

Flood and Water Management Act 2010

Section 19 Flood Investigation Report

Storm Dennis – Flood Investigation Area RCT02 (Aberdare & Aberaman)

July 2022

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This report should be read in its entirety

This report has been prepared in accordance with the requirements of section 19 Flood and Water Management Act 2010. The Council assumes no responsibility or liability from any person in connection with its contents or findings.

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EXECUTIVE SUMMARY

This report has been produced through the duties placed upon Rhondda Cynon Taf County Borough Council under Section 19 of the Flood and Water Management Act 2010. The Act states, “On becoming aware of a flood in its area, a lead local flood authority must, to the extent that it considers it necessary or appropriate, investigate:

- a) which risk management authorities have relevant flood risk management functions and
- b) Whether each of those risk management authorities has exercised, or is proposing to exercise those functions in response to the flood”.

This Section 19 investigation provides an investigative report of the storm event that occurred on 15 and 16th of February 2020 within the Rhondda Cynon Taf County Borough Council area, focusing investigation on the flooding at Aberdare and Aberaman North in the Cynon valley (Flood Investigation Area RCT02, Figure 1).

This report was undertaken to identify the mechanism of flooding, establish which Risk Management Authorities have relevant flood risk management functions under the Flood and Water Management Act 2010 and ascertain if those Risk Management Authorities’ have undertaken or were planning to undertake actions related to those functions to manage the risk of flooding.

The flooding that affected RCT on 15 and 16th of February 2020, was a result of an extreme rainfall event, designated by the Met Office as ‘Storm Dennis’. The impact of the event at investigation area RCT02 resulted in internal flooding to 45 residential properties, 5 commercial premises and flooding to the highway. These impacts were identified through inspections made by RCT’s Flood Risk Management Team during the days following the storm event, as well as information collated by residents, RCT’s Public Health team, Natural Resources Wales and Dŵr Cymru Welsh Water.

It has been established from the evidence gathered within this report that the primary source of flooding at RCT02 on the 15 and 16th February 2020 was a result of significant overland runoff being generated from the steep hillsides above Aberdare and Aberaman North draining to lower ground via a series of ordinary watercourses, many of which became overwhelmed with water and debris and eventually overtopped, impacting several properties on its course of flow.

On review of the condition and hydraulic performance of the culverted infrastructures identified as sources of flooding to properties, 2 culvert networks provided inadequate standards of protection in both free-flowing and blockage conditions. The remaining

culvert network identified as a source of flooding was identified as having adequate standards of protection in free-flowing condition. Despite the 'Nant Gwawr' culvert network having sufficient capacity to manage the expected flows, the culverted infrastructure was observed to be obstructed and its capacities significantly reduced due to blockages caused by mobilised debris from upstream.

The overtopping of the River Cynon at RCT02 was also identified as a primary source of flooding to properties at Wellington Street within the Trecynon sub-catchment and influencing the overtopping of the unnamed ordinary watercourse to the rear of Gloucester Street. The unprecedentedly high river levels on the River Cynon during Storm Dennis is considered to have contributed to the severity of the overtopping, with NRW's Aberdare station recording its highest recorded peak during the event (2.125 metres).

Surface water flooding associated to sheeting runoff from the hillsides and overwhelmed highway drainage network was also identified as contributing sources of flooding to several properties within RCT02 during Storm Dennis.

RCT as the Lead Local Flood Authority and Land Drainage Authority has been determined as the relevant Risk Management Authority responsible for managing the ordinary watercourse and surface water flooding that occurred at RCT02 during Storm Dennis.

In response to the flooding at investigation area RCT02, the LLFA has undertaken 16 actions and have proposed to undertake a further 11. A summary of which include;

- Undertaken clearance works to the culvert inlet structures identified as sources of flooding following the storm event (assisted by the Highway Authority);
- Carried out survey, jetting and cleansing operations to an estimated 921 metres of ordinary watercourse drainage network length within the investigation area;
- Led on the development of a central Control Room to compliment the Council's Contact Centre and CCTV Centre, to provide a comprehensive and informed response to residents during storm events;
- Carried out significant upgrades to culvert inlet structures and culverted ordinary watercourse networks across RCT02 to reduce the risk of potential blockages; and
- Installed remote telemetry monitoring devices at key culvert structures to enable operators to ensure the drainage systems within RCT02 are operating effectively.

NRW has been determined as the relevant Risk Management Authority with permissive powers to manage the main river flooding that occurred during Storm Dennis. In response to the flooding at investigation area RCT02, NRW have;

- Carried out their own post event investigative analysis work to understand the mechanism of flooding from the River Cynon at Aberdare;
- Commissioned a Cynon Flood Modelling Project, the outcomes of which will include an initial assessment of the viability of potential flood risk management options; and
- Developed a series of recommendations and a detailed action plan to address areas of improvement for future storm events, including the performance and expansion of NRW's Flood Warning Service and incident management response.

The event that occurred on 15 and 16th February was extreme, and it is unlikely flooding from a similar event could be prevented entirely. It is concluded that Risk Management Authorities satisfactorily carried out their flood risk management functions in response to the flood event. All relevant RMAs have proposed further measures to improve preparedness and responses to future flood events.

ABBREVIATIONS

BJC – Business Justification Case

DCWW – Welsh Water

FRMP – Flood Risk Management Plan

FWMA – Flood and Water Management Act 2010

LDA – Land Drainage Authority

LFRMS – Local Flood Risk Management Strategy

LLFA – Lead Local Flood Authority

NRW – Natural Resources Wales

OBC – Outline Business Case

Q – Return Period (1 in X chance of an event occurring in any given year)

RCT - Rhondda Cynon Taf CBC

RCT02 – Flood Investigation Area RCT02

RMA – Risk Management Authority

SAB – Sustainable Drainage Approval Body

SFRA – Strategic Flood Risk Assessment

SOC – Strategic Outline Business Case

SuDs – Sustainable Drainage Systems

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1. INTRODUCTION

1.1 PURPOSE OF INVESTIGATION

On the 15 and 16th February 2020 Rhondda Cynon Taf County Borough Council (RCT) was impacted by an extreme weather event which was designated by the Met Office as 'Storm Dennis'. Due to the extent and impact of the event, the LLFA opted to undertake a formal investigation.

The storm resulted in widespread residential and commercial flooding within the Rhondda Cynon Taf County Borough Council area. This report will focus on Flood Investigation Area RCT 02 which covers the town and village of Aberdare and Aberaman in the Cynon valley.

The reason behind RCT's investigation is in response to the duties of the local authority in regard to Section 19; of the Flood and Water Management Act 2010, which states:

1. "on becoming Aware of a flood in its area, a lead local flood authority must, to the extent that it considers it necessary or appropriate, investigate:
 - a) "Which risk management authorities have relevant flood risk management functions and,
 - b) Whether each of those risk management authorities has exercised, or is proposing to exercise, those functions in the response to the flood."
2. "When an authority carries out an investigation under subsection (1) it must publish the results of its investigation, and notify any relevant risk management authority"¹

The purpose of the investigation is to determine which Risk Management Authorities have relevant flood risk management functions and which functions have been exercised in response to a flood.

Specific details of Storm Dennis, such as rainfall analysis are covered within a separate overview report that covers the wider RCT area. The report is titled 'Storm Dennis February 2020 – Overview Report' and will be referred to as 'FRM – Storm Dennis – Overview Report'².

¹ Flood and Water Management Act 2010 – Section 19 - <https://www.legislation.gov.uk/ukpga/2010/29/section/19>

² [Flood Investigation Reports | Rhondda Cynon Taf County Borough Council \(rctcbc.gov.uk\)](https://www.rctcbc.gov.uk/flood-investigation-reports)

1.2 SITE LOCATION

The area investigated within this report falls within the electoral wards of Aberdare East, Aberdare West and Aberaman North, all located within the Cynon River catchment to the north of Rhondda Cynon Taf (Figure 1).

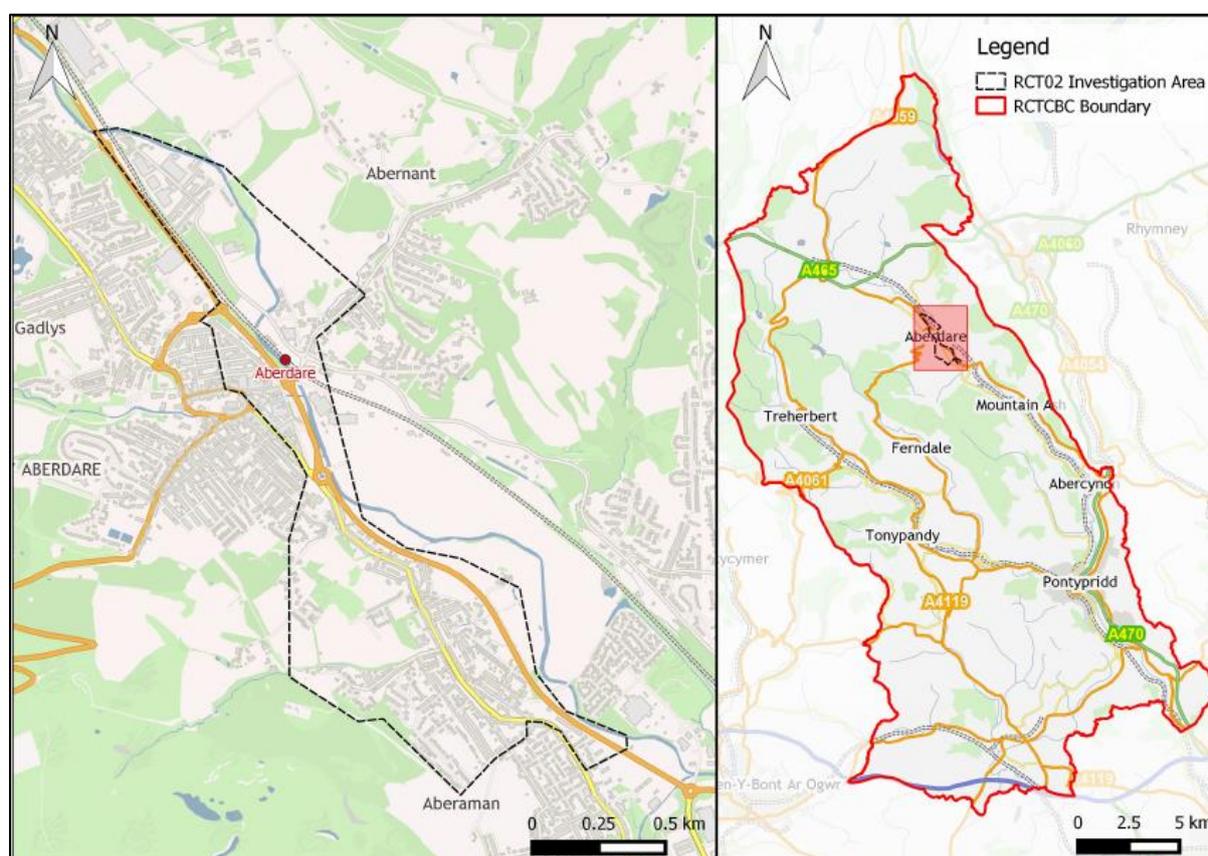


Figure 1: Flood Investigation Area RCT02 Location Plan

The primary settlements located within investigation area RCT02 are Aberdare and Aberaman which are both situated at the valley floor of the River Cynon owing to the steep topography of the valley sides. Much of the land cover in the upper catchment of RCT02 is agricultural, natural and woodland.

The River Cynon flows north to south through the centre of the investigation area. RCT02 is drained to the northeast by the Nant y Wenallt watercourse discharging into the River Cynon at Aberdare. The River Dare drains the western area and is partially culverted beneath Aberdare before discharging into the River Cynon a short distance downstream of the Nant y Wenallt. Aberaman North, to the southeast of the investigation area, is drained to the east by the Nant Gwawr watercourse and is partly culverted through the village of Aberaman.

The most apparent source of flooding is noted to be ordinary watercourse flooding, sourced from culvert inlets and the overtopping of watercourse embankments, according to RCT's Flood Risk Management Plan (FRMP)³, however within areas adjacent to the River Cynon, and particularly to the north of RCT02 in Robertstown, it is considered that both main river and surface water flooding were the primary sources of flooding. The extent of flood risk from both main river and local sources (ordinary watercourse and surface water) is illustrated within Figure 2 and identified investigation area RCT02 as an area of medium to high flood risk, particularly towards the lower reaches of Aberdare and Aberaman and adjacent to the River Cynon.

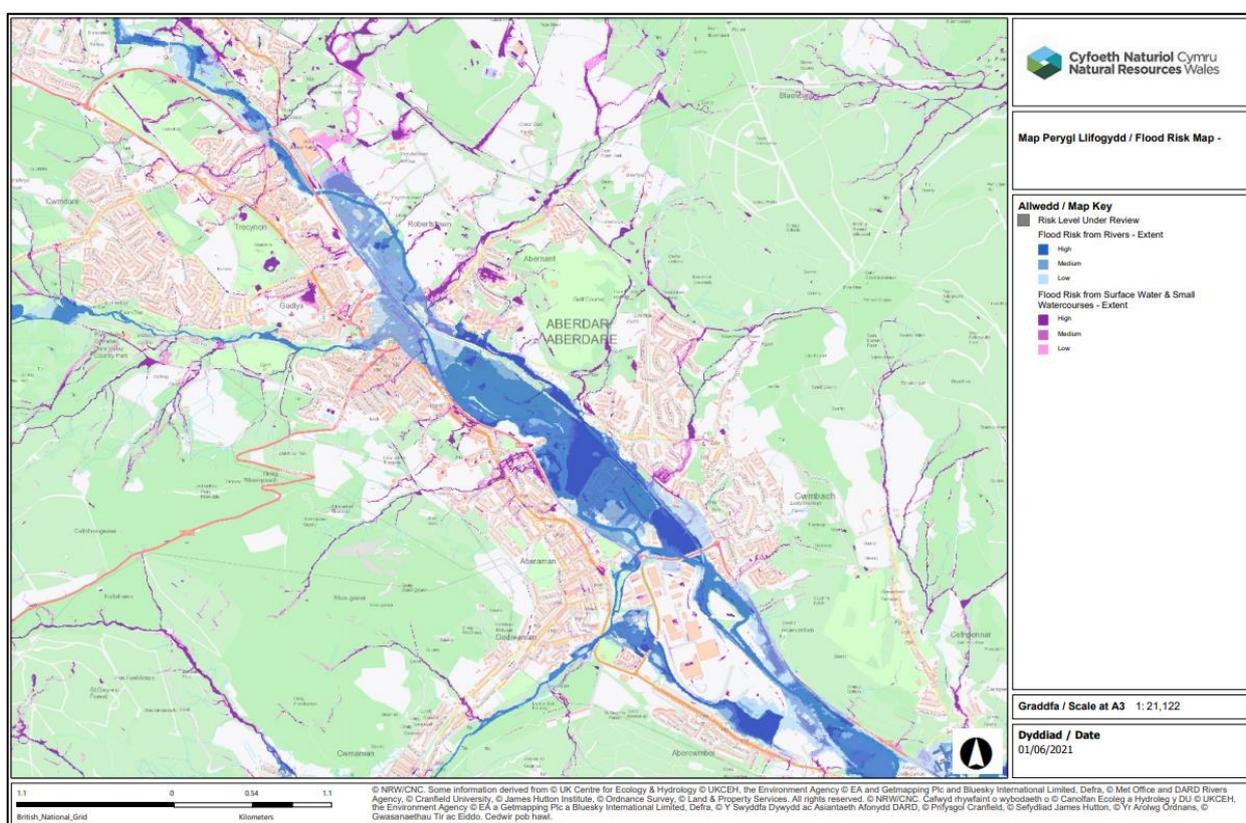


Figure 2: Natural Resources Wales' Flood Risk Assessment Wales (FRAW) map for rivers and ordinary watercourse and surface water flood risk at investigation area RCT02. Contains Natural Resources Wales information © Natural Resources Wales and database right. All rights reserved.

