 100, 200, 500 and 1000-year return periods are required. The impact of climate change will also be considered, based on the latest guidelines.

1.2 Overview of catchment

Item	Comments
Brief description of catchment, including key features needing consideration or reference to section in accompanying report. Map/s should be presented here or in section 2.1 of this report.	The Grandison Brook is a small tributary of the River Neath, with a catchment area of approximately 3.4 km^2 at the downstream extent. The watercourse rises in Margam Forest to the east of Briton Ferry. It flows in a north-westerly direction towards Ynysymaerdy and is culverted from Ynysymaerdy Road to Morgan's Terrace (between the A474 Neath Road and the railway line). The channel then curves around the north of Brynhyfryd, passing under the Neath Canal, to join the River Neath. At Ynysymaerdy Road, at the eastern edge of Jersey Park, there is a channel bifurcation with some water directed out of the catchment. This will be represented in the hydraulic model. The lower part of the catchment is moderately urbanised. The upper part of the catchment is rural with grassland and woodland being the predominant land uses. The topography is moderately steep with little floodplain in the upper catchment. There are no significant surface water features (lakes, reservoirs) in the catchment, although there are a couple of small ponds/storage areas in the upstream area. Soils and geology information for the catchment is detailed below and was obtained from: • http://www.landis.org.uk/services/soilscapes.cfm • http://mapapps2.bgs.ac.uk/geoindex/home.hmtl Most of the catchment is underlain by slowly permeable, wet, very acid upland soils with a peaty surface. The headwaters and northern part of the catchment are underlain by freely draining acid loamy soils over rock. The British Geological Survey (BGS) website 1:625,000 scale mapping shows that the catchment is underlain by bedrock geology of the South Wales Upper Coal Measures Formation. This is dominated by mudstone, siltstone, sandstone, coal, ironstone and ferricrete. The bedrock geology is overlain by superficial deposits of Till in some locations. The catchment response to rainfall is likely to be fast due to the small size of the catchment, steep topography, generally slowly permeable soils, and impermeable geology.

Item	Comments
	A location map, plan showing the scheme and culvert location and a catchment map are in **Figure 1**, **Figure 2** and **Figure 3**.

