RHONDDA CYNON TAF COUNTY BOROUGH COUNCIL

Flood and Water Management Act 2010

Section 19 Flood Investigation Report

Storm Dennis –

Flood Investigation Area RCT18 (Trehafod)

April 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 the 15th and 16th of February 2020 within the Rhondda Cynon Taf County Borough Council area, focusing the investigation on the flooding that occurred within the impacted areas of Trehafod in the Rhondda valley (Flood Investigation Area RCT18, Figure 1).

This report was undertaken to identify the mechanisms 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 are planning to undertake actions related to those functions to manage the risk of flooding.

The flooding that affected RCT on the 15 and 16th of February 2020 was a result of an extreme rainfall event, designated by the Met Office as ‘Storm Dennis’. The storm event resulted in the internal flooding of at least 68 properties: including 65 residential properties and 3 non-residential properties. Significant flooding to the highway also occurred throughout the investigation area. 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, RCT’s Highway and Streetcare Depot, Natural Resources Wales and Dŵr Cymru Welsh Water.

The evidence gathered within this report identified the surcharging of a culvert inlet situated above the railway track at the northeastern boundary of the investigation area as the primary source of flooding at RCT18. A reported localised landslip is considered to have contributed debris towards the culvert inlet and network, reducing its hydraulic capacity to manage the flow of water, resulting in its surcharge over the railway, onto the A4058 and onwards towards Trehafod Road.

Intense rainfall across the catchment and localised surface water accumulation is also considered to have contributed to and exacerbated the flooding experienced across RCT18, especially in those areas identified at high risk of surface water flooding as per NRW's Flood Risk Assessment Wales maps.

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

In response to the flooding at investigation area RCT18 during Storm Dennis, the LLFA has undertaken 11 actions and have proposed to undertake a further 6. A summary of which include;

- Carried out survey, jetting and cleansing operations to the highway drainage infrastructure following the storm event (assisted by the Highway Authority);
- Led on the development of a central Control Room to compliment the Council's Contact Centre and CCTV Centre; and to provide a comprehensive and informed response to residents during storm events;
- Exercised its powers, under Section 13 and 14 of the Flood and Water Management Act 2010, to engage the DCWW in relation to their responsibilities as the Risk Management Authority for sewer flooding, and Network Rail and Transport for Wales in relation to the responsibilities as significant asset owners within RCT18; and
- Initiated an interim Property Flood Resistance project offering expandable flood gates to those properties deemed at high risk of flooding from local sources.

RCT as the Lead Local Flood Authority are also working closely with the Highway Authority and DCWW to evaluate surface water management options to alleviate the risk of flooding from local sources to properties within the village of Trehafod.

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, however, further functions have been proposed by all RMAs to better address preparedness and response to future flood events.

ABBREVIATIONS

CaRR – Communities at Risk Register

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

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

RCT - Rhondda Cynon Taff CBC

RCT18 – Flood Investigation Area RCT 18

RMA – Risk Management Authority

SAB – Sustainable Drainage Approval Body

SFRA – Strategic Flood Risk Assessment

SOC – Strategic Outline Business Case

SuDs – Sustainable Drainage Systems

TABLES AND FIGURES

1 INTRODUCTION

1.1. PURPOSE OF INVESTIGATION

On the 15 and 16th of February 2020, 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 RCT18 (further referred to as RCT18) which covers the village of Trehafod in the Rhondda 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 (a) publish the results of its investigation, and (b) notify any relevant risk management authority"[1]

The purpose of the investigation is to determine which RMAs 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)

1.2. SITE LOCATION

The area investigated within this report covers the village of Trehafod, located within the central region of RCT in the Rhondda Valley, between the towns of Porth and Pontypridd (Figure 1). The area is split between the electoral wards of Cymmer to the west and Rhondda to the east.