1.3 DRAINAGE SYSTEM

The surface water drainage systems that serve investigation area RCT02 are that of the highway drainage network designed to manage the surface water within the

³ [RCT'S Flood Risk Management Plan \(rctcbc.gov.uk\)](http://rctcbc.gov.uk)

highway and public surface water sewer and combined sewer networks operated by Dŵr Cymru Welsh Water.

1.4 INVESTIGATION EVIDENCE

To support the investigation, a range of qualitative and quantitative evidence has been gathered from numerous sources, the summary of which is listed in Table 1.

Table 1: Investigative evidence gathered in preparation of the Storm Dennis Section 19 report

Source	Data
Residents	Photos, videos, statements, email correspondence, public engagement survey responses
Responders' statements	Local responders' statements
CCTV Surveys	Internal surveys of the local drainage networks
Met Office Data	Weather Warning information (see FRM – Storm Dennis – Overview Report)
Rain Gauges	RCT and NRW operated gauge information (see FRM – Storm Dennis – Overview Report)
Natural Resources Wales	River Level and Flood Warning data
RCT Flood Risk Management Plan	Site specific information and data for each electoral ward in RCT
Communities at Risk Register	Flood risk ranking and scores for all flood types based on community data in Wales
Flood Investigation Report (Redstart's FIR)	A summary of the source-pathway-receptors, culvert capacity assessment and hydraulic modelling work undertaken by Redstart. The Flood Investigation Report was commissioned by RCT prior to writing the Section 19 report.

Evidence sourced from the 'Flood Investigation Report', commissioned by RCT, will be further referred to as 'Redstart's FIR' throughout this report.

1.5 PUBLIC ENGAGEMENT

Following the initial flooding event that occurred on the 15 and 16th February during Storm Dennis, flood risk officers from the RCT Flood Risk Management department were deployed to areas across the borough to investigate reports of internal flooding by residents. Residents were engaged with by the Flood Risk Management team to determine the initial impacts caused by the flooding event and to investigate the potential source(s) and pathway(s) of flood water during the event. Due to the volume of calls received by RCT's Out of Hour department, visits were prioritised to those areas experiencing significant internal flooding to residential properties.

To support the flood investigations, a public engagement exercise was undertaken between the 4th and 25th of January 2021 by Redstart, on behalf of RCT. The aim of this was to engage with the local residents who were affected by the flood event to capture details on how they were impacted, the source and movement of flood water within the area, how receptors were impacted as well as drawing on local knowledge to query how local conditions could have exacerbated the event. This data is useful to help the LLFA better understand and validate our assessment of the flood event to support the investigation under Section 19 of the FWMA.

FLOODING HISTORY

2.1 PREVIOUS FLOOD INCIDENTS

Previous incidences of flooding to properties within the wider investigation area have occurred over the past twenty years, often in relation to the network of ordinary watercourses and culverted infrastructure which convey a substantial volume of water through Aberdare and Aberaman.

Information relating to historical flood incidences prior to Storm Dennis is limited however, in recent years the frequency and impact of property flooding has increased with the most notable flood event being Storm Bronagh on 20-21st September 2018 and Storm Callum on 12-13th October 2018.

During RCT's public engagement exercise, residents at Cardiff Road expressed that they had experienced frequent surface water flooding to the highway, in addition to groundwater ingress into properties, with one resident stating that the flooding was "increasing in severity". During Storm Callum in October 2018, several properties at Cardiff Road were recorded as internally flooded as a result of overwhelmed highway drainage and surcharging manholes causing surface water to accumulate along the highway.

Properties at Brook Street were also recorded as flooded during Storm Callum as a result of ordinary watercourse flooding sourced by the Nant Gwawr ordinary watercourse and its tributaries.

Historic flooding from the River Cynon was also reported by residents at Wellington Street. The last known main river flooding event to impact the River Cynon occurred in December 1979. Residents at Gloucester Street also reported previous incidences of flooding to their properties during December 1979.

2.2 FLOOD INCIDENT

The flooding that occurred on the 15th and 16th February 2020 was a result of an extreme rainfall event, designated by the Met Office as ‘Storm Dennis’ which affected the majority of RCT and caused widespread flooding to communities.

Specific details of Storm Dennis, such as rainfall and river level analysis are covered within a separate overview report that covers the wider RCT area, referenced ‘FRM – Storm Dennis – Overview Report’².

The post event inspections undertaken on the days following the storm event by RCT’s Flood Risk Management Team and RCT’s Public Health, Protection and Community team identified 45 residential properties and 5 commercial properties, including one care home, as internally flooded.

A summary of the source(s) and pathway(s) of flooding within investigation area RCT02 during Storm Dennis have been outlined in Table 2 and further described throughout this section.

Table 2: Summary of the source(s), pathway(s) and receptor(s) affected during Storm Dennis within investigation area RCT02

Source	Pathway	Receptor
Trecynon Sub-Catchment		
Water levels on the River Cynon exceeded river bank levels to the rear of properties at Wellington Street.	Flood water, which overtopped the banks of the River Cynon, travelled through the rear of at least three properties at Wellington Street and onto the highway. The capacity of the highway drainage in the area became overwhelmed, exacerbating flooding issues to the front of properties and also contributed to the conveyance of flows towards Waterloo Place.	3 properties flooded internally at Wellington Street from the rear. A further 2 properties situated at lower ground levels at Waterloo Place internally flooded.
Abernant Sub-Catchment		
Intense rainfall running off the hillsides to the northeast of Abernant and draining to lower ground via steep hillsides	Surface water runoff was channelled via Abernant Road towards properties within the lower reaches of the catchment.	Contributed to the internal flooding to 2 residential properties and 1 non-residential property in the lower

<p>and impermeable highway surface of Abernant Road.</p>	<p>Additional flows were also channelled onto the highway from adjacent land which were unable to enter the highway drainage network due to capacity constraints, and instead flowed towards residential properties at the base of the valley.</p>	<p>reaches of Abernant Road.</p>
<p>Intense rainfall running off the hillsides to the northeast of Abernant and draining to lower ground via the Nant y Wenallt ordinary watercourse.</p> <p>A culvert inlet associated to the Nant y Wenallt surcharged during the storm event.</p>	<p>Exceedance flows from the surcharged culvert inlet conveyed towards adjacent properties which are situated lower than the surrounding highway.</p>	<p>Contributed to the internal flooding to 2 residential properties and 1 non-residential property in the lower reaches of Abernant Road.</p>
<p>Aberdare West Sub-Catchment</p>		
<p>The unnamed ordinary watercourse to the rear of Gloucester Street overtopped during the storm event.</p>	<p>The ordinary watercourse overtopped privately owned retaining walls to the rear of properties at Gloucester Street, resulting in water ingress to the rear of several properties.</p>	<p>Internal flooding to 9 residential properties.</p> <p>External flooding to several more properties.</p>
<p>Intense rainfall running off the hillsides west of Aberdare and draining to lower ground via an unnamed ordinary watercourse.</p> <p>A culvert inlet situated adjacent to Maesyffynon Lane surcharged during the storm event</p>	<p>Surcharging flows from the culvert inlet caused water to flow down Maesyffynon Lane towards properties at Wind Street and Cardiff Road.</p>	<p>Internal flooding 1 residential property at Wind Street and a further property situated at the junction of Cardiff Road and Maesyffynon Lane.</p> <p>The surcharging flows also contributed to the flooding of 10 residential properties along Cardiff Road.</p>
<p>Surcharged ordinary watercourse manhole at Cardiff Road.</p>	<p>Surcharging flows from the ordinary watercourse manhole contributed additional overland flows along the B4275 (Cardiff Road).</p>	<p>Contributed to the internal flooding of 13 residential properties along Cardiff Road.</p>

<p>Surcharged combined sewer manhole within the rear garden of a property at Cardiff Road.</p>	<p>Surcharging foul water flows from the combined sewer manhole caused water ingress into the rear of one residential property.</p>	<p>Contributed to the internal flooding of 1 residential property at Cardiff Road.</p>
<p>Overland flow originating from the steep hillside to the rear of Sunnybank Street.</p>	<p>Surface water runoff flowed overland down the hillside to the rear of Sunnybank Street and entered properties from the rear and conveyed along the highway to impact properties from the front also.</p>	<p>Contributed to the internal flooding of 4 residential properties at Sunnybank Street.</p>
<p>Intense rainfall and subsequent surface water runoff from the surrounding area.</p>	<p>The surface water drainage infrastructure at several streets within the sub-catchment, including Cardiff Road and Cardiff Street, became overwhelmed by the volume of surface water entering the highway as a result of intense rainfall and exceedance flows from surcharged infrastructures.</p>	<p>Contributed to the internal flooding of several properties within the sub-catchment area, including 13 residential properties along Cardiff Road, 1 commercial property at Cardiff Street and 4 residential properties at Sunnybank Street.</p>
Aberaman Sub-Catchment		
<p>Intense rainfall running off the hillsides west of Aberaman and draining to lower ground via the Nant Gwawr ordinary watercourse and its tributaries.</p> <p>A tributary to the Nant Gwawr ordinary watercourse overtopped its banks during the storm event.</p> <p>Further downstream, a culvert inlet which conveys flow beneath the A4059 surcharged. the Nant Gwawr overtopped its banks at the location where the</p>	<p>The overtopping of the tributary adjacent to Rhos Nathan Wyn caused water to enter the rear gardens of properties along Gwawr Street.</p> <p>Further downstream, a culvert inlet adjacent to the A4059 surcharged and caused water to back up the Nant Gwawr watercourse and overtop near Tudor Place, resulting in water conveying towards properties situated at the point of diversion.</p>	<p>Internal flooding to 2 residential properties at Gwawr Street and a further 2 residential properties at Tudor Place.</p>

watercourse diverts into two open channels near Tudor Place.		
Overland flow originating from the hillside to the south of Club Street on land adjacent to the Blaengwawr School estate.	Surface water runoff flowed overland from the area of land adjacent to the Blaengwawr School estate and conveyed via a small pathway towards Club Street. Water conveyed down the highway towards the B4275 (Cardiff Road).	Internal flooding to 1 residential property at Club Street from the front and a further 1 residential property at Cardiff Road.
Intense rainfall and subsequent surface water runoff from the surrounding area.	The surface water drainage infrastructure at several streets within the sub-catchment, including Curre Street, Kiln Street, Lower Station Street and Cardiff Road, became overwhelmed by the volume of surface water entering the highway as a result of intense rainfall. This resulted in the accumulation of surface water at localised low points within the highway which entered several properties from the front.	Internal flooding to 2 residential properties at Curre Street, 1 residential property at Kiln Street, 1 residential property at Lower Station Street and 1 residential and 3 non-residential properties along the B4275 (Cardiff Road) in Aberaman.

On review of Table 2, the principal sources of flooding in this incident originated from intense rainfall generating significant surface water runoff from the steep hillsides surrounding the investigation area and draining to lower ground. This runoff was routed towards residential dwellings within the investigation area via steep areas of hillside and several ordinary watercourses, many of which became overwhelmed during Storm Dennis which resulted in property flooding. Surface water flooding as a result of overwhelmed highway drainage infrastructure was also reported by residents as a secondary source of flooding to several properties.

The catchment areas above investigation area RCT02 can be sub-divided into four main watersheds, referred to as sub-catchments, to illustrate the area of land that would expect to drain towards the investigation area (hatched areas in Figure 3).

The Trecynon sub-catchment forms a large part of the upper watershed of the River Cynon basin and includes parts of the village of Trecynon (blue hatched area, Figure 3). The Abernant sub-catchment includes parts of the village of Abernant located at the confluence of the Nant y Wenallt watercourse and the River Cynon (purple hatched area, Figure 3). The sub-catchment is formed by the catchments of the Nant y Wenallt

and Nant y Geugarn ordinary watercourses, eastern tributaries of the River Cynon. Aberdare West sub-catchment includes the principal town of Aberdare which is located at the confluence of the River Dare and Cynon (red hatched area, Figure 3). Aberaman sub-catchment includes parts of the village of Aberaman which is located at the confluence of the Aman River and the Cynon (green hatched area, Figure 3). The catchments of the Nant Gwawr Ordinary Watercourse form the sub-catchment and discharge to the River Cynon.

The flood incident at RCT02 during Storm Dennis will be further described per sub-catchment area.

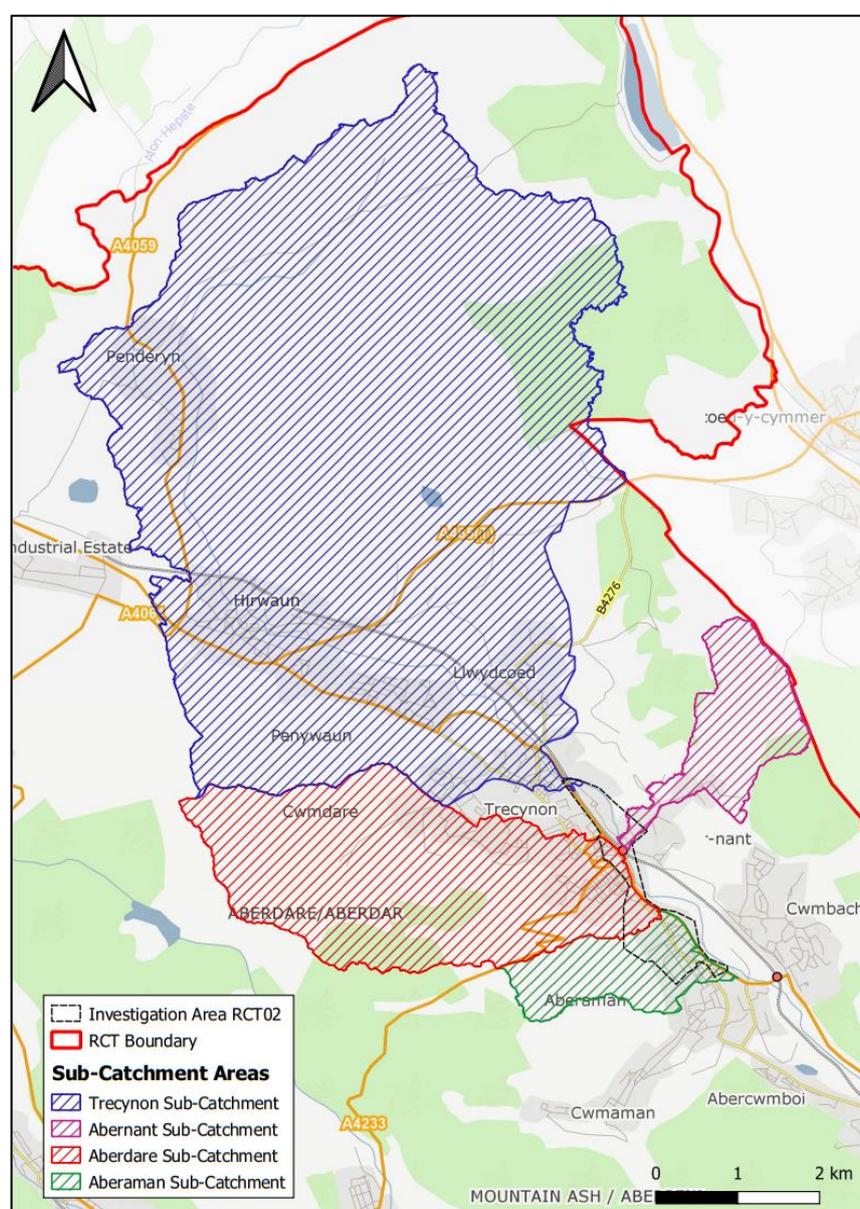


Figure 3: Sub-catchment boundary areas for investigation area RCT02

2.2.1. TRECYNON SUB-CATCHMENT

The primary source of the recorded flooding within the Trecynon sub-catchment in this incident originated from the main River Cynon when river levels exceeded riverbank levels to the rear of properties at Wellington Street.