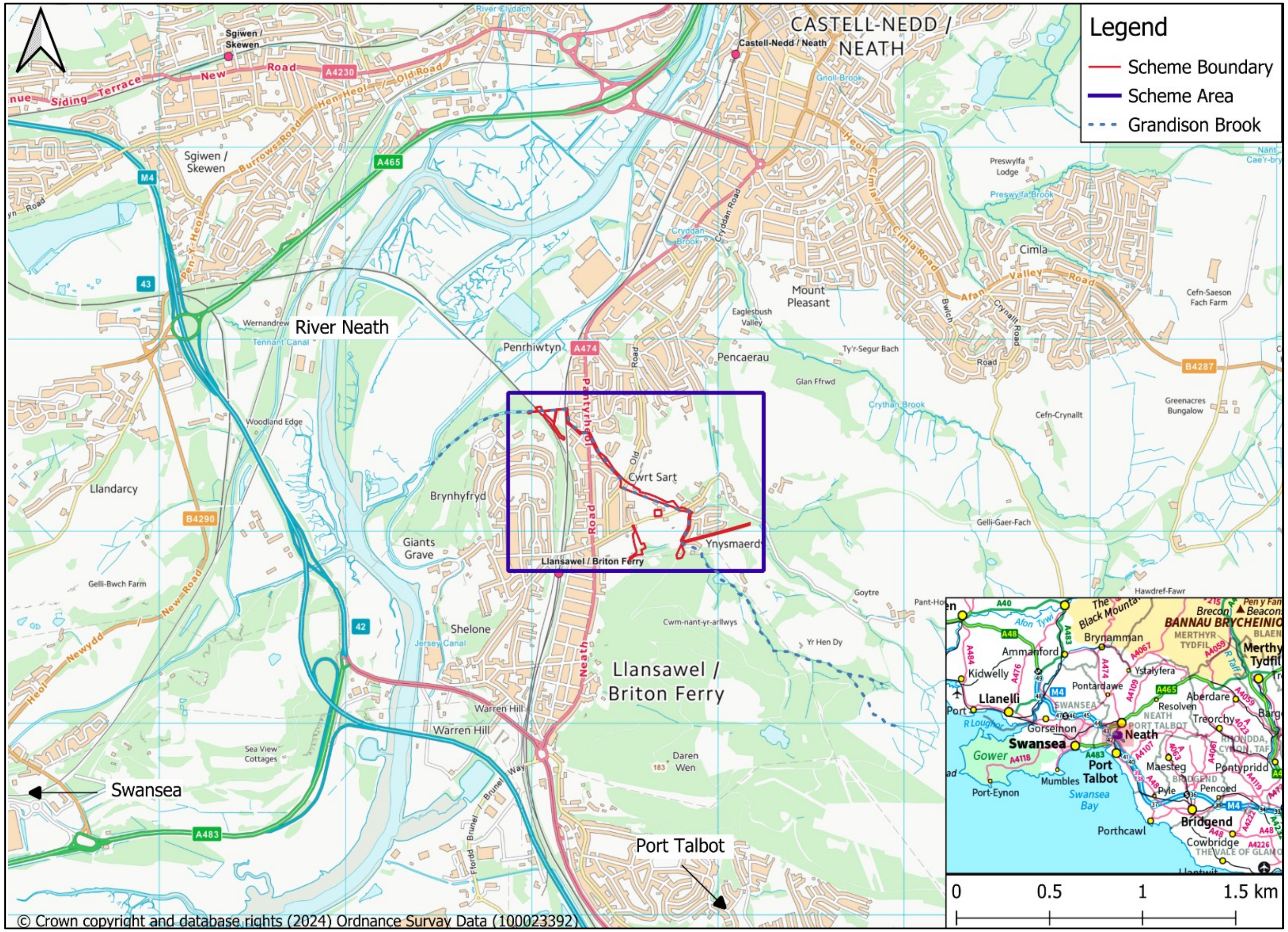

Figure 1 – Location map

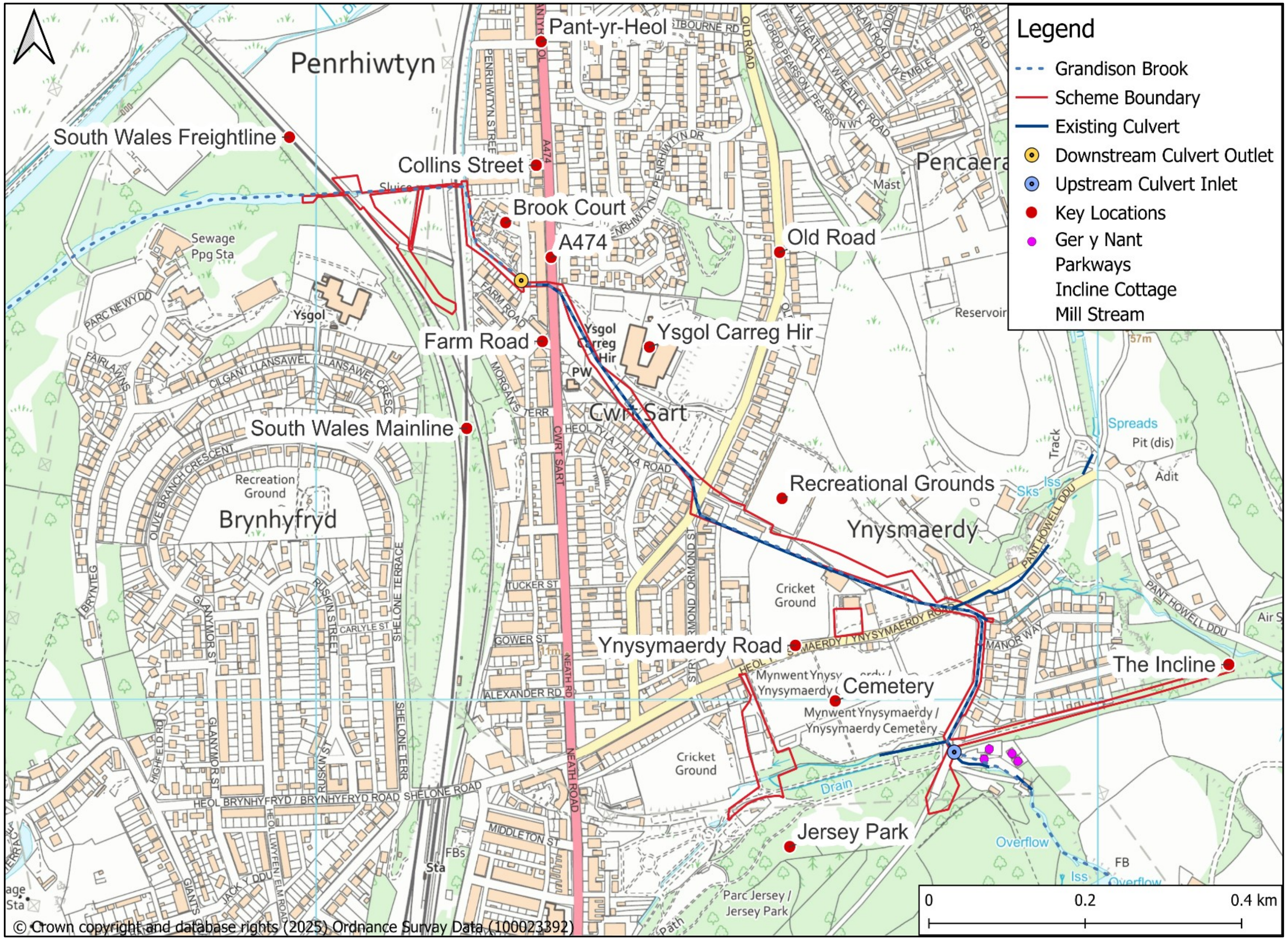

Figure 2 – Culvert location and study area

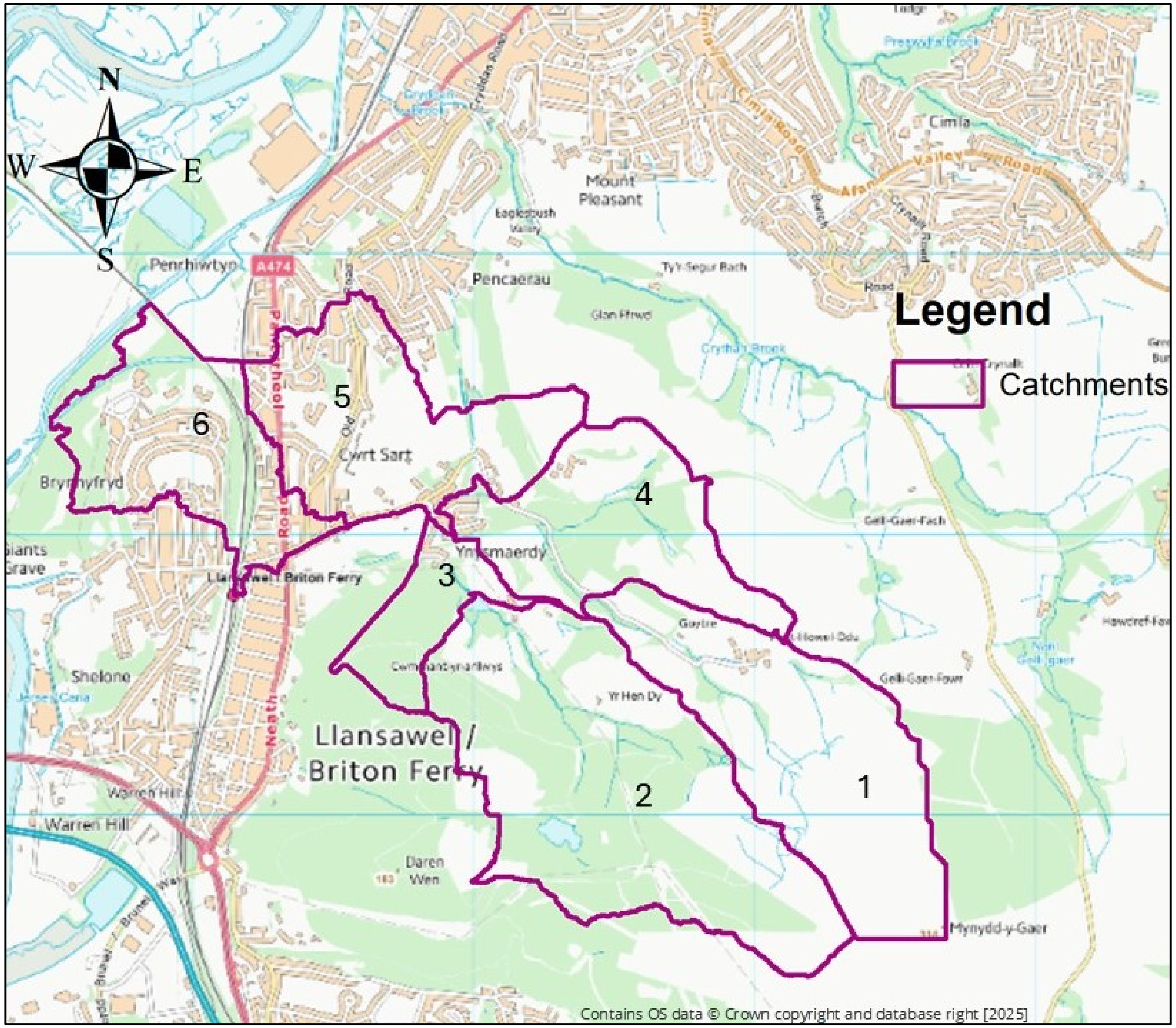

Figure 3 – Catchment map

1.3 Source of flood peak data

Item	Comments
Was the NRFA Peak Flows dataset used? If so, which version?	The pooling group was originally developed in February 2020 and Version 8 of the NRFA was used, released in September 2019 and containing data up to the end of September 2018. A check of the FEH statistical flows using the NRFA version 13, containing data up to the end of September 2023 and WINFAP5.2 was also carried out and these results are in the report Appendix.

1.4 Gauging stations (flow or level)

Within, or near to, the study area. Most stations will be included on National River Flow Archive (NRFA), but other stations may also be available.

Watercourse	Station name	NRFA number	Grid reference	Catchment area (km^2)	Location relative to study area (eg, within), note any significant differences in catchments (eg URBEXT)
The catchment is ungauged.					

1.5 Data available at each gauging station

Station name or number	Start and end date on NRFA	Suitability (Pooling/ QMED/ Neither)?	Update for this study?	Comments on data availability (quality is covered in next section). If not a QMED or pooling station then describe how data will be used e.g. for Tp calculation or QMED calculation from daily mean flow
N/A				

1.6 Data quality at each gauging station