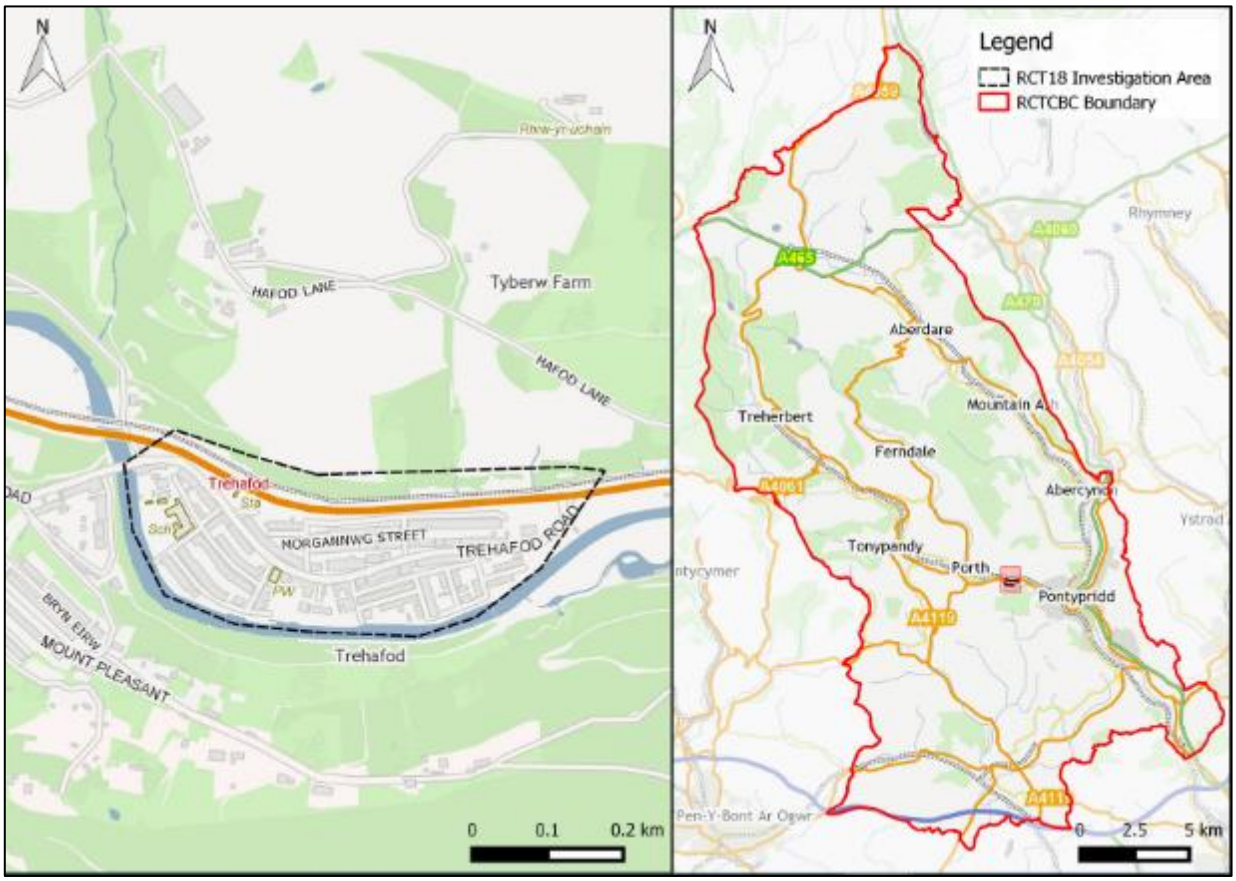

Figure 1: Flood Investigation Areas RCT18 Location Plan

The investigation area is bounded to the north by the A4058 and to the south by the Rhondda River flowing west to east. A number of unnamed watercourses drain the highlands to the north of investigation area RCT18 and are partially culverted beneath Trehafod's residential area before discharging into the Rhondda River.

According to the Welsh Government's CaRR, the community of Trehafod is ranked 132nd for surface water flood risk and 91st for main river flooding in Wales.

NRW's FRAW map (Figure 2) identifies a low to high risk of surface water and ordinary watercourse flooding along the western streets of investigation area RCT18, sourced

by blocked culvert inlets and potential bank breaches/overtopping related to the network of ordinary watercourse draining the northern hillsides. A low risk of river flooding is also noted at Trehafod, sourced by the Rhondda River breaching/overtopping its northern banks and affecting the majority of the investigation area. Flood risk throughout Trehafod is further described within RCT's FRMP[3].