It was reported by residents that the River Cynon had “breached” (overtopped) its banks during the early hours of Sunday 16th February and floodwater was entering properties. According to residents, water overtopped the rear retaining walls of properties along Wellington Street, in addition to the allotment area, before continuing its flow path onto the highway and impacting properties from the front. Three residential properties at Wellington Street were confirmed as internally flooded by RCT officers.

Water conveyed downhill towards Waterloo Place, causing internal flooding to a further two properties. Water was reported to have reached flood depths of over 1 metre in depth at Waterloo Place, submerging cars along the road in addition to causing property flooding.

2.2.2. ABERNANT SUB-CATCHMENT

The primary source of flooding to properties within the Abernant sub-catchment was identified as surface water flooding associated to overwhelmed highway drainage infrastructure and ordinary watercourse flooding, notably from the Nant y Wenallt watercourse which flows parallel to Abernant Road.

Upon an inspection of the area undertaken by RCT officers in the days following the storm event, significant surface water was observed as pooling within the car park grounds of a non-residential property at Abernant Road (Figure 4) and conveying towards localised low points in the area. Evidence of blocked highway drainage infrastructure and a surcharged surface water sewer manhole along the unadopted road were also identified in the area, considered to have contributed runoff towards localised low points during Storm Dennis.



Figure 4: Evidence of surface water ponding and runoff within localised low points at Abernant Road (captured by RCT officers post Storm Dennis)

Furthermore, it was reported by residents within the lower reach of Abernant Road that flooding was originating from a “culvert” close to their properties. The Nant y Wenallt watercourse is culverted in three sections at the bottom of the valley however the available evidence suggests that ‘Culvert Inlet 1’ (shown in Figure 5) surcharged during the storm event.

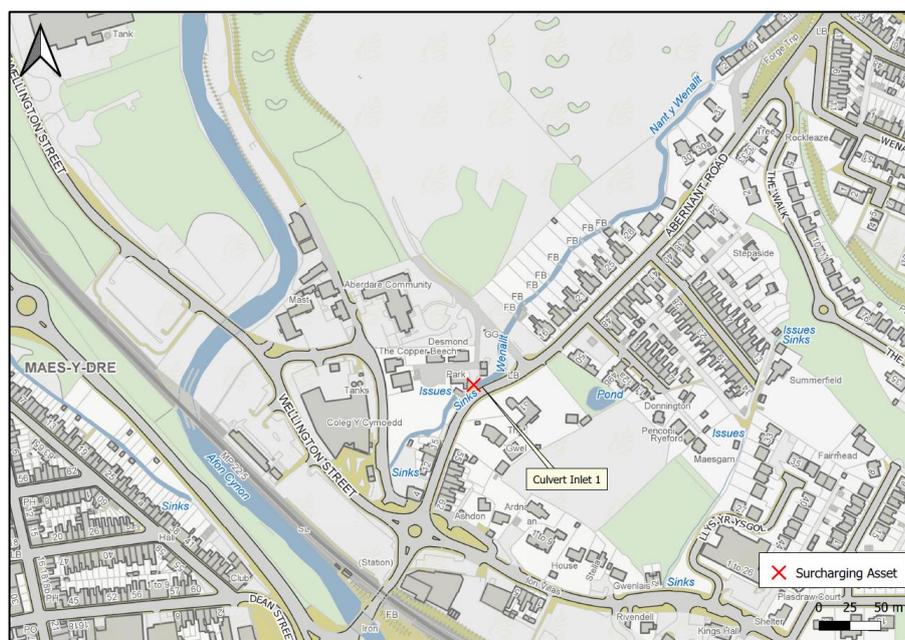


Figure 5: ‘Culvert Inlet 1’ associated to the Nant y Wenallt watercourse identified as a source of flooding within the Abernant sub-catchment during Storm Dennis (15-16th February 2020)

An assessment of available LIDAR data show that 'Culvert Inlet 1' is at a similar level or slightly higher than the surrounding properties, which would indicate any out-of-bank flow would direct its way towards the impacted properties. Two residential properties and 1 non-residential property within the lower reach of Abernant Road was confirmed by RCT officers as internally flooded during Storm Dennis.

Surface water runoff directed towards the investigation area via steep valley hillsides and impermeable urban surfaces was also identified as a secondary source of flooding within the Abernant sub-catchment. The gradient and extent of impermeable surface within the sub-catchment generates fast surface water flows directed towards the lower parts of Abernant, creating a rapid catchment response which is considered to have contributed to the accumulation of surface water within the low points at Abernant Road.

2.2.3. ABERDARE WEST SUB-CATCHMENT

Several calls were received from residents at Gloucester Street on the 16th of February 2020 to report water ingress into multiple residential properties. Upon a site inspection undertaken by RCT's Flood Risk Management team in the days following the storm event, an unnamed ordinary watercourse to the rear of properties at Gloucester Street was identified. The unnamed watercourse is illustrated in Figure 6, captured post event.



Figure 6: Images of the unnamed ordinary watercourse to the rear of properties at Gloucester Street within the Aberdare East sub-catchment (captured by RCT officers post Storm Dennis)

Information provided by residents during the public engagement exercise indicate that the unnamed watercourse overtopped its banks during the storm event and entered the rear gardens of several properties. RCT officers confirmed 9 residential properties along Gloucester Street were internally flooded as a result. It was reported that there was some compartmentalisation of flooding to properties due to some properties' rear garden boundary providing some flood protection.

Reports of surface water accumulation along the highway is also considered to have contributed to external flooding to the front of properties along Gloucester Street.

Further south within the Aberdare East sub-catchment, a culvert inlet adjacent to Maesyffynon Lane was identified as surcharging during the storm event. Exceedance flows from the surcharged inlet travelled towards Wind Street and Cardiff Road, resulting in internal flooding to one residential property at Wind Street and one residential property at the junction to Cardiff Road. The location of the culvert inlet (labelled 'Culvert Inlet 2') and the associated flow paths are illustrated in Figure 7).



Figure 7: Observed flow path as a result of 'Culvert Inlet 2' surcharging during Storm Dennis (15-16th February 2020)

Exceedance flows travelling along the highway were observed to have overwhelmed the highway drainage infrastructure along Cardiff Road, resulting in surface water accumulation outside the fronts of several properties.

A surcharging combined sewer manhole was reported by residents as surcharging foul water within the rear garden of a residential property at Cardiff Road. The manhole is labelled 'Manhole 2' in Figure 8 and was identified as a contributing source of flooding to one residential property.

A surcharging ordinary watercourse manhole (labelled 'Manhole 1' in Figure 8) at Cardiff Road was also reported as surcharging during the storm event, contributing additional surface water to the highway which was unable to drain away via the surface water drainage infrastructure along the B4275 (Cardiff Road). In addition to contributing to the internal flooding of 13 residential properties along Cardiff Road, overwhelmed surface water drainage infrastructure was also identified as the primary source of flooding to one commercial property at Cardiff Street.

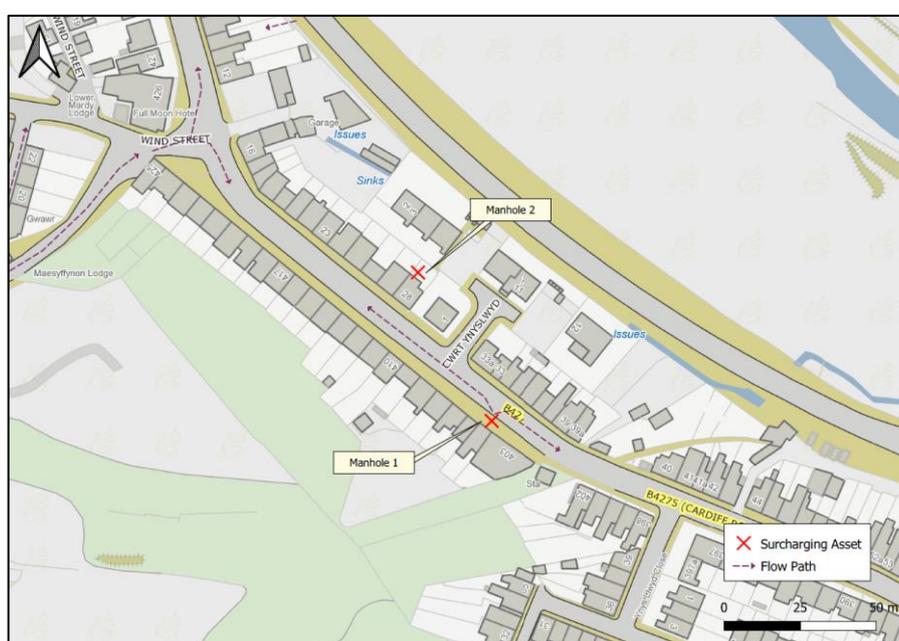


Figure 8: Observed flow path as a result of surcharged infrastructure along the B4275 (Cardiff Road) during Storm Dennis (15-16th February 2020)

At the southern extent of the Aberdare West sub-catchment, it was also confirmed by RCT officers that 4 residential properties at Sunnybank Street were internally flooded during Storm Dennis as a result of overland flows travelling down the hillside to the rear of their properties. Water reportedly entered the rear of the properties and conveyed onto the highway to impact properties from the front also.

2.2.4. ABERAMAN SUB-CATCHMENT

Anecdotal reports provided by residents during post event inspections carried out by RCT officers identified a tributary to the Nant Gwawr ordinary watercourse, which flows adjacent to Gwawr Street, to have overtopped during the storm event following intense rainfall. The unnamed tributary is highlighted within the red box in Figure 9. The watercourse exceeded its typical levels and entered the rear gardens of some properties, resulting in internal flooding to two residential properties at Gwawr Street.

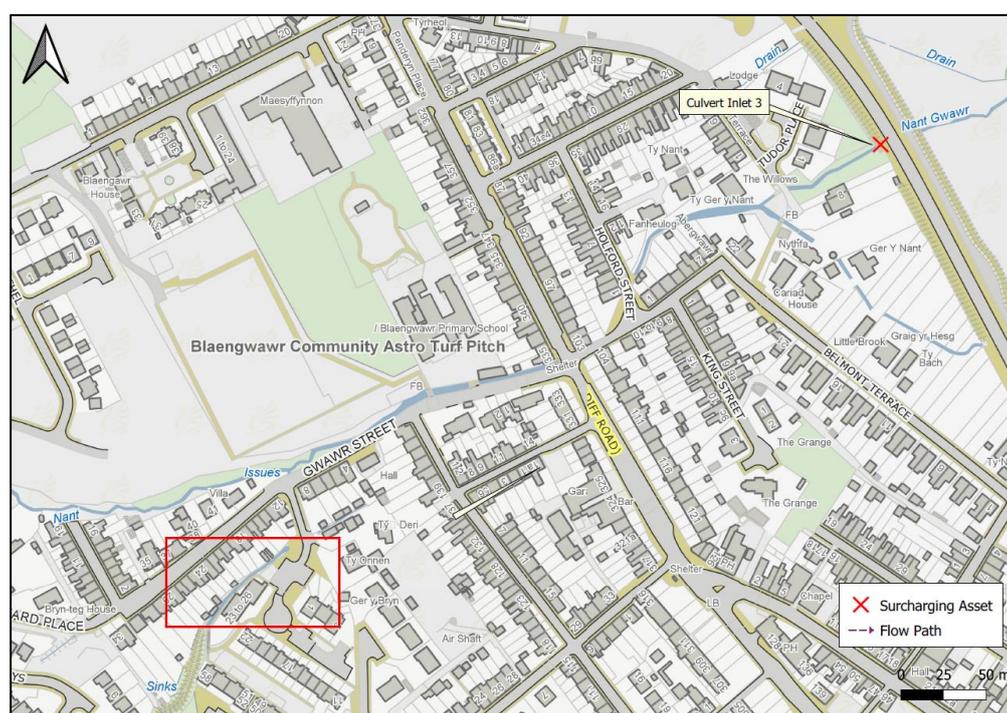


Figure 9: Observed flow path as a result of surcharged infrastructure and the unnamed tributary associated to the Nant Gwawr watercourse during Storm Dennis (15-16th February 2020).

The unnamed channel and associated culvert inlet were identified as heavily silted with deposited debris during post event inspections (depicted in Figure 10), indicating that the culvert inlet was operating at a reduced capacity during Storm Dennis. Damage caused to the rear retaining wall of the impacted properties suggest that the watercourse became overwhelmed during the storm event and overtopped.



Figure 10: Evidence of deposited silt and debris within the unnamed ordinary watercourse channel and culvert inlet during post event inspection (captured by RCT's Flood Risk Management team on 21/02/2020)

Further downstream of the Nant Gwawr ordinary watercourse, a culvert inlet (labelled 'Culvert Inlet 3' in Figure 9) which conveys beneath the A4059 was identified as surcharging during the storm event. Figure 11 depicts evidence of saturated ground and debris surrounding 'Culvert Inlet 3' following clearance works carried out by the Council's Highway and Streetcare Depot.



Figure 11: Image of 'Culvert Inlet 3' captured post event during cleansing operations (captured by RCT officers on 19th February 2020)

It is considered that the Nant Gwawr watercourse backed up flow upstream of 'Culvert Inlet 3', resulting in its overtopping. Exceedance flows conveyed towards two residential properties at Tudor Place, both of which are situated at low points which allowed water to convey and accumulate outside both properties causing internal flooding.

At Belmont Terrace, residents stated that debris and woody material within the Nant Gwawr watercourse channel was creating a damming effect and causing the watercourse to overtop into rear gardens, however no internal flooding was recorded at this part of the channel.

Several isolated incidences of surface water flooding as a result of intense rainfall and overwhelmed highway drainage infrastructure were also identified as a predominant source of flooding within the Aberaman sub-catchment area during Storm Dennis. RCT officers confirmed internal flooding to 5 residential properties and 3 non-residential properties across several streets including Curre Street, Kiln Street, Lower Station Street and the B4275 (Cardiff Road) in Aberaman.