Station name or number	Comments on rating quality focusing on QMED and above e.g. degree of extrapolation, availability of recent flow gaugings, amount of scatter in the gaugings, bank full level and out of bank flow
N/A	

N/A1.7 Other data available and how it has been obtained

Consider flood history and local data if available.

Type of data	Source of data	Details and reference/link to relevant reports
Historic flood data	JBA Flood Estimation	2017s6786 - Grandison Brook-Calc Record_v1 (Aug 2018).pdf This report contains information on the flood mechanisms.

Type of data	Source of data	Details and reference/link to relevant reports
	Calculation Record, 2018	
15-min river level/flow and rainfall data for events (if carrying out Tp or ReFH analysis)	N/A	
Results from previous studies	JBA Flood Estimation Calculation Record, 2018	2017s6786 - Grandison Brook-Calc Record_v1 (Aug 2018).pdf This report contains flood flows for one site at the railway line, downstream of the flood risk area.

1.8 Initial choice of approach

Item	Comment
Outline the conceptual model. Address questions such as: • Where are the main sites of interest? • What is likely to cause flooding at those locations? (e.g. peak flows, flood volumes, combination of peaks, groundwater, snowmelt, tides) • Might those locations flood from runoff generated on part of the catchment only e.g. downstream of a reservoir?	