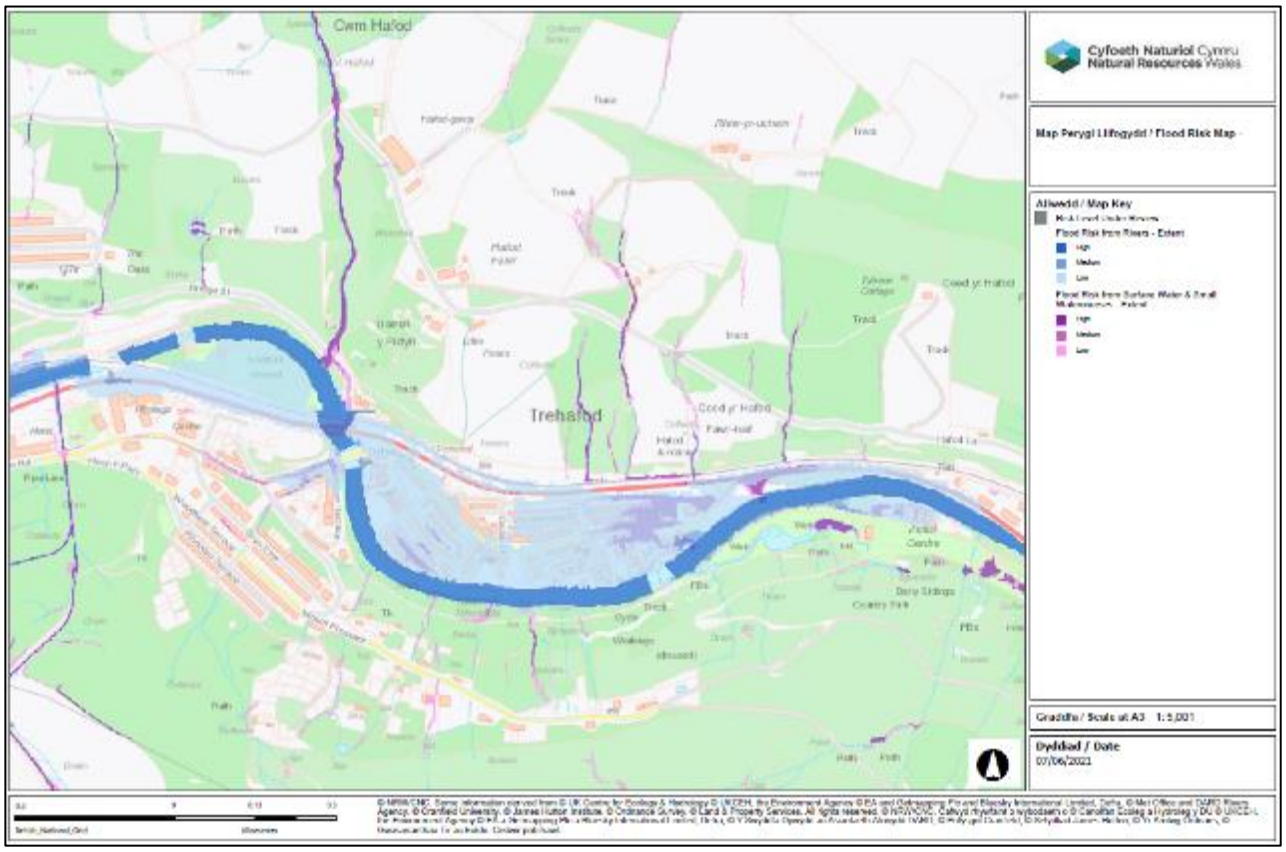

Figure 2: Natural Resources Wales' Flood Risk Assessment Wales (FRAW) map for rivers and ordinary watercourse and surface water flood risk at investigation area RCT18. Contains Natural Resources Wales information © Natural Resources Wales and database right. All rights reserved.

1.3. DRAINAGE SYSTEM

The surface water drainage system that serves investigation area RCT18 is that of the highway drainage network designed to manage the surface water within the highway and public surface water and combined sewer networks operated by Dŵr Cymru Welsh Water.

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

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 of February during Storm Dennis, flood risk officers from RCT's Flood Risk Management department were deployed to areas across the borough to investigate reports of internal flooding by residents. Residents engaged with the Flood Risk Management team to help determine the initial impacts caused by the flooding event and to investigate the potential source(s) and pathway(s) of flood water. Due to the volume of calls received

by RCT's Out of Hours 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 exercise was to engage with 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.

2 FLOODING HISTORY

2.1. PREVIOUS FLOOD INCIDENTS

Historical flood information and residents accounts captured by RCT's Flood Risk Management officers following Storm Dennis indicate that several isolated and minor incidents of internal flooding have been experienced at properties within RCT18 prior to Storm Dennis, with 6 different cases being reported between 2010 and 2019. Historic cases of internal flooding were primarily caused by localised surface water accumulation and overwhelmed highway drainage infrastructure.

Many reports of external flooding have also been recorded, with highways such as Trehafod Road experiencing frequent surface water flooding over the past 10 years as result of intense rainfall and blocked highway drainage infrastructure.

The community of Trehafod has also historically been impacted by main river flooding sourced by the River Rhondda. The last known main river flood event at Trehafod occurred in December 1979 where the River Rhondda overtopped its banks and floodwaters entered the low-lying areas of Colliery Street and Great Street causing flooding to several properties.