It was also confirmed during post event investigations that overland flows originating from land adjacent to the Blaengwawr School estate caused internal flooding to two residential properties at Club Street and Cardiff Road during the storm event.

2.3. RAINFALL ANALYSIS

See RCT's 'Overview Report' of Storm Dennis, reference 'FRM – Storm Dennis – Overview Report'², for a detailed analysis of the rainfall and ordinary watercourse response.

3. POSSIBLE CAUSES

3.1. CULVERT CONDITIONS

Within investigation area RCT02 there are several named and unnamed watercourses which drain the hillsides to the east and west of RCT02 and discharge into the River Cynon. Many of these watercourses are culverted beneath Aberdare and Aberaman's urban settlements.

Several culvert inlets were inspected by RCT's Flood Risk Management team and Highway and Streetcare Dept following the flood event to assess their condition and help determine whether they served as a contributing factor to the flooding at RCT02. CCTV survey inspections of the culvert networks were undertaken to ascertain both the operational condition of the network, and its structural integrity along sections of the network. Figures 12 and 13 outline the 5 networks surveyed and highlights the culverted infrastructure known to have surcharged based on the available evidence.

It should be noted that all surveys reported in this section were undertaken post flood event. It's not possible to say what debris identified in the survey was mobilised and deposited as a result of the storm event and what had been deposited by previous events. As such, the following should be considered to be reflective of the asset condition at the end of the storm event and may not necessarily be reflective of the condition of the assets prior to the onset of the storm event.

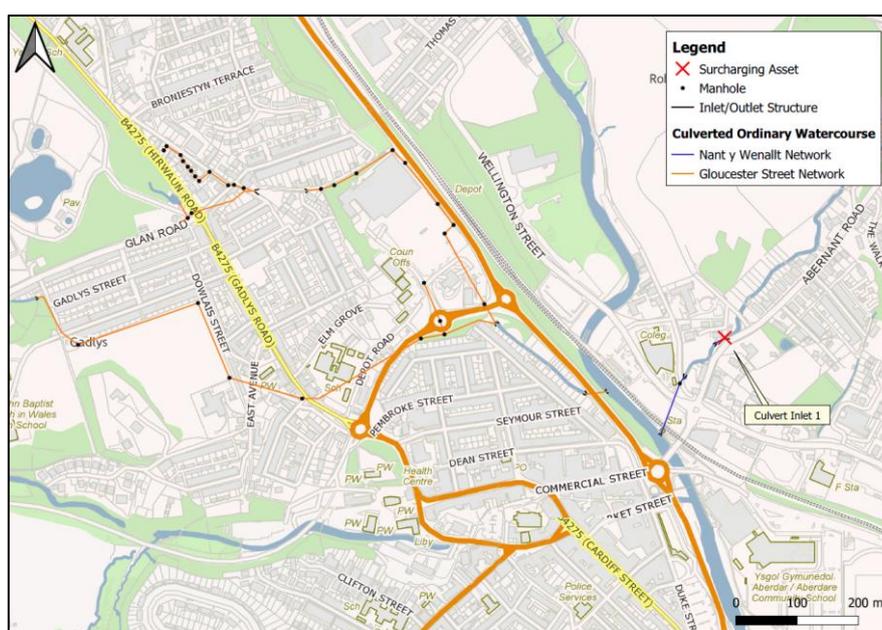


Figure 12: Surveyed culverted ordinary watercourses and surcharged culverted infrastructure within the northern half of RCT02 (Abernant & Aberdare sub-catchments)

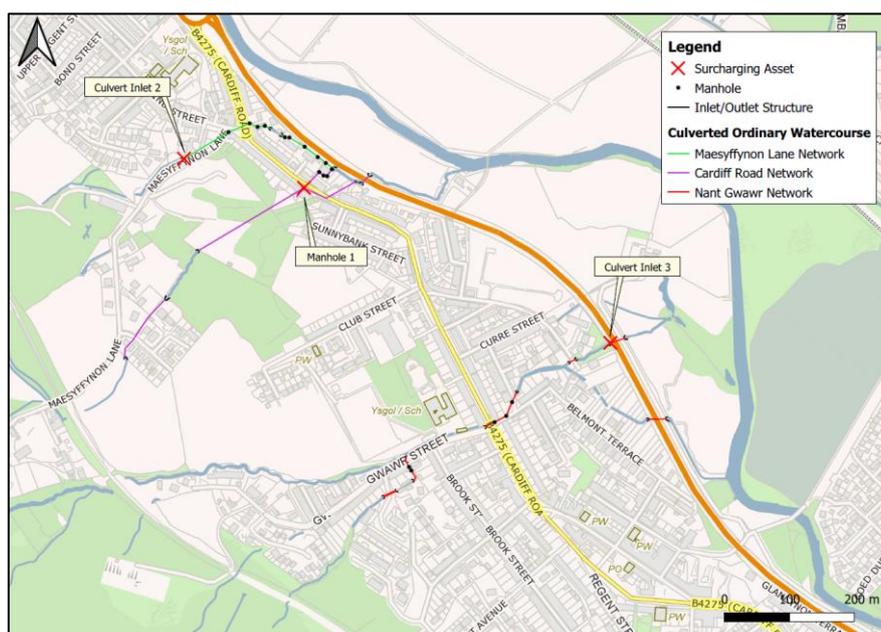


Figure 13: Surveyed culverted ordinary watercourses and surcharged culverted infrastructure within the southern half of RCT02 (Aberdare & Aberaman sub-catchments)

Based on the available evidence presented within this investigation, ‘Culvert Inlet 1’ associated to the ‘Nant y Wenallt’ culvert network (Figure 12) is considered to have surcharged during the storm event, contributing to the internal flooding of two properties at Abernant Road. ‘Culvert Inlet 1’ conveys the Nant y Wenallt beneath the highway leading from Abernant Road and is identified as a privately owned asset. Post event surveying of the ‘Nant y Wenallt culvert network’ identified large debris reducing the culvert networks cross-sectional area by 90% as illustrated in Figure 14. The identified debris is considered to have been mobilised from upstream, causing an obstruction and reduction in the culvert network’s hydraulic capacity to manage the flow of water, leading to the Nant y Wenallt surcharging at ‘Culvert Inlet 1’.

Culvert inspections indicates that ‘Culvert Inlet 1’ has a very shallow gradient which inhibits the culvert’s ability to discharge flow and promotes sediment deposition which increases the structures risk to blockages. Anecdotal reports from residents affected by the flooding refer to the culvert being unable to manage the flows within the watercourse during the event, further suggesting that the inlet surcharged during Storm Dennis.

The CCTV survey also identified significant defects and blockages present in the culvert network downstream of ‘Culvert Inlet 1’, further indicative of the mobilisation of debris from the upper catchment.



Figure 14: Evidence of settled debris within the 'Nant y Wenallt' culvert network downstream of 'Culvert Inlet 1' (captured during post event CCTV surveying)

'Culvert Inlet 2' associated to the 'Maesyffynon Lane' culvert network (Figure 13) was observed to have surcharged during the storm event, resulting in flooding to properties at Wind Street and Cardiff Road within the Aberdare West sub-catchment. The inlet is identified as the responsibility of the Council and was inspected by RCT's Highway and Streetcare Depot post event and identified as blocked with debris mobilised from the upstream channel.

The culvert network downstream of 'Culvert Inlet 2' was assessed as being in acceptable condition with limited structural defects and settled debris observed. The outfall was also observed to have little debris, inferring that the debris screens upstream of 'Culvert Inlet 2' succeeded in reducing the volume of debris conveying into the culvert network but in doing so caused an obstruction to the debris screen at 'Culvert Inlet 2' which led to the watercourse overtopping.

Following the observed surcharging of 'Manhole 1', the associated 'Cardiff Road' culverted watercourse network and overflow system (Figure 13) were surveyed on several occasions post Storm Dennis. The culvert network was assessed as being in poor structural and operational condition with debris identified within the network, both downstream and upstream of 'Manhole 1', restricting CCTV operations. Figure 15 illustrates the poor condition of the 'Cardiff Road' culvert network during CCTV survey operations.



Figure 15: Debris accumulation upstream of 'Manhole 1' (left) and deformed overflow culvert network downstream of 'Manhole 1' (right) (captured during post event CCTV surveying operations)

The main line culvert network downstream of 'Manhole 1' was assessed as being in poor condition. The culvert network was identified as deformed with several fractures present which is considered to have impacted the hydraulic efficiency of the network to manage the flows entering the system. The main line culvert network also has a 90-degree bend downstream of 'Manhole 1' which is considered to have hydraulically locked the culvert system, contributing to the surcharge at 'Manhole 1' during Storm Dennis.

The overflow network was also assessed as being in poor condition with several fractures, cracks and sections of broken pipe present (Figure 15, right). The outlet to the overflow network was also identified as buried with silt and debris which is considered to have impacted the outflow control, further contributing to the surcharge of 'Manhole 1'.

Based on the available evidence, the poor condition of the 'Cardiff Road' culvert network is considered to have contributed to the surcharging of 'Manhole 1' during Storm Dennis. The debris identified throughout the network and at the outfall is also indicative of the high flow rates which enabled the erosion and transportation of debris from the upper catchment and into the culvert network during the storm event.

In response to the defects identified within the culvert network, the Council appointed a contractor to cleanse the 'Cardiff Road' culvert network and undertake culvert lining and repair works to the overflow culvert network.

Within the Aberaman sub-catchment, several culvert inlets associated to the Nant Gwawr ordinary watercourse and its tributaries were inspected post storm event. The unnamed tributary channel adjacent to Rhos Nathan Wyn, which was identified as the

source of flooding to two residential properties at Gwawr Street, was observed as heavily silted with deposited debris (Figure 10) which was observed as causing a 50% obstruction to the inlet's debris screen. This debris is considered to have impacted the culvert inlet's ability to manage the flow of water, resulting in a backing up effect of flow upstream which contributed to the overtopping of the watercourse over the rear retaining walls of properties at Gwawr Street. The high velocity flows within the Nant Gwawr watercourse during Storm Dennis are also considered to have influenced the overtopping of the unnamed tributary by impacting the discharge of water into the Nant Gwawr at the outfall.

The Nant Gwawr is initially culverted beneath the B4275 (Cardiff Road) and outfalls adjacent to Holford Street. The culvert inlet was inspected following the storm event and found to be partially blocked with debris however no flooding was attributed to the inlet. CCTV footage captured by RCT's monitoring station depicts the rapid rise and fall in water levels on the Nant Gwawr watercourse during Storm Dennis (Figure 16). Within a 14-hour period, levels within the Nant Gwawr rose extremely suddenly during Saturday (15 Feb) night and remained high until suddenly falling by Sunday (16 Feb) morning, leaving behind deposited debris mobilised during the peak flows.



Figure 16: Images of the Nant Gwawr inlet at the B4275 (Cardiff Road) captured at RCT's monitoring station (15/02/20 20:34 (top left), 16/02/20 03:30 (top right), 16/02/20 08:27 (bottom left), 16/02/20 10:27 (bottom right))

The 'Nant Gwawr' culvert network downstream of the culvert inlet depicted in Figure 16 was surveyed to be in poor operational condition. Debris, inclusive of woody debris, was identified downstream of the culvert inlet (shown in Figure 17), indicative of the mobilisation of debris carried downstream during the storm event.



Figure 17: Large woody debris identified within the culvert network downstream of the culvert inlet adjacent to the B4275 (Cardiff Road) (captured during CCTV surveying operations)

Further downstream the Nant Gwawr ordinary watercourse flows as an open channel and is diverted into two channels near Tudor Place which are both culverted beneath the A4059 and discharge into the River Cynon to the east of RCT02.

'Culvert Inlet 3', which conveys the Nant Gwawr watercourse beneath the A4059, was identified as surcharging during the storm event. Post event inspections identified the culvert as blocked with debris, resulting in the watercourse backing up flow upstream and overtopping. In response to the identified debris, RCT's Highway and Streetcare Depot undertook cleansing operations to remove approximately 20-30 tonnes of material from the inlet and upstream watercourse (depicted in Figure 18).

The culvert network downstream of 'Culvert Inlet 3' was assessed as being in acceptable condition with no structural defects and little settled debris observed, inferring that the obstruction to inlets' debris screen was the primary cause of surcharge at 'Culvert Inlet 3'.



Figure 18: Debris removed from 'Culvert Inlet 3' and the upstream watercourse (captured by RCT officer post Storm Dennis)

The observed blockages to the 'Nant Gwawr' culverted infrastructure are indicative of the mobilisation and conveyance of debris carried downstream during the storm event. Residents in the downstream section of the Nant Gwawr watercourse also reported that debris, inclusive of woody material, was creating a damming effect within the watercourse. This debris is considered to have been washed down through the culvert network, causing an obstruction at 'Culvert Inlet 3' which led to its surcharging.

The culverted network associated to the unnamed ordinary watercourse which was identified to have overtopped to the rear of Gloucester Street (Figure 12) was also inspected by RCT officers post event to determine its condition and assess its impact on the overtopping of the watercourse. The culverted network upstream of the unnamed ordinary watercourse was assessed as being in mostly acceptable condition, with little settled deposits observed. The condition of the 'Gloucester Street' culvert network is not considered to have contributed to its overtopping during Storm Dennis.

3.2. OPEN WATERCOURSE CONDITIONS

Several sections of natural ditches and open watercourses which drain the steep hillsides above RCT02 are identified to flow through the investigation area and discharge into the River Cynon (Figure 19). The most notable watercourses include the Nant y Wenallt watercourse to the east of Aberdare and the Nant Gwawr watercourse which flows through the Aberaman.