The main site of interest are the Pantyrheol, Cwrt Sart and Ynysymaerdy areas of Briton Ferry, Neath. Flooding has been experienced many times after intense sustained periods of rainfall. The cause of the flooding has been identified as the under-capacity of the Grandison Brook culvert, forcing flows to the surface through surcharged culvert inlets and drainage connections. Overland flow paths develop as this water gravitates downhill, resulting in water collecting on the A474 before entering properties.

Item	Comment
Any unusual catchment features to account for? For example: • highly permeable (BFIHOST> 0.65) • highly urbanised – consider choice of method carefully; consider aritifical drainage and storm sewer inflow and outflows • small catchment (<40 km^2) – small catchment pooling method • pumped watercourse – consider lowland catchment version of rainfall-runoff method • major reservoir influence – consider flood routing • extensive floodplain storage – consider choice of method carefully	The catchment is small with urbanisation in the lower reaches.
Initial choice of method(s) and reasons • Will method often known as FEH Hybrid be used for peak flow estiamtes? (Statisical for QMED to 1% AEP, then growth factor from ReFH applied to 1% event for events to 0.1% AEP) • If not appropriate, describe why and give details of the other method/s to be used. • What method will be used for hydrograph calculation? • Will the catchment be split into sub-catchments/intervening areas? If so, how will flows for intervening areas be estimated?	The hybrid method will be used, with flow hydrographs calculated using ReFH2 scaled to FEH statistical peak flows.
Software to be used including version number	WINFAP4 (checked using WINFAP5.2, with results in the Annex). ReFH2.