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 Public Health Wales identified 65 residential properties and 3 commercial properties as internally flooded.

A summary of the source(s) and pathway(s) of flooding within investigation area RCT18 during Storm Dennis have been outlined in the 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 RCT 18

Source	Pathway	Receptor
Intense rainfall running off the steep hillsides to the north of RCT18 and draining to lower ground via several unnamed ordinary watercourses. A localised landslip north-east of RCT18 resulted in the obstruction of a culvert inlet, leading to surcharge.	The impeded watercourse surcharged, and flood water conveyed onto the adjacent highway, the A4058 (Gyfeillon Road). From the A4058, flood water conveyed onto several streets throughout RCT18, including Trehafod Road, Fountain Street and Western Street.	63 residential properties and 3 non-residential properties reported internal flooding across the impacted streets during Storm Dennis.
Intense rainfall and localised surface water accumulation.	Overland flows from the hillsides surrounding RCT18 combined with localised surface water accumulation overwhelmed the highway drainage infrastructure at several streets within RCT18.	Internal flooding of 2 residential properties at the western end of Trehafod Road as a result of overwhelmed highway drainage. Localised surface water accumulation also contributed

	A surface water pumping station at Afon Street also became overwhelmed during the storm event, contributing to the accumulation of surface water along adjacent streets.	to the internal flooding experienced across RCT18.

On review of Table 2, the primary source of recorded flooding within RCT18 was the surcharging of a culvert inlet to the north-east of the investigation area which resulted in significant surface water runoff to convey towards the village of Trehafod via the highway network. The culvert inlet surcharged following a localised landslip on the hillside above, resulting in the conveyance of material which obstructed the inlet and caused flows from the unnamed ordinary watercourse to convey across the railway embankment, onto the A4058 (Gyfeillon Road) and onwards towards the village

The single known exception to the primary flood mechanism is a property on Wayne Street, which flooded due to a combination of both surface water flows from the surrounding hillsides and localised surface water accumulation along the highway.

Both mechanisms of flooding identified within RCT18 were significantly influenced by the intense rainfall and subsequent surface water flows across the investigation areas topographic catchment during Storm Dennis. A LIDAR based cross section of the Rhondda Valley at Trehafod (Figure 3), produced as part of Redstart's FIR, illustrates the gradual incline of the northern hillside that is unlikely to divert surface water flows due to the presence of only one ridge formation uphill of the railway embankment. Figures 4 and 5 outline the wider topographic catchment of RCT18 and the corresponding flow pathways identified immediately north of the investigation area.

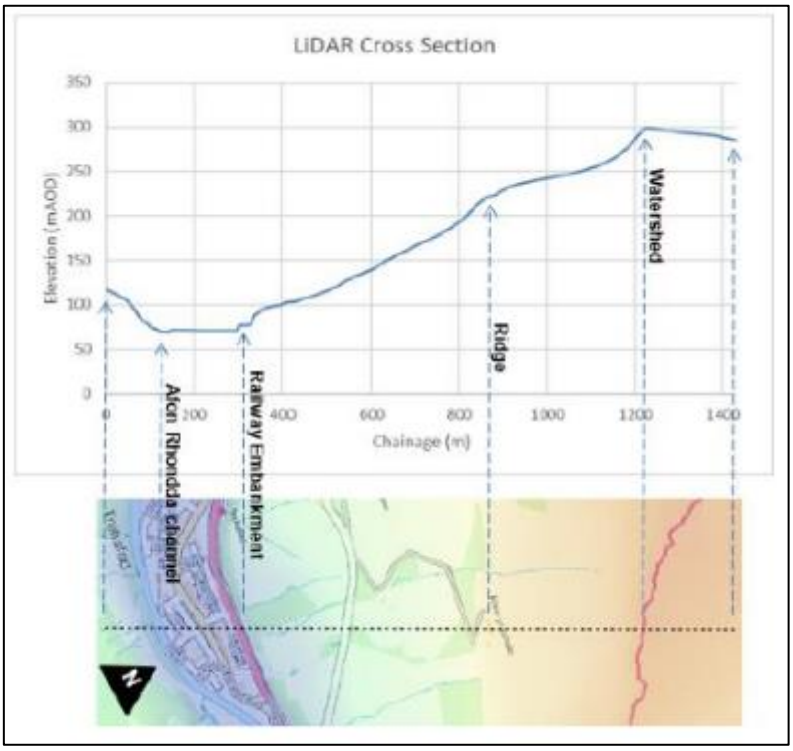

Figure 3: Partial Cross Section of the Rhondda Valley, based on LiDAR