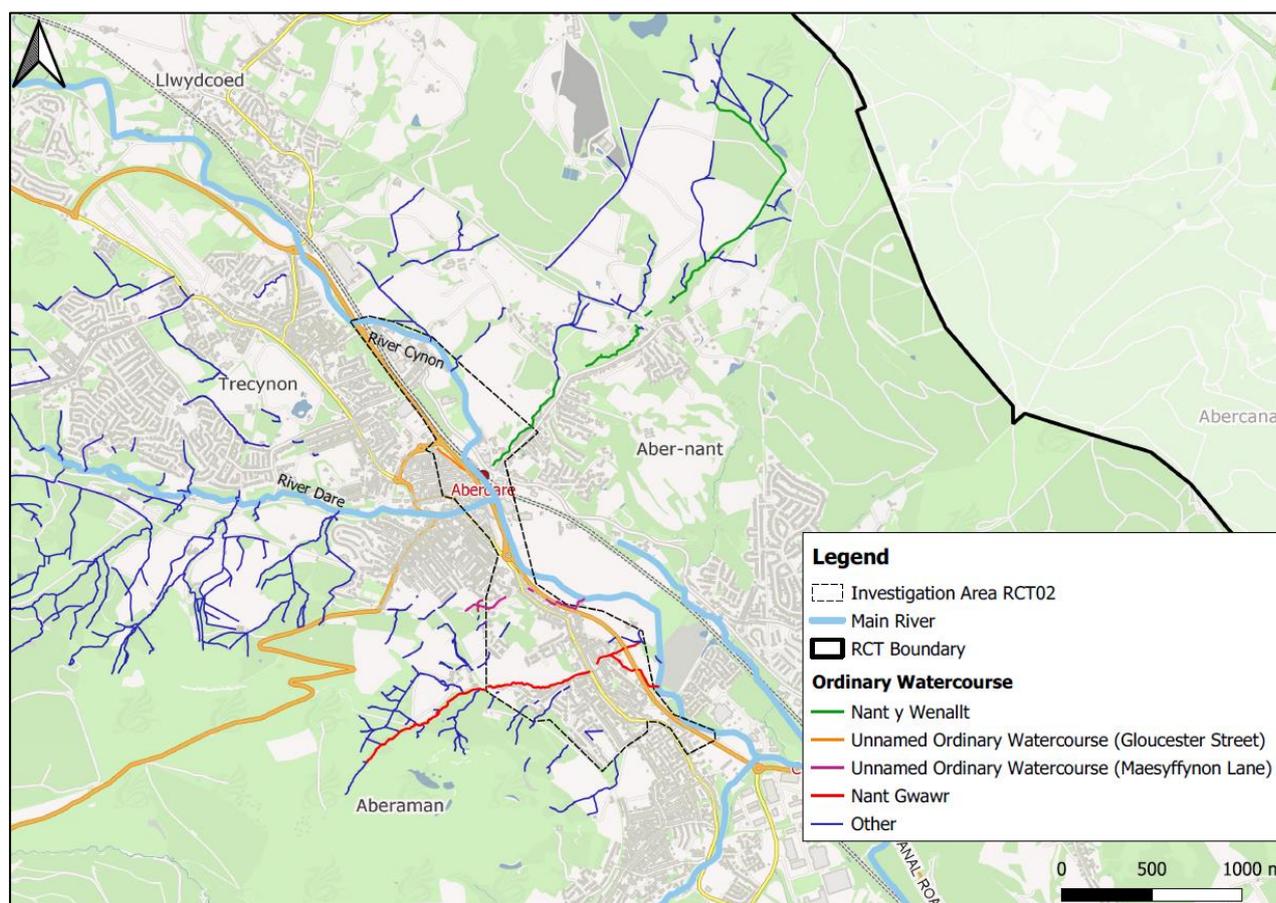


Figure 19: Map of Ordinary Watercourses flowing through RCT02

Following the storm event, RCT Flood Risk Management officers carried out a site walk-over assessment, where possible, of the ordinary watercourses upstream of the culverted infrastructure identified as sources of flooding (highlighted in Figures 12 and 13) to assess the condition of the watercourses for any signs of overtopping, evidence of scour and any land movement of the hillsides.

3.2.1. NANT Y WENALLT ORDINARY WATERCOURSE

The Nant y Wenallt ordinary watercourse conveys from the upper Abernant catchment to the northeast of investigation area RCT02 towards the River Cynon at Aberdare (highlighted green in Figure 19). The Nant y Wenallt largely flows as an open channel along the hillside before becoming more heavily culverted towards the lower reach of Abernant Road where ‘Culvert Inlet 1’ was identified as surcharging during Storm Dennis.

On review of the Nant y Wenallt ordinary watercourse post event there was evidence of deposited natural scour material and debris throughout the length of the channel (Figure 20). The watercourse was also observed as showing signs of embankment scouring and undercutting within the upper reaches, indicative of the fast-flowing water conveying downstream.

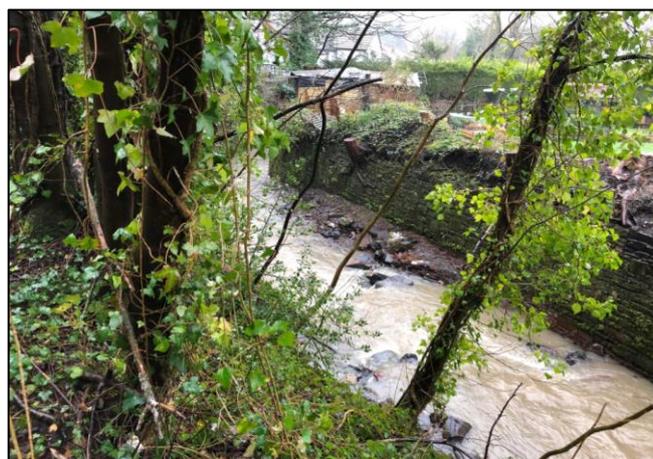
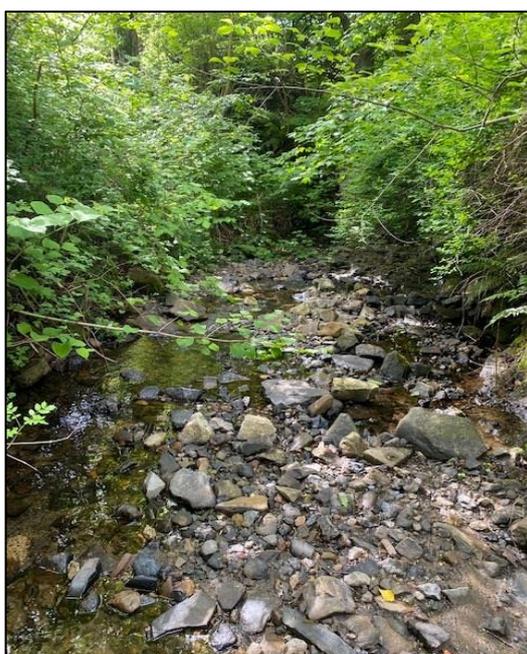


Figure 20: Debris deposition within the Nant y Wenallt ordinary watercourse during post event inspections carried out by RCT officers

The debris removed from the culvert network downstream of ‘Culvert Inlet 1’ was indicative of natural scour material, indicating that the condition of the upstream ordinary watercourse contributed erosive material towards ‘Culvert Inlet 1’ during the storm event. Although it is not possible to conclude that this material was wholly transported downstream during the storm event, the material cleansed from the downstream culvert network consisted of similar natural erosive material identified upstream of the Nant y Wenallt.

3.2.2. UNNAMED ORDINARY WATERCOURSE (GLOUCESTER STREET)

The unnamed ordinary watercourse to the rear of Gloucester Street (highlighted orange in Figure 19) was identified as overtopping and causing internal flooding to 9 residential properties. The watercourse and associated culverted infrastructure are depicted in Figure 21.

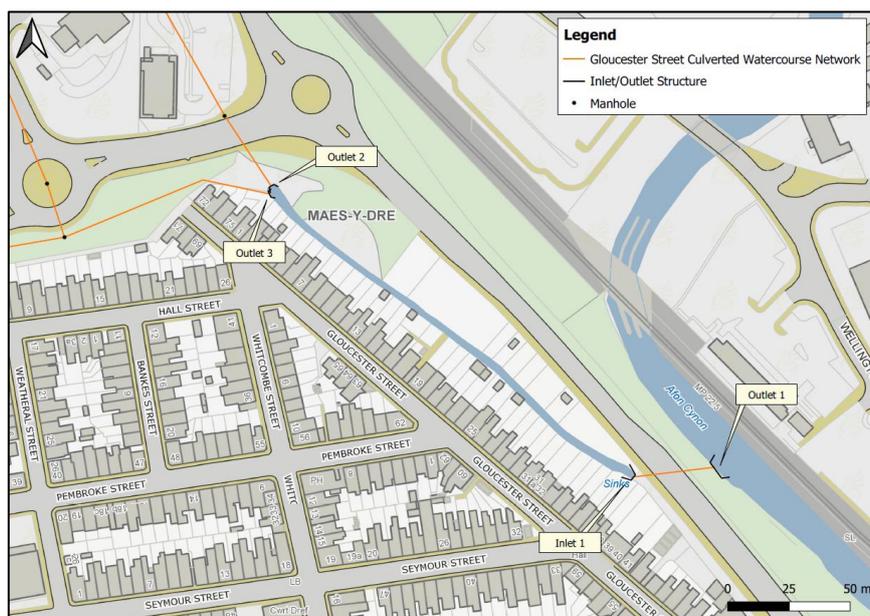


Figure 21: Map of unnamed ordinary watercourse to the rear of Gloucester Street and labelled culverted infrastructure

During post event inspections, the watercourse was observed to be in poor condition with heavy vegetation restricting on-site inspections, particularly towards the lower extent of the watercourse. Figure 22, captured post storm event, shows evidence of settled debris within the watercourse, in addition to areas of minor scouring of the embankments, indicative of the high and fast flows during the storm event. The condition of the unnamed ordinary watercourse is not considered the primary cause of overtopping during the storm event, however.



Figure 22: Evidence of stripped topsoil on the embankments of the unnamed ordinary watercourse to the rear of Gloucester Street (captured by RCT officers post storm event)

Responses provided by residents during the public engagement exercise reported that the unnamed ordinary watercourse near 'Inlet 1' (Figure 21) was observed as ponding with little flow identified within the channel during the storm event. The unnamed ordinary watercourse discharges into the River Cynon beneath the A4059 at 'Outlet 1'. It is considered that the high river levels on the River Cynon during Storm Dennis restricted the discharge of flow from the unnamed ordinary watercourse contributing to the overtopping of the watercourse into the rear gardens of several properties.

Asset information relating to the culverted infrastructure depicted in Figure 21 was assessed to determine the cross-sectional area of the outlet and inlet structures to manage the flows. 'Outlet 2' and 'Outlet 3' (Figure 21) comprise of 1200mm dia and 750mm dia concrete pipes, providing a combined cross-sectional area of 1.57m². Both outlet structures are depicted in Figure 23.

'Inlet 1' consists of a 1.5 x 1.48 metre reinforced concrete box structure which conveys beneath the A4059 and discharges flow into the River Cynon at 'Outlet 1'. The cross-sectional area for 'Inlet 1' is 2.22m². 'Inlet 1' is depicted in Figure 24 (left). Figure 24 (right) depicts the interaction between the ordinary watercourse and main river flows at 'Outfall 1', illustrated by the variation in colour of flow.

The assessment concludes that the cross-sectional area of 'Inlet 1' is approximately 1.4 times greater than the total cross-sectional area of 'Outlets 2 and 3', indicating that 'Inlet 1' has sufficient capacity to manage the flows conveying from 'Outlet 2 and 3'.

No flooding was observed at 'Outlet 2 and 3', further supporting the belief that high levels on the River Cynon contributed to the overtopping of the ordinary watercourse.



Figure 23: Image of 'Outlet 2 and 3' associated to the 'Gloucester Street' culvert network (captured by RCT officers post event)



Figure 24: Downstream view of 'Inlet 1' (left) and image of 'Outlet 1' looking upstream of the River Cynon (right) (captured by RCT officers prior to Storm Dennis)

3.2.3. UNNAMED ORDINARY WATERCOURSE (MAESYFFYNON LANE)

'Culvert Inlet 2' takes inflow from a short section of unnamed ordinary watercourse (highlighted pink in Figure 19) which flows adjacent to Maesyffynon Lane within the Aberdare sub-catchment. The upper unnamed ordinary watercourse channel is largely natural while the downstream channel comprises of gabion structures and twin debris screens to minimise the risk of scour and debris mobilisation.

The unnamed ordinary watercourse showed some evidence of debris deposition within the channel however the upper watercourse channel was observed as largely undefined with dense vegetation restricting on-site inspections. The inspecting officer did however observe evidence of out-of-bank flows whereby debris and flattened grass was identified along the eastern embankment in Figure 25. It is considered that significant flows conveying downstream, as a result of intense rainfall during Storm Dennis, caused the watercourse to overtop and mobilise material from the surrounding embankment area towards 'Culvert Inlet 2', contributing to its blockage and associated surcharge.



Figure 25: Photo of the unnamed ordinary watercourse channel upstream of 'Culvert Inlet 2' (captured by RCT officers post event)

3.2.4. NANT GWAWR ORDINARY WATERCOURSE

The Nant Gwawr ordinary watercourse is the primary named watercourse which flows west to east through the village of Aberaman and discharges into the River Cynon to the east of the A4059.

Following reports of debris mobilisation throughout the Nant Gwawr culvert network and sections of open channel during Storm Dennis, the Nant Gwawr ordinary watercourse was inspected post Storm Dennis. On review of the upstream watercourse, significant debris deposition was observed. This debris comprised primarily of large boulders, mixed stonewash, silt and woody debris, indicative of natural erosive material. Areas of embankment scour and undercutting were also observed within the upper reaches of the Nant Gwawr watercourse, as depicted in Figure 26.



Figure 26: Evidence of debris deposition and embankment scour within the upper section of the Nant Gwawr ordinary watercourse (captured by RCT officers post Storm Dennis)

The condition of the watercourse in the upper reaches of the Nant Gwawr are considered to have contributed to the deposited debris observed within the downstream channel. Figure 27 depicts the deposition of eroded material within the Nant Gwawr channel adjacent to Gwawr Street. This material is considered to have been washed down the catchment towards the culverted infrastructure during the storm event.



Figure 27: Deposition of material and scouring to the eastern embankment of the Nant Gwawr ordinary watercourse adjacent to Gwawr Street (captured by RCT officers on 18th February 2020)

The rapid flows conveying down the Nant Gwawr also caused significant channel and embankment scour adjacent to Gwawr Street (Figure 27), further indicative of the mobilisation of material within the watercourse during the storm event. The eroded sections of embankment at Gwawr Street have since been repaired by a Council appointed contractor.

On review of the ordinary watercourse conditions upstream of 'Culvert Inlet 3', which surcharged during the storm event after becoming blocked with debris, the channel was observed to be largely undefined with evidence of embankment scour and out-of-bank flows identified (Figure 28). These out-of-bank flows are considered to have mobilised material from the surrounding embankment area towards 'Culvert Inlet 3', contributing to its blockage and associated surcharge.

The delivery of sediment and stone towards the investigation area via the unnamed and named ordinary watercourses is considered to have contributed to the surcharging of culverted infrastructure at RCT02.



Figure 28: Condition of the Nant Gwawr ordinary watercourse upstream of 'Culvert Inlet 3' (captured by RCT officers on 19th February 2020)

3.3. MAIN RIVER

The designated main River Cynon enters the investigation area from the northwest and flows through the centre of Aberdare, before continuing in a south easterly direction to the east of Aberaman (Figure 1). Properties located in the area where the River Cynon enters the investigation area were impacted during Storm Dennis.

3.3.1. MAIN RIVER LEVELS AND FLOOD WARNINGS

The hydrograph in Figure 29 illustrates the rapid rise in levels of the River Cynon in response to rainfall between the 14 – 17th February 2020. River level data was captured at NRW's Aberdare monitoring station which is situated within Aberdare town centre.

NRW issued a 'Flood Alert' (indicating possible flooding) for the River Cynon at 12:51 on the 15th of February, during that time the River Cynon at Aberdare had reached over a metre in depth. The River Cynon continued to rise during the early hours of Sunday 16th February morning before reaching a peak level of 2.125 meters at 03:00 on 16th February 2020; the highest level recorded for the River Cynon at Aberdare.