2. Locations where flood estimates are required

2.1 Map of study area, including subject site(s) and gauging stations (where applicable).

See figures in Section 1.2.

2.2 Summary of subject sites

The table below lists the locations of subject sites. Use site codes in all subsequent tables to save space.

Site code	Watercourse	Site Name (description)	Easting	Northing	AREA on FEH Web Service (km^2)	Revised AREA if altered (km^2)	Peak flow, hydrograph or both required?
1	Grandison Brook	Upstream inflow	275400	194800	-	0.708	Hydrograph
2	Grandison Brook	Upstream inflow	275000	194800	-	1.060	Hydrograph
3	Grandison Brook	Lateral inflow	274750	195000	-	0.176	Hydrograph
4	Grandison Brook	Lateral inflow	274750	195050	-	0.473	Hydrograph
5	Grandison Brook	Lateral inflow	274200	195600	-	0.542	Hydrograph
6	Grandison Brook	Lateral inflow	273550	195450	-	0.460	Hydrograph
Total	Grandison Brook	Total catchment	273550	195450	3.18*	-	Peak flow and hydrograph

* Flows at the downstream extent were calculated using the FEH statistical and ReFH2 methods with default FEH parameters. The purpose of calculating flows at this location was to provide FEH statistical/ReFH2 scaling factors. The summed catchment area of Catchments 1-6 is slightly larger than the Total catchment area from the FEH webservice.

2.3 Important catchment descriptors at each subject site (incorporating any changes made)

Site code	AREA (km^2)	BFIHOST19	DPLBAR (km)	DPSBAR (m/km)	FARL	FPEXT	PROPWET	SAAR (mm)	*Urban area km^2
1	0.708	0.508	1.04	142.5	1	0.0155	0.52	1487	0.025
2**	1.06	0.489	1.06	145.9	1	0.0186	0.52	1433	0.032
3**	0.176	0.489	1.06	145.9	1	0.0186	0.52	1433	0.023
4**	0.473	0.489	1.06	145.9	1	0.0186	0.52	1433	0.033
5**	0.542	0.489	1.06	145.9	1	0.0186	0.52	1433	0.2206
6**	0.460	0.489	1.06	145.9	1	0.0186	0.52	1433	0.2004
Total	3.18	0.473	2.44	143.1	1	0.081	0.52	1415	0.414 (URBEXT2000 0.083)

* For Catchments 1 to 6, the urban area was entered into the ReFH2 models rather than updating the URBEXT2000. For Total, the URBEXT2000 from the FEH webservice was updated using the FEH UEF equation.

** Catchment descriptors for Catchments 2 to 6 were based on Catchment 2.

2.4 Checking catchment descriptors

Item	Comment
Record how catchment boundary was checked • Describe any changes • Add maps if needed	Catchment boundaries were delineated using the FEH webservice and updated using LiDAR and OS maps.
Record how catchment descriptors were checked, especially soils • Describe any changes • Include a before and after table if necessary	The BFIHOST19 values were checked against local geology and soils. No changes were needed.
Method for updating URBEXT • Refer to WINFAP Urban Adjustment procedures/guidance	Catchments 1 to 6: URBAN values were calculated from OS maps. Total: URBEXT2000 updated using FEH UEF equation.

3. Statistical method

3.1 Donor stations and QMED adjustment factors

Note that donor catchments will usually be rural but may be urban provided the data is deurbanised prior to the adjustment process. Include a map if necessary.

Station name	**NRFA station number**	**Record Length**	**Is station hydrologically connected to subject site? Ie, upstream / downstream**	**Gauged QMED (m^3/s)**	**Deurbanised Gauged QMED (A) (m^3/s)**	**Catchment descriptors QMEDrural (B) (m^3/s)**	**Adjustment ratio (A/B)**	**Chosen or rejected**
Afan @ Marcroft Weir	58012	40 (to September 2018)	No	95.0	93.0	81.0	1.15	Chosen
Comments • Mention distance from subject site (based on catchment centroid), whether they are on the same, adjacent or nearby watercourse and features which may impact applicability, eg FARL , quality of flood peak data, length of record.								