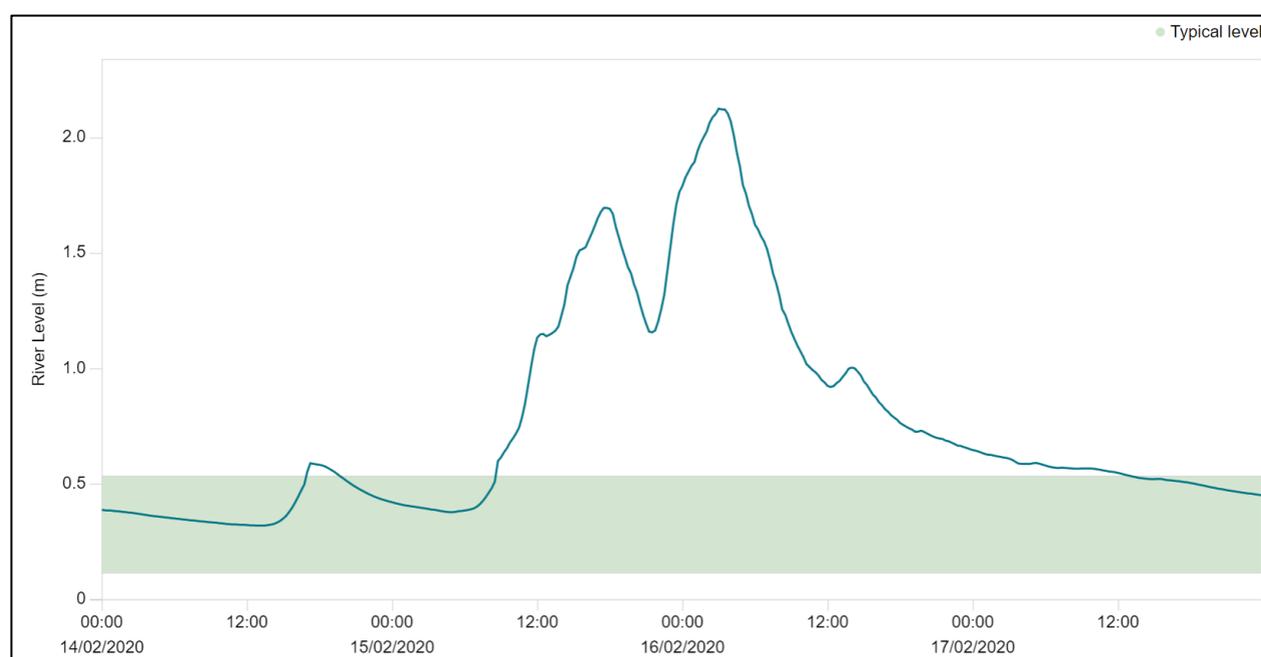


Figure 29: The River Cynon levels at Aberdare station between the 14th and 17th February 2020 (Natural Resources Wales)

The green bar displayed on the hydrograph shows the typical level of the River Cynon at Aberdare station, ranging between 0.1 and 0.55 metres. At its peak, the River Cynon

at Aberdare almost tripled in height compared to its average level, stressing the extreme and unprecedented levels that RCT's rivers rose to during the storm's peak intensity. As a result of the significant rise in river levels following heavy and persistent rainfall, the River Cynon overtopped its banks to the rear of Wellington Street, leading to property flooding.

River levels in the Cynon at Aberdare subsided relatively quickly following the peak, returning to its typical levels the following day on the 17th of February 2020.

Investigation area RCT02 falls primarily within NRW's Aberdare Flood Warning Area. The Flood Warnings issued by NRW for Aberdare, and the associated river levels for the River Cynon captured at NRW's Aberdare station during Storm Dennis are shown in Table 3.

Table 3: Flood Warnings issued by NRW for the River Cynon at RCT02 during Storm Dennis

Flood Warning Type	Location	Start Time	River Level (m) at Aberdare
Flood Alert	River Cynon	12:51 15/02/2020	1.139
Flood Warning	River Cynon at Aberdare	02:58 16/02/2020	2.125

NRW issued a 'Flood Warning' alert (indicating flooding is expected) for the River Cynon at Aberdare at 02:58 on the 16th of February; at which point the main river was over 2.1 metres in depth. Evidence provided by residents as part of the public engagement exercise indicate that main river flooding at Wellington Street and Waterloo Place had already commenced prior to the 'Flood Warning' alert being issued.

NRW have acknowledged within their 'Flood Incidence Response Review'⁴ that the operation of the Flood Warning Service "came under significant pressure during February and at times became overwhelmed" resulting in flood warnings being issued late (after the onset of flooding) or not issued at all. At this location (RCT02), this is in reference to the 'Flood Warning' alert at Aberdare.

Improvements to their flood forecasting and warning services are being internally investigated by NRW and where feasible implemented to deliver the recommendations outlined within their Flood Incident Response Review⁴.

⁴ [February 2020 Floods in Wales: Flood Incident Management Review \(cyfoethnaturiol.cymru\)](https://www.cymru.gov.uk/mediacentre/2020/02/2020-floods-in-wales-flood-incident-management-review)

3.3.2. MAIN RIVER FLOOD RISK

As outlined in Section 2, the overtopping of the River Cynon at Waterloo Street during Storm Dennis has been identified as the primary cause of flooding to 5 residential properties within the investigation area.

Figure 30 in an excerpt from NRW's Flood Risk Assessment Wales (FRAW) mapping exercise which depicts the main river flood risk extents for the 'Defended' scenario, i.e., with the presence of flood defence infrastructure. The darker shading identifies areas at higher risk of flooding (more frequent/less extreme rainfall events) and lighter shading showing the lower risk areas (less frequent/more extreme rainfall events).

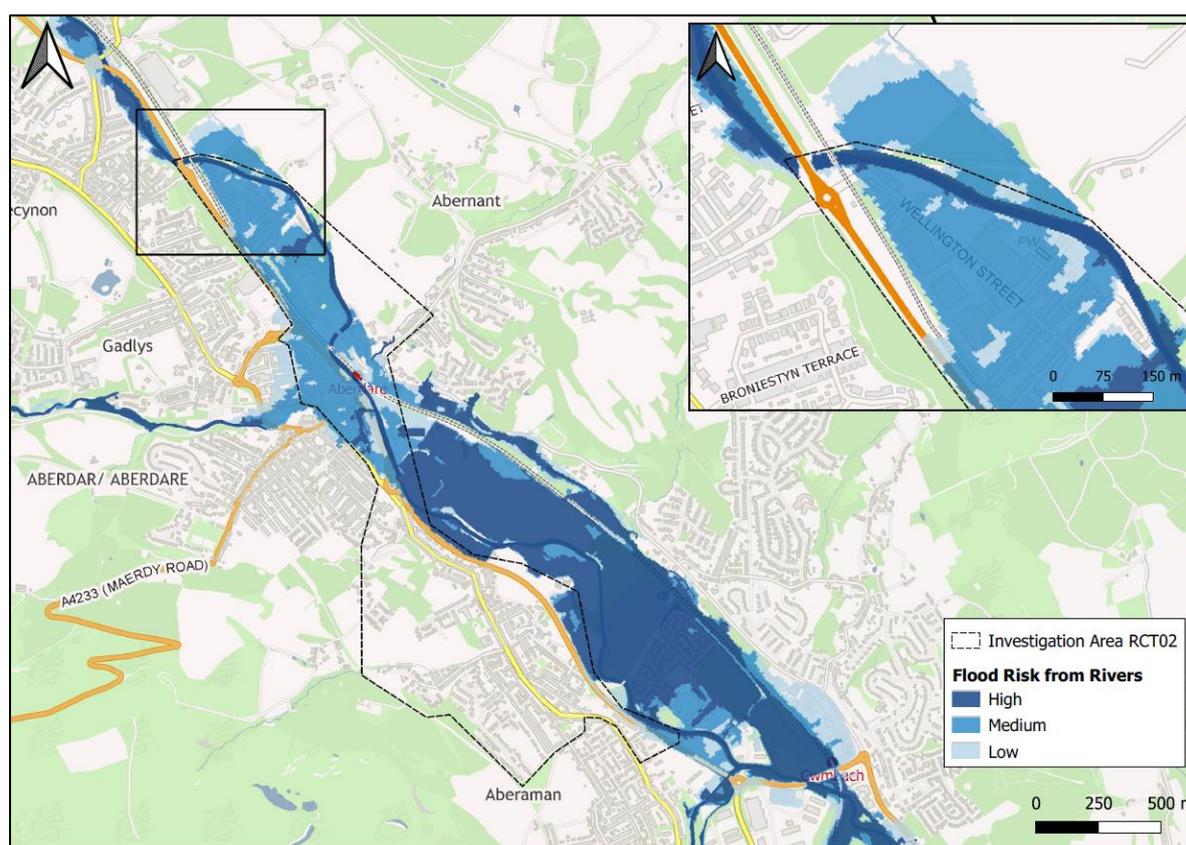


Figure 30: NRW's FRAW map for River sources at RCT02. Contains Natural Resources Wales information © Natural Resources Wales and database right. All rights reserved.

The flooding that occurred within RCT02 during Storm Dennis is largely consistent with the modelled outputs of NRW's FRAW map (Figure 30), with the impacted properties falling within an area of high and medium risk of fluvial flooding. A high risk of flooding means that an area has a chance of flooding of greater than 1 in 30 (3.3%) each year; a medium risk of flooding signifies a yearly chance of flooding between 1

in 100 (1%) and 1 in 30 (3.3%); meanwhile a low risk of flooding means that an area has a chance of flooding between 1 in 1000 (0.1%) and 1 in 100 (1%) each year.

According to residents affected by the overtopping of the unnamed watercourse to the rear of Gloucester Street, the watercourse was observed to be unmoving and ponding. It is considered that the elevated levels on the River Cynon contributed to the overtopping of the unnamed ordinary watercourse by influencing the discharge of water from 'Outlet 1' (Figure 21) and into the River Cynon.

3.3.3. MAIN RIVER FLOOD DEFENCES

The properties impacted by the River Cynon at RCT02 are currently 'undefended', i.e., there are no formally designated flood defence infrastructure under the operation and maintenance of NRW in place along the River Cynon at Aberdare.

3.4. HIGHWAY DRAINAGE CONDITIONS

Surface water runoff along the highway was reported by residents at various locations within the investigation area during Storm Dennis. The highway drainage infrastructure was overwhelmed by intense rainfall and subsequent surface water flows, in addition to ordinary watercourse flooding associated to culvert infrastructure surcharging, and the River Cynon overtopping to the north of RCT02, which led to the accumulation of standing water entering properties within the lower reaches of the investigation area.

During post event CCTV survey operations of the 'Cardiff Road' culverted watercourse infrastructure, the surface water drainage network which connects to the main culvert network was identified to be in poor condition. The highway surface water drainage network was assessed as being in poor condition with settled deposits identified. The poor condition of the highway drainage network at this location is considered to have contributed to and exacerbated the surface water flooding along the southern extent of Cardiff Road.

In response to the defective highway drainage infrastructure at Cardiff Road, the Highway Authority carried out several cleansing operations to remove debris from the surface water drainage network.

Blocked highway drainage gullies were observed along the unadopted road to the west of Abernant Road within the Abernant sub-catchment (Figure 31). The poor condition of the privately owned surface water drainage infrastructure is considered to have exacerbated the surface water flooding in this area by reducing its capacity to manage the surface water runoff and standing water.



Figure 31: Blocked highway drainage gullies and ponding surface water along the unadopted road to the west of Abernant Road (captured by RCT officers post event)

In addition to the drainage infrastructure in RCT02 becoming overwhelmed by the volume of water entering the networks, overland flows from areas of hillside, runoff originating from surcharged culvert infrastructure, and the overtopping of the River Cynon to the rear of Waterloo Street, also resulted in deposition of mud, silt and debris across several streets which is assumed to have entered the highway drainage network via gullies. In these instances, it is likely that highway drainage assets will have had a limited capacity to intercept flows within the investigation area, further exacerbating the surface water flooding.

Highway drainage is not designed to manage overland flows from private areas, parks or open space. In this instance, the capacity of the highway drainage was exceeded by the substantial surface water flows entering the drainage network across RCT02. Given the severity of the storm, the maintenance condition of the highway surface water drainage system is not considered to have significantly impacted on the flooding experienced within RCT02.

3.5. DCWW APPARATUS

DCWW received 2 calls from residents on 16th February 2020 regarding flooding at Cardiff Road. Upon an investigation undertaken by DCWW officers, a nearby culvert ('Culvert Inlet 2') was observed as surcharging and there was evidence of deposited debris along the road and highway drainage gullies. On attendance, DCWW confirmed that their network in the area was operating fine, albeit with high flows but no restrictions identified.

Evidence received from residents and RCT's investigating officer during the storm event confirmed the source of flooding to one property at Cardiff Road was identified as a surcharging combined sewer water manhole ('Manhole 2', Figure 8) within the rear garden of a residential property. DCWW confirmed no failure within their network at this location, suggesting that 'Manhole 2' became hydraulically overloaded and surcharged.

DCWW reported no further issues within RCT02 during Storm Dennis and it is not believed that any DCWW infrastructure was damaged during the storm event. Whilst DCWW have concluded that their assets were working and operating as designed during Storm Dennis, the majority of drainage infrastructure within the investigation area is comprised of combined sewer networks which are likely to have become overwhelmed during the storm event for the reasons outlines in Section 3.4.

3.6. SURFACE WATER

Surface water flows generated by intense rainfall and overwhelmed surface water drainage infrastructure conveying via local topography and the highway network is considered the primary source of flooding to several properties within investigation area RCT02, including at Abernant Road, Cardiff Road, Club Row, Curre Street, Kiln Street, Lower Station Street and Sunnybank Street.

The pathways for surface water flooding during the storm event was observed primarily along the highway network. It should be noted that the exact flow routes have not been confirmed due to limited anecdotal evidence regarding the isolated incidences which occurred during the storm event however, NRW's national surface water and ordinary watercourse flood map (Figure 32) provides a reasonable indication of the pathways and areas of surface water flooding that would have occurred during Storm Dennis.

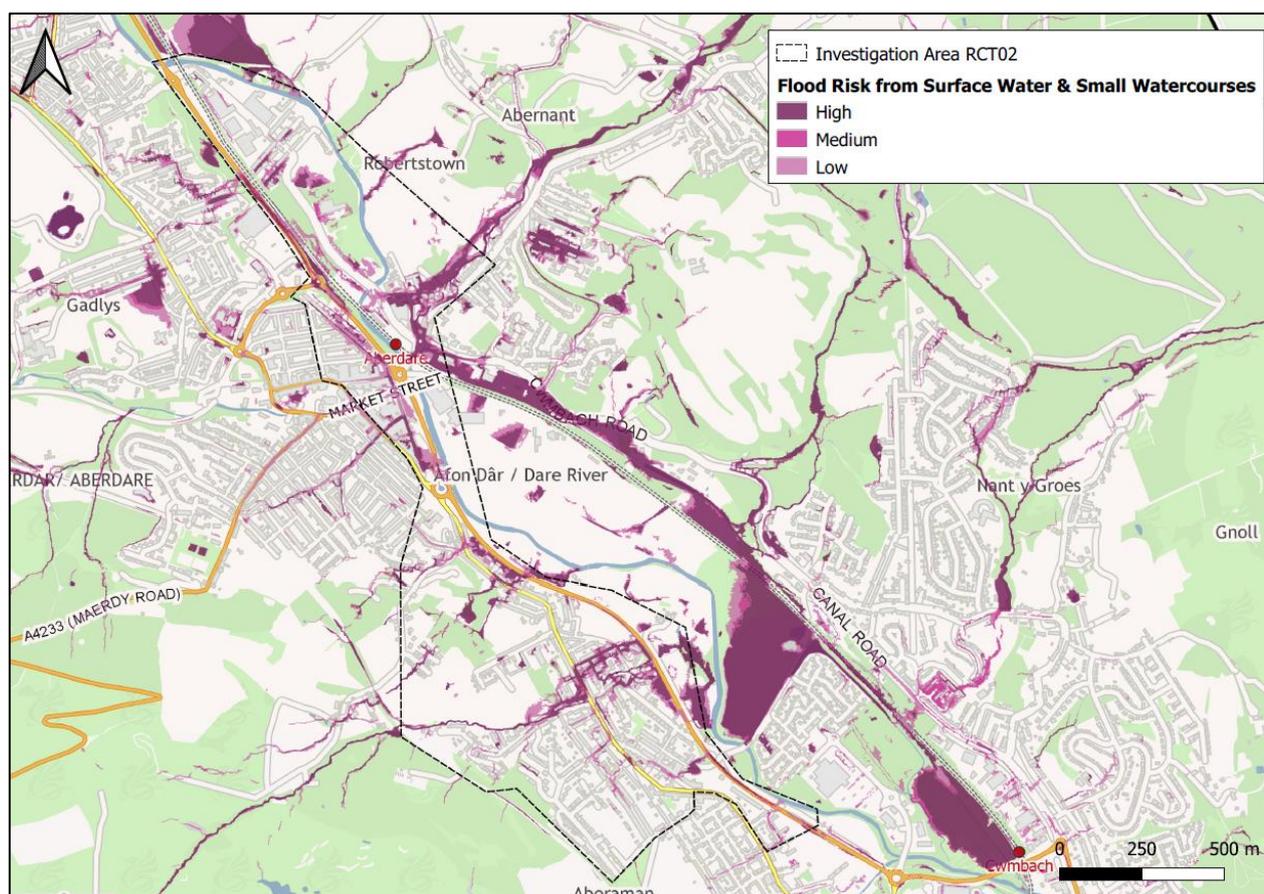


Figure 32: NRW's FRAW map for surface water and ordinary watercourse sources in RCT02. Contains Natural Resources Wales information © Natural Resources Wales and database right. All rights reserved.

On review of NRW's national surface water and ordinary watercourse flood map (Figure 32), the extent of flooding from pluvial sources within RCT02 is significant and correlates well with the observed flooding during Storm Dennis. A high to low flood risk is observed along several streets within the investigation area, mainly associated to the network of ordinary watercourses and culverted infrastructure.

Within the Aberdare sub-catchment area, overland flows originating from land to the rear of Sunnybank Street was reported by residents as the primary cause of flooding to four properties. Upon a review of the FRAW map (Figure 28), a high to low risk of surface water and ordinary watercourse flooding is observed to convey along the hillside towards the impacted properties.

At Club Row and Cardiff Road, two residential properties were recorded as internally flooded as a result of overland flows conveying from the former Blaengwawr School Estate. Upon a review of historical land use using Google Earth imagery, it is observed that the former Blaengwawr School estate has been recently developed to provide new housing, however, works on site had not begun during Storm Dennis in February 2020. It is considered, based on the topography and contours of the former Blaengwawr School Estate, surface water runoff from a large green area of land is considered to have conveyed towards Club Row and onwards towards the lower reaches of Cardiff Road.

3.7. ACCESS STRUCTURES

No access structures were identified during the asset investigations within the area, as such 'access structures' have not been considered within this report.

3.8. SYSTEM AT CAPACITY

Culvert networks within the investigation area (Figure 12 and 13) were surveyed post event to ascertain the internal condition of the networks, the results of which fed into a review of the hydraulic performance of the network to ascertain its current standard of protection using Causeway Flow modelling. The results of the culvert inlet capacity assessments are summarised in the Table below (refer to Figures 12 and 13 for culvert labels).

Table 4: Summary of culvert capacity assessment results which indicate the current standard of protection of the culverted networks in free flowing and blockage conditions within RCT02

Culvert Network	Standard of Protection (SOP) – Free Flowing	Standard of Protection (SOP) – Blockage Condition
Culvert Inlet 1	<Q2 (50% AEP)	<Q2 (50% AEP)
Culvert Inlet 2	<Q20 (5% AEP)	<Q20 (5% AEP)
Culvert Inlet 3	Q100 (1% AEP)	<Q100 (1% AEP)

The results from the culvert capacity assessments and hydraulic modelling undertaken as part of Redstart’s FIR, infer that ‘Culvert Inlet 1’ associated to the ‘Nant y Wenallt’ culvert network, and ‘Culvert Inlet 2’, associated to the ‘Maesyffynon Lane’ culvert network, do not provide adequate standards of protection in both free-flowing and blockage conditions.

Based on the culvert capacity assessments, it can be concluded that both ‘Culvert Inlet 1 and 2’ became hydraulically overwhelmed during Storm Dennis however, on review of the poor operational condition of both culvert networks, in addition to the blockages observed at ‘Culvert Inlet 2’, it is considered that the ‘Nant y Wenallt’ and ‘Maesyffynon Lane’ networks’ hydraulic capacities were further reduced by mobilised debris, resulting in the surcharging of both culvert inlets.

‘Culvert Inlet 3’ has been assessed as having adequate capacity in free-flowing conditions, however this is reduced to below current design standards in blockage conditions. It is considered that the inlet’s hydraulic capacity was severely restricted

by mobilised debris during the storm event which resulted in its surcharge and backing up of flow upstream within the Nant Gwawr ordinary watercourse.

3.9. SUMMARY OF POSSIBLE CAUSES

The above sections have identified and described the possible causes of flooding within RCT02 during Storm Dennis which occurred on the 15 and 16th February 2020. A summary of the identified source(s) and possible cause(s) of flooding (issue) has been outlined below in Table 5.

Table 5: Summary of source(s) and possible cause(s) of flooding in investigation area RCT02 during Storm Dennis

Ref No	Asset (Source)	Issue	Asset Owner	Type of Flooding
1	River Cynon	Unprecedentedly high river levels within the River Cynon resulted in the main river overtopping its banks to the rear of Wellington Street, resulting in flood water conveying into 5 residential properties at Wellington Street and Waterloo Place.	Mixed Ownership	Main River
2	Culvert Inlet 1	The culvert inlet surcharged during the storm event after becoming hydraulically overwhelmed. Debris mobilised from the ordinary watercourse upstream is also considered to have contributed to the inlet surcharging, resulting in water flowing overland towards properties at lower elevations.	Private Landowner(s)	Ordinary Watercourse
3	Culvert Inlet 2	The culvert inlet surcharged during the storm event after becoming blocked with debris mobilised from the ordinary watercourse upstream, causing water to overtop at the inlet and flow towards Wind Street and Cardiff Road.	RCT Highway Authority	Ordinary Watercourse

4	Manhole 1	An ordinary watercourse manhole surcharged during the storm event after becoming hydraulically overwhelmed. This has been attributed to debris accumulation and the poor structural condition of the culvert network.	RCT Highway Authority	Ordinary Watercourse and Surface Water
5	Manhole 2	A combined sewer manhole surcharged foul water within the rear garden of a residential property at Cardiff Road, contributing to its internal flooding.	DCWW	Sewer
6	Unnamed Ordinary Watercourse to the rear of Gloucester Street	Unprecedentedly high river levels on the River Cynon influenced the overtopping of the unnamed ordinary watercourse to the rear of Gloucester Street which overtopped into the rear garden boundary walls of several properties, resulting in flooding to 9 residential properties.	Private Landowners	Ordinary Watercourse & Main River
7	Unnamed Ordinary Watercourse adjacent to Rhos Nathan Wyn	The unnamed ordinary watercourse adjacent to Rhos Nathan Wyn overtopped the rear garden boundary walls of properties at Gwawr Street, resulting in flooding to 2 residential properties.	Private Landowner(s)	Ordinary Watercourse
8	Culvert Inlet 3	The culvert inlet surcharged during the storm event after becoming hydraulically overwhelmed. Debris mobilised from the ordinary watercourse upstream is also considered to have contributed to the inlet	RCT Highway Authority	Ordinary Watercourse

		surcharging, resulting in water flowing overland towards properties at lower elevations.		
9	Overland flow from the hillside to the rear of Sunnybank Street	Surface water flows travelling overland from the hillside to the rear of Sunnybank Street resulted in internal flooding to 4 residential properties.	RCT	Surface Water
10	Overland flow from land adjacent to the former Blaengwawr School estate	Surface water flows travelling overland from the former Blaengwawr School estate towards Club Street resulted in property flooding to 2 residential properties.	Private Landowner	Surface Water
11	Surface water drainage network across RCT02	Intense rainfall across RCT, combined with the overtopping of the main river, exceedance flows from surcharging ordinary watercourse infrastructure and overland flow from areas of hillside, severely overwhelmed the highway drainage infrastructure and resulted in the accumulation of surface water on several streets throughout the investigation area.	RCT Highway Authority	Surface Water

4. RISK MANAGEMENT AUTHORITY ACTIONS

A Welsh Risk Management Authority is defined in Section 6 of the Flood and Water Management Act 2010 as NRW; a LLFA, a district council for an area where there is no unitary authority, or a highway authority wholly in Wales; an internal drainage board for an internal drainage district that is wholly or mainly in Wales; a water company that exercises functions in relation to an area in Wales. As the LLFA, RCT has the responsibility to coordinate the management of flood risk and the interaction of Risk Management Authorities across Rhondda Cynon Taf.

An overview of the relevant Risk Management Authority in relation to flood type is provided in Table 5. For further details of the roles and responsibilities of individual Risk Management Authorities in managing flooding, refer to Welsh Government's National Strategy for Flood and Coastal Erosion Risk Management, Section 4 'Roles and Responsibilities'⁵, and RCT's 'FRM – Storm Dennis - Overview Report'**Error! Bookmark not defined.**

Table 6: Risk Management Authority with relevant functions to manage the risk for different flood types

Type of Flooding	Relevant Risk Management Authority
Flooding from Main River, reservoirs and the sea (including coastal erosion).	Natural Resources Wales
Flooding from ordinary watercourses, surface water and groundwater	Lead Local Flood Authority
Flooding from water and sewage systems	Water Companies (Dŵr Cymru Welsh Water)
Flooding from the highway	Highway Authority
Flooding from the highway (motorways and major trunk roads)	Welsh Government Trunk Road Agency

Risk Management Authorities have direct flood risk management functions under the Flood and Water Management Act 2010, as well as the Land Drainage Act 1991 and the Highways Act 1980. Through the investigation of the flooding that impacted investigation area RCT02, the flood risk management functions exercised, or proposed to exercise, by relevant RMA's was recorded in response to the duties

⁵ [National Strategy for Flood and Coastal Erosion Risk Management in Wales \(English\) \(gov.wales\)](#)

placed on the local authority in regard to Section 19 of the Flood and Water Management Act 2010, which states;

“On becoming aware of a flood in its area, a lead local flood authority must, to the extent that it considers it necessary or appropriate, investigate:

- a) Which risk management authorities have relevant flood risk management functions and,
- b) Whether each of those risk management authorities has exercised, or is proposing to exercise, those functions in the response to the flood.”

Through the investigation process, the source(s) and possible cause(s) of flooding in RCT02 during Storm Dennis have been previously identified and summarised within Table 5. The Risk Management Authorities responsible for managing that flooding have been listed in Table 7 below, along with a series of recommendations put forward by the LLFA.

Table 7: Recommendations provided by the LLFA to be considered by the relevant Risk Management Authority identified in response to the source(s) of flooding in RCT02 (as per Table 5)

Ref No	Asset (Source)	Asset Owner	Type of Flooding	Relevant Risk Management Authority	Recommendations
1	River Cynon	Mixed Ownership	Main River	Natural Resources Wales	R1A NRW to “complete detailed investigative analysis work to understand the mechanisms of flooding in areas known to have flooded from main rivers”, including the River Cynon at Aberdare. Aligns with recommendation ‘Action FD2’ within NRW’s Flood Incident Management Review.

					R1B	NRW to work with asset owners to assess and review the risk of flooding from the Rhondda Cynon at RCT02 to identify the viability of risk management options.
					R1C	NRW to review its flood warning service provision, especially for extreme events. This will form part of NRW's Flood Warning Service Review Implementation Programme and aligns with the recommendations set out in their 'Flood Incidence Management Review'.
2	Culvert Inlet 1	Private Landowner(s)	Ordinary Watercourse	Lead Local Flood Authority and Land Drainage Authority	R2A	The LLFA and LDA to identify drainage asset ownership and responsibility.
					R2B	The LLFA and LDA to investigate the standard of protection and the condition of the culvert structure and network as a whole.
					R2C	Jet and cleanse the ordinary watercourse network.

					R2D	The LLFA and LDA to engage and work with the riparian landowner to regulate the ordinary watercourse infrastructure to ensure the watercourse is free flowing and unobstructed.
					R2E	The LLFA and LDA to work with riparian landowners to identify suitable management methods to reduce the risk of scour within the Nant y Wenallt ordinary watercourse.
					R2F	The LLFA to develop a SOC to identify suitable management methods to reduce the risk of ordinary watercourse, surface water and groundwater flooding.
3	Culvert Inlet 2	RCT Highway Authority	Ordinary Watercourse	Lead Local Flood Authority and Land Drainage Authority	R3A	The LLFA and LDA to identify drainage asset ownership and responsibility.
					R3B	The LLFA and LDA to investigate the standard of protection and the condition of the culvert structure and network as a whole.