3.2 Overview of estimation of QMED at each subject site

- Methods: CD: catchment descriptors alone, DT: data transfer, BCW: catchment descriptors and bankfull channel width, FV: flow variability (using flow duration statistics)
- Urban adjustment procedures should be applied regardless of whether the subject site is rural or urban.
- If more than one donor has been used, use multiple rows for the site and give the weights used in the averaging. Record the weighted average adjustment factor in the table.
- Edit table columns/add rows as needed

Site code	QMEDrural from CDs (m^3/s)	NRFA numbers for donor site/s used	Distance between centroids (km)	Distance attenuation alpha factor used? If not explain why below.	Final adjustment factor applied to site QMED	Final estimate of QMEDrural (m^3/s)	Final estimate of QMEDurban (m^3/s)
Total	2.75	53012	9.29	Yes	1.06	2.92	3.21
Distance attenuation alpha factor comments					None		
Are the values of Final QMED and QMED adjustment factors consistent, for example at successive points along the watercourse and at confluences?					Only 1 site.		

3.3 Derivation of pooling groups

- Several subject sites may use the same pooling group.
- The composition of pooling groups should be presented in the Appendix.

Pooling group name	Site for which pooling group was derived	If applied to more than on site, list their codes	**Method: Single Site / with History, Enhanced Single Site or Pooled / Small Catchment Pooled?** Include reasons for choice of method	**Changes made to default pooling group, with reasons** Include any sites that were investigated but retained in the group

Total	Total	-	Pooled	Removed: 76011 – experimental catchment 71003 – disparity in range of high flows in early/late record 47022 – china clay workings in catchment 49005 – discordant 27073 – surface and groundwater catchments may differ condsiderably 26802 – Chalk 44008 – Chalk
Were non-flood year adjustments made to any stations? if so give details			No	
URBEXT2000 threshold used to create pooling group(s).			0.03	
Have pooling group growth curves been deurbanised?			Yes	

3.4 Derivation of flood growth curves at subject sites

- A pooling group derived at one location can be applied to estimate growth curves at several ungauged sites. However, each site may have a different urban adjustment, and therefore different growth curve parameters.

- Urban adjustments to growth curves should use the latest methodologies in WINFAP
- Any relevant frequency plots from WINFAP, particularly showing any comparisons between single-site and pooled growth curves (including flood peak data on the plot) should be shown in an Appendix.

Site code	Pooling group name	Distribution used and reason for choice	Was an urban adjustment made	Growth factor for 100-year return period (1% AEP) event
Total	Total	GL – best fit	Yes, UAF = 1.099	2.776

3.5 Flood estimates from the statistical method

Site code	Flood peak (m^3/s) for the following return period or AEP events											
	2 **50%**	**5** **20%**	**10** **10%**	**20** **5%**	**25** **4%**	**30** **3.3%**	**50** **2%**	**75** **1.3%**	**100** **1%**	**200** **0.5%**	**500** **0.2%**	**1000** **0.1%**
Total	3.21	4.29	5.12	6.06	6.39	6.68	7.55	8.32	8.92	10.6	13.2	15.7

4. Revitalised flood hydrograph (ReFH2) method for peak flow estimation

This section records calculations for peak flow estimates and will generally use default parameters. If different calculations are subsequently made for hydrographs, details should be recorded in section 5.

4.1 Design events for ReFH2 method for peak flow estimation

Site code	Season of design event (summer or winter)	Recommended Storm duration (hours)

1	Winter	5.75 hours, highest peak flow for Total catchment
2		
3		
4		
5		
6		
Total		

Was FEH22 used for design rainfall statistics? If not, why?	No, study was completed before 2022
Comments	Sewer flows for Catchment 5 and Catchment 6 were exported out of the catchment based on information received during the study from the engineers and hydraulic modellers. The exports were calculated using the methods discussed in the ReFH2 guidelines, with the urban parameters kept as default in the absence of any flow data. For the 5.75 hour duration, the sewer capacities were estimated as $0.4m^3/s$ for Catchment 5 and $0.36m^3/s$ for Catchment 6.

4.3 Peak flow estimates from the ReFH2 method

		Flood peak (m^3/s) for the following return periods (in years) or AEP											
Site code	**Urban/ rural?**	**2** **50%**	**5** **20%**	**10** **10%**	**25** **4%**	**30** **3.3%**	**50** **2%**	**75** **1.3%**	**100** **1%**	**200** **0.5%**	**500** **0.2%**	**1000** **0.1%**	**100:1000** **1%:0.1%** **ratio**
1	Urban results used	0.70	0.94	1.12	1.40	1.47	1.66	1.83	1.96	2.32	2.86	3.57	1.82
2		1.07	1.43	1.71	2.13	2.23	2.52	2.79	2.99	3.55	4.37	5.45	1.82
3		0.19	0.26	0.31	0.39	0.40	0.46	0.50	0.54	0.64	0.78	0.97	1.81
4		0.49	0.66	0.79	0.99	1.03	1.17	1.29	1.38	1.64	2.02	2.51	1.82
5		0.32	0.37	0.48	0.59	0.70	0.75	0.84	0.92	0.99	1.11	1.44	1.57
6		0.29	0.38	0.46	0.57	0.59	0.67	0.74	0.79	0.94	1.20	1.61	2.04
Total		2.35	3.00	3.46	4.08	4.21	4.60	4.94	5.21	6.00	7.58	9.35	1.80
How do peak flows compare to statistical estimates.			FEH statistical peak flows are higher.										

5. Revitalised flood hydrograph (ReFH2) method for model inflow hydrographs

5.1 Parameters for ReFH2 model for model inflow hydrographs

This section records calculations for model inflow hydrographs, parameters may have been calibrated and storm durations changed.

If parameters are all estimated from catchment descriptors, they are easily reproducible, so it is not essential to record them here –Just enter ‘all’ under site code and ‘Catchment descriptors’ under method. Table can be amended as needed.

Site code	Details of method • Catchment descriptors (CD) • Tp (Time to peak) calculation • Optimisation (Calibration Utility)	CD Tp (hours)	Adjusted Tp if different (hours)
All	Catchment descriptors	Catchment descriptors	N/A
Description of any Tp calculation or calibration work, add references to other documents where appropriate			

5.2 Design events for ReFH method for model inflow hydrographs

Storm duration (hours)	ARF	Source of Storm Duration and ARF	Why Chosen

5.75	0.969	Total catchment	Gives highest ReFH2 peak flow for the 100-year event for Total catchment.
Were hydrographs scaled to alternative peak flow estimates? If so, give details			Scaled based on FEH statistical/ReFH2 peak flows for Total catchment.
Provide link/reference to location of hydrographs or provide in appendix			

6. Final peak flow and hydrograph estimates

6.1 Comparison of peak flow estimates from different methods

This table compares peak flows from the ReFH method, FEH Statistical method and any available previous study at each site for two key return periods. Note and explain any significant difference from previous studies.

	QMED (50% AEP)				**100-year return period / 1% AEP**			
Site code	**Statistical**	**ReFH**	**Previous Study**	**Comment**	**Statistical**	**ReFH**	**Previous Study**	**Comment**
Total	3.21	2.35	2.7	The catchment area in the previous study is at the railway line and is 2.8km^2 (this study catchment is 3.18km^2).	5.21	8.92	7.2	The catchment area in the previous study is at the railway line and is 2.8km^2 (this study catchment is 3.18km^2).

6.2 Final peak flow estimates

	Flood peak (m^3/s) for the following return periods (in years) or AEP										
Site code	**2** **50%**	**5** **20%**	**10** **10%**	**20** **5%**	**25** **4%**	**30** **3.3%**	**50** **2%**	**75** **1.3%**	**100** **1%**	**200** **0.5%**	**1000** **0.1%**
Total	3.21	4.29	5.12	6.06	6.39	6.68	7.55	8.32	8.92	12.1	28.3

State choice of method, ie Hybrid approach (Statistical for QMED to 100 year, ReFH growth factor from 100yr applied to statistical 100yr, for rarer events) Statistical ReFH	Hybrid approach (Statistical for QMED to 100 year, ReFH growth factor from 100yr applied to statistical 100yr, for rarer events). For Catchments 1 – 6 the ReFH2 hydrographs have been scaled using the Total catchment FEH statistical/ReFH2 scaling factors.

6.3 Uncertainty

Give what information you can on uncertainty in the flood estimates

For example, using the methods detailed in 'Making better use of local and historic data, and estimating uncertainty in FEH design flood estimation (FEH Local) SC130009'.