					R3C	Jet and cleanse the ordinary watercourse network.
					R3D	The LLFA and LDA to work with riparian landowners to identify suitable management methods to reduce the risk of scour within the ordinary watercourse.
					R3E	The LLFA to carry out repair works to the culvert inlet structure following damages caused during Storm Dennis.
					R3F	The LLFA to install remote telemetry monitoring at Culvert Inlet 2 to monitor the risk of blockage.
					R3G	The LLFA to develop a BJC to identify suitable management methods to reduce the risk of ordinary watercourse, surface water and groundwater flooding.
4	Manhole 1	RCT Highway Authority	Ordinary Watercourse & Surface Water	Lead Local Flood Authority, Land Drainage Authority and	R4A	The LLFA and LDA to identify drainage asset ownership and responsibility.
					R4B	The LLFA and LDA to investigate the standard of

				Highway Authority		protection and the condition of the culvert structure and network as a whole.
					R4C	Jet and cleanse the ordinary watercourse network.
					R4D	The LLFA to carry out repair works to the defective culvert network downstream of Manhole 1.
					R4E	The LLFA to develop a BJC to identify suitable management methods to reduce the risk of ordinary watercourse, surface water and groundwater flooding.
5	Manhole 2	DCWW	Sewer	DCWW	R5A	DCWW to evaluate the standard of service and the condition of the sewer network servicing Cardiff Road.
					R5B	DCWW to work with the LLFA and Highway Authority to identify suitable management methods to reduce the risk of flooding from surface water and sewer sources.
6	Unnamed Ordinary Watercourse	Private Landowner(s)	Ordinary Watercourse	Lead Local Flood Authority and	R6A	The LLFA and LDA to identify drainage asset ownership and responsibility.

	to the rear of Gloucester Street			Land Drainage Authority	R6B	The LLFA and LDA to investigate and assess the condition of the ordinary watercourse.
					R6C	The LLFA and LDA to work with landowners to identify suitable management methods to reduce the risk of ordinary watercourse flooding to properties.
					R6D	The LLFA and LDA to engage with NRW to work collaboratively to manage the flood risk caused by the influence of the River Cynon upon the unnamed ordinary watercourse to the rear of Gloucester Street.
7	Unnamed Ordinary Watercourse adjacent to Rhos Nathan Wyn	Private Landowner(s)	Ordinary Watercourse	Lead Local Flood Authority and Land Drainage Authority	R7A	The LLFA and LDA to identify drainage asset ownership and responsibility.
					R7B	The LLFA and LDA to investigate and assess the condition of the ordinary watercourse.
					R7C	The LLFA and LDA to work with riparian landowners to identify suitable

						management methods to reduce the risk of scour within the ordinary watercourse.
					R7D	The LLFA to install remote telemetry monitoring at the unnamed watercourse to monitor the risk of blockage to the associated culvert inlet debris screen.
					R7E	The LLFA to develop an OBC to identify suitable management methods to reduce the risk of flooding from local sources in Aberaman.
8	Culvert Inlet 3	RCT Highway Authority	Ordinary Watercourse	Lead Local Flood Authority, Land Drainage Authority and Highway Authority	R8A	The LLFA and LDA to identify drainage asset ownership and responsibility.
					R8B	The LLFA and LDA to investigate the standard of protection and the condition of the culvert structure and network as a whole.
					R8C	Jet and cleanse the ordinary watercourse network.
					R8D	The LLFA and LDA to work with landowners to identify suitable management methods to reduce

						the risk of ordinary watercourse flooding to properties.
					R8E	The LLFA to develop an OBC to identify suitable management methods to reduce the risk of flooding from local sources in Aberaman.
9	Overland flow from the hillside to the rear of Sunnybank Street	RCT	Surface Water	Lead Local Flood Authority and Land Drainage Authority	R9A	The LLFA and LDA to identify drainage asset ownership and responsibility.
					R9B	The LLFA and LDA to investigate the ordinary watercourse conditions and surface water drainage arrangements on the area of hillside to the rear of Sunnybank Street.
10	Overland flow from land adjacent to the former Blaengwawr School estate	Private Landowner(s)	Surface Water	Lead Local Flood Authority and Land Drainage Authority	R10A	The LLFA and LDA to identify drainage asset ownership and responsibility.
					R10B	The LLFA and LDA to investigate the surface water drainage arrangements on the former estate.
11	Surface water drainage network across RCT02	RCT Highway Authority	Surface Water	Highway Authority and Lead Local Flood Authority	R11A	The Highways Authority to jet and cleanse the highway drainage network and actions repairs accordingly.

					R11B	The LLFA and Highway Authority to evaluate surface water management options to alleviate pluvial flooding at locations across the investigation area.
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4.1. LEAD LOCAL FLOOD AUTHORITY

In review of Ref 2 – 4 and 6 - 11 in Table 7, the LLFA has been determined as the relevant Risk Management Authority in relation to the ordinary watercourse and surface water flooding which occurred at investigation area RCT02 during Storm Dennis.

The LLFA exercised the following functions in response to the flooding at RCT02;

- Officers investigated the initial flooding and have produced this report in line with Section 19 of the Flood and Water Management Act 2010.
- Officers contacted residents affected by flooding to offer support and advice to assist in the recovery following the event.
- A public engagement exercise carried out by Redstart, on behalf of RCT as the LLFA, was undertaken in order to gain further local insight and anecdotal evidence to support the flood investigation.
- The LLFA and LDA have exercised their permissive powers under Section 64 of the Land Drainage Act 1991 to investigate the condition of culvert structures, network conditions, ordinary watercourse conditions and surface water drainage arrangements to determine their impacts on the flooding within the investigation area. **(R2B, R3B, R4B, R6B, R7B, R8B, R9B, R10B, R11B)**
- An estimated 921 metres of culverted ordinary watercourse network length within RCT02 has been surveyed following the event to ascertain both the operational condition of the network, and its structural integrity along section of the network. **(R2B, R3B, R4B, R8B)**
- An estimated 41 tonnes of material and debris was removed from the culvert inlet structures and networks within RCT02 during jetting and cleansing operations. **(R2C, R3C, R4C, R8C)**
- The LLFA, assisted by the Highway Authority, have undertaken clearance works to the culvert network systems which fall under the responsibility of the Authority. **(R3C, R4C, R8C)** In addition to this, the LLFA and Highway Authority have carried out clearance works to the culvert inlet structures which fall under private ownership. **(R2C)**
- The LLFA commissioned Redstart to investigate the standard of protection of the existing culvert networks in RCT02 to determine their hydraulic capacity following the identification of several structural and operational defects within sections of the network. **(R2B, R3B, R4B, R8B)**

- The LLFA has exercised its powers, under Section 13 of the FWMA, to request information and co-operation from the relevant risk management authorities (NRW and DCWW) in relation to their responsibilities as RMAs in response to Storm Dennis.
- The LLFA has set up a central Control Room, to compliment the Council's Contact Centre and CCTV centre which is based at the Council's offices, to provide a comprehensive and informed response to the residents of RCT as appropriate during storm events.
- The LLFA have initiated an interim Property Flood Resistance project offering expandable flood gates to those properties deemed at high risk of flooding from local sources.
- The LLFA, working in partnership with NRW, have expanded their interim Property Flood Resistance project offering expandable flood gates to those properties deemed at high risk of flooding from the main river, as per NRW's determination.
- The LLFA and LDA have initiated engagement with riparian landowners to ensure the ordinary watercourse infrastructure is free flowing and unobstructed. **(R3D, R7C, R8D)**
- The LLFA have installed remote telemetry monitoring devices at key culvert structures to enable operators to ensure the drainage systems in RCT02 are operating effectively. **(R3F, R7D)**
- In response to Ref 3, the LLFA, assisted by the Highway Authority, undertook emergency works to clear the ordinary watercourse upstream of 'Culvert Inlet 2' of mobilised debris, replace the damaged debris screen and completed repair and re-lining works to the culvert network downstream of 'Culvert Inlet 2'. **(R3E)**
- In response to the flooding associated to 'Manhole 1' at Cardiff Road, the LLFA have undertaken repair and relining works to the overflow culvert network which was identified to be in poor condition during CCTV survey operations. **(R4D)**

The LLFA propose to exercise the following functions in response to the flooding at investigation area RCT02;

- Following the surveying of culvert networks in RCT02, the LLFA propose to input and update all relevant asset data.
- The LLFA and LDA intend to clarify drainage asset owners and management responsibilities to make them aware of their personal risk. To ensure landowners manage the risk in compliance with the relevant legislation, a team

of Flood Enforcement Officers including legal support is to be appointed. **(R2A, R3A, R4A, R6A, R7A, R8A, R9A, R10A)**

- The LLFA and LDA will work with landowners and property owners to manage their personal flood risk through local measures, such as property resilience and resistance measures.
- The LLFA and LDA will continue to engage with riparian landowners and regulate the ordinary watercourse infrastructure to ensure the infrastructure is free flowing and unobstructed.
- The LLFA have applied for Welsh Government funding to develop a BJC to deliver a Flood Alleviation Scheme in the Aberdare area, specifically the area of Cardiff Road, Maesyffynon Lane and Cwrt Ynyslwyd, to manage the risk of ordinary watercourse and surface water flooding. **(R3G, R4E)**
- The LLFA propose to develop an OBC for the Nant Gwawr ordinary watercourse catchment area to better understand the risk of flooding, using a whole catchment approach to provide recommendations for suitable management mechanisms and thus reduce the wider risk of flooding to people and properties from local sources (Ordinary Watercourse, Surface Water and Groundwater). **(R7E, R8E)**
- The LLFA propose to develop a SOC to better understand the risk of flooding within Aberdare East associated with the Nant y Wenallt ordinary watercourse. The SOC will use a whole catchment approach to provide recommendations for suitable management mechanisms and thus reduce the wider risk of flooding to people and properties from local sources (Ordinary Watercourse, Surface Water and Groundwater). **(R2F)**
- As part of RCT's comprehensive review of the County Borough's most at risk communities, the LLFA are proposing to undertake a formal SFRA of the Upper Cynon catchment area to better understand the overall risk from ordinary watercourse and surface water flooding in order to target investment to areas of highest risk. The SFRA also aims to encourage whole catchment measures, including working with natural processes, to alleviate flood risk in those areas of highest risk. **(R2F, R3G, R4E, R7E, R8E)**
- The LLFA and LDA propose to undertake Geomorphological assessments of the upper catchments above RCT02 to determine the risk of culvert blockages as a result of scour and debris potential. In addition to this the LLFA and LDA will engage with Riparian landowners to identify suitable management methods to reduce the risk of scour within the ordinary watercourse. **(R2E, R3D, R7C)**

- The LLFA and LDA will engage with NRW to work collaboratively to manage the flood risk caused by the influence of the River Cynon upon the ordinary watercourse to the rear of Gloucester Street. **(R6D)**

4.2. NATURAL RESOURCES WALES

In review of Ref 1 and 6 in Table 7, NRW has been identified as the relevant Risk Management Authority in relation to the main river flooding from the River Cynon during Storm Dennis.

NRW has exercised the following functions in response to the flooding at investigation area RCT02;

- NRW have carried out post event data collection including an assessment of the properties impacted by main river flooding and a survey of wrack marks, i.e. the marked high-water level.
- Following Storm Dennis, NRW undertook clearance works to remove the accumulation of debris from the river channel at Robertstown highway and rail bridge.
- Utilising post event data and information, NRW have reviewed the Resultant Thresholds for the River Cynon at Aberdare and Aberaman Flood Warning Areas (FWA). This is critical for assessing the performance, timeliness and accuracy of the warning service after a flood. **(R1C)**.
- NRW has introduced improved digital services to provide comprehensive flood risk, river level and rainfall information to households, businesses and communities across Wales. The improved service was launched in September 2020 on the NRW website and will, according to NRW, improve how live flood warning and water level data is shared before and during flood events. **(R1C)**
- Following the flooding events of February 2020, NRW published a review of its incident response to Storm Ciara and Dennis in October 2020⁶. This review contains several recommendations for improvements to their ways of working and services which NRW are in the process of implementing through an internal delivery programme.
- NRW have developed a detailed Implementation Programme to address the areas of improvement work required to deliver the recommendations of the Flood Warning Service Review carried out by NRW in 2018. Several of the recommendations directly link to the recommendations set out by NRW within their Flood Incident Management Review **(R1C)**.
- NRW have commissioned a Cynon River flood modelling project for completion by Summer 2022. **(R1A)**

⁶ [Natural Resources Wales / Our response to Storm Ciara and Storm Dennis](#)

NRW propose to exercise the following functions in response to the flooding at RCT02:

- Following the completion of NRW's Cynon flood modelling project, NRW propose to undertake an initial assessment of the viability of potential flood risk management options. Consideration should be given to areas at high risk of flooding from rivers on a prioritised basis. **(R1A)**
- Following the completion of NRW's Cynon flood modelling project, NRW propose to undertake further threshold work and flood warning area amendments. **(R1A, R1C)**
- NRW to undertake scheduled T89 inspections at different locations across the main river channel within Aberdare on a 6-monthly basis.

4.3. WATER COMPANY

In review of Ref 5 in Table 7, DCWW has been identified as the relevant Risk Management Authority in relation to the sewer flooding at Cardiff Road during Storm Dennis.

DCWW have exercised the following functions in response to the flooding at RCT02;

- DCWW carried out their own investigations in response to incidences of flooding that were reported by residents directly to DCWW.
- DCWW have carried out desilting workings to ensure their network at Cardiff Road are fully operating.
- DCWW have installed a Non-Return Valve to help mitigate the risk of surface water and sewer flooding whilst works to the culvert network at Cardiff Road were being undertaken. **(R5B)**
- DCWW have carried out connectivity surveys of their combined sewer network with the aim of reducing surface water connections into DCWW's system to alleviate sewer flooding in the area and improve the performance of their network during severe weather. **(R5B)**

DCWW propose to exercise the following functions in response to the flooding at RCT02;

- DCWW will continue to monitor their network and carry out remedial works that are identified as required.

4.4. HIGHWAY AUTHORITY

During the investigation into the flooding at investigation area RCT02 during Storm Dennis, the Highway was identified as flooding from a combination of sources, most notable as a result of ordinary watercourse and surface water flooding associated to intense rainfall and blocked and overwhelmed culverted watercourse infrastructure. Flooding from the main River Cynon was also identified to have impacted the highway.

Ref 11 of Table 7 identifies the Highway Authority as a relevant Risk Management Authority in relation to the surface water flooding that occurred along the highway across RCT02.

RCT as the Highway Authority have exercised the following functions in response to the flooding at investigation area RCT02:

- The Highway Authority assisted with the emergency response during the event by supplying equipment and sandbags to residential and commercial properties and by using sandbags to redirect flood water away from properties.
- The Highway Authority exercised their functions under Section 100 of the Highways Act 1980, to arrange for all gullies and open drains in the highway to be inspected and cleansed following the influx of flood water to ensure the safety of the highway post event. **(R11A)**
- The Highway Authority has undertaken emergency clearance and repair works to the culverted infrastructure identified as sources of flooding. **(R2C, R3C, R4C, R8C)**
- The Highway Authority have increased their resource capacity by establishing a dedicated 'Pluvial Drainage Team' to focus entirely on the refurbishment and maintenance of RCT's existing and enhanced highway.

RCT as the Highway Authority propose to undertake the following function in relation to the storm event at investigation area RCT02:

- The Highway Authority to work with the LLFA to evaluate surface water management options to alleviate pluvial flooding at location across the investigation area. **(R11B)**

USEFUL LINKS/CONTACTS

Blue Pages – property Resilience - <http://bluepages.org.uk/>

Flood Re – Flooded Property Insurance Scheme - <https://www.floodre.co.uk/>

Natural Resources Wales – Check Flood Warnings - <https://naturalresources.wales/flooding/check-flood-warnings/?lang=en>

Natural Resources Wales - Long Term Flood Risk - <https://naturalresources.wales/evidence-and-data/maps/long-term-flood-risk/?lang=en>

Rhondda Cynon Taf CBC - Local Flood Risk Management Plan - <https://www.rctcbc.gov.uk/EN/Resident/ParkingRoadsandTravel/Roadspavementsandpaths/FloodAlleviation/Floodriskregulations2009.aspx>

Rhondda Cynon Taf CBC - Local Flood Risk Management Strategy - <https://www.rctcbc.gov.uk/EN/Resident/ParkingRoadsandTravel/Roadspavementsandpaths/FloodAlleviation/LocalFloodRiskManagementStrategy.aspx>

Rhondda Cynon Taf CBC – Sustainable Drainage – <https://www.rctcbc.gov.uk/EN/Resident/ParkingRoadsandTravel/Roadspavementsandpaths/SustainableDrainage/SustainableDrainage.aspx>

Welsh Government - National Strategy for Flood and Coastal Erosion Risk Management - <https://gov.wales/sites/default/files/publications/2019-03/national-strategy-for-flood-and-coastal-erosion-risk-management-in-wales.pdf>

Welsh Water – How to Contact Us – <https://www.welshwater.com/en/Contact-Us.aspx>