Site Code	**95% confidence interval factor for QMED** (eg 0.48-2.1 for ungauged locations with 0 donors)	**95% confidence interval factor for 100 year (1% AEP) flood**	**Comments,** include comments on QMED estimation method, gauging station relative location/s, record length, data quality, consistency between stations, flood history and catchment characteristics
Total	0.4 – 2.51	0.34 – 2.94	(ungauged, 1 donor moderately urbanised). QMED CI range: 1.3 to 8.1 100-year CI range: 131 to 26.2

6.4 Hydrographs for modelling

How were these calculated, for example, scaling ReFH hydrographs to final flow estimates, adjusting C_{ini}? include link/reference to hydrographs.	ReFH2 hydrographs calculated using a 5.75 hour storm duration for catchments 1 to 6 were scaled using the Total catchment FEH statistical / ReFH2 scaling factors.
How will flows be applied in the model. If intervening areas are used, will hydrographs be adjusted to better match downstream flows, or will best estimate inflows be used and resulting downstream flows accepted?	Best estimate inflows be used and resulting downstream flows accepted

6.5 Checks

Are the results consistent, for example at confluences?	Yes
What do the results imply regarding the return periods of floods during the period of record?	N/A
What is the 100-year growth factor? Is this realistic? (The guidance suggests a typical range of 2.1 - 4.0)	2.776
If 1000-year flows have been derived, what is the range of ratios for the 1000-year flow over 100-year flow?	Ratio is 1.81 for 1000/100.
What is the range of specific runoffs (l/s/ha)? Are there any inconsistencies?	No inconsistencies

How did the results compare with those of other studies? Explain any differences and conclude which results should be preferred	Not directly comparable with the previous JBA study because of the difference in catchment area, but the results are similar.
Are the results compatible with the longer-term flood history?	N/A
Describe any other checks on the results	None

6.6 Assumptions and limitations

List the main assumptions made specific to the study	The CDs from the FEH webservice for Catchment 2 are suitable to also estimate flows for Catchments 3 – 6.
Discuss any particular limitations For example, applying methods outside the range of catchment types for which they were developed	The catchment is ungauged.
Comment on the suitability of the results for future studies For example, at nearby locations or for different purposes	Would be useful as a comparison.
Give any other comments on the study For example, suggestions for additional work	The installation of a gauging station would reduce the uncertainty in the design flow estimates.

Appendix: supporting information

Pooling group composition

AM Data | Catchment Descriptors

	Station	Distance	Years of data	QMED AM	L-CV	L-SKEW	Discordancy
1	45816 (Haddeo @ Upton)	1.352	25	3.456	0.306	0.399	0.894
2	28033 (Dove @ Hollinsclough)	1.520	43	4.205	0.231	0.369	0.969
3	91802 (Allt Leachdach @ Intake)	1.746	34	6.350	0.153	0.257	1.000
4	27051 (Crimple @ Burn Bridge)	1.800	46	4.539	0.219	0.148	1.111
5	25003 (Trout Beck @ Moor House)	1.926	45	15.120	0.167	0.302	0.954
6	54022 (Severn @ Plynlimon Flume)	1.946	38	14.988	0.156	0.171	0.919
7	25011 (Langdon Beck @ Langdon)	2.092	32	15.533	0.235	0.334	1.559
8	206006 (Annalong @ Recorder)	2.243	48	15.330	0.189	0.052	1.653
9	25019 (Leven @ Easby)	2.500	40	5.384	0.343	0.378	1.898
10	57017 (Rhondda Fawr @ Tynewydd)	2.658	17	24.060	0.136	0.018	1.324
11	49003 (de Lank @ de Lank)	2.699	52	13.985	0.223	0.209	0.391
12	27010 (Hodge Beck @ Bransdale Weir	2.700	41	9.420	0.224	0.293	0.093
13	27032 (Hebden Beck @ Hebden)	2.802	52	3.923	0.207	0.244	0.236
14							
15	Total		513				
16	Weighted means				0.215	0.246	

Additional supporting information

The study was carried out in 2020. There have been updates to data and methods since and therefore a check of the flows for the Total catchment was undertaken using the ReFH2 method with FEH22 rainfall, and the FEH statistical method using WINFAP5 and the NRFA version 13.

The results are below. The flows were scaled to FEH statistical peaks and the FEH statistical flows are very similar. The ReFH2 flows using FEH22 rainfall are slightly higher than when FEH13 is used.

	ReFH	ReFH FEH22	WINFAP4 NRFA v8	WINFAP5 NRFA v13
2	2.1	2.5	3.2	3.2
5	2.8	3.2	4.3	4.3
10	3.2	3.7	5.1	5.2
25	3.9	4.4	6.1	6.1
30	4.0	4.5	6.7	6.7
50	4.4	4.9	7.5	7.5
75	4.7	5.2	8.3	8.3
100	5.0	5.5	8.9	8.8
200	5.7	6.1	10.6	10.3
1000	9.0	8.3	15.7	14.6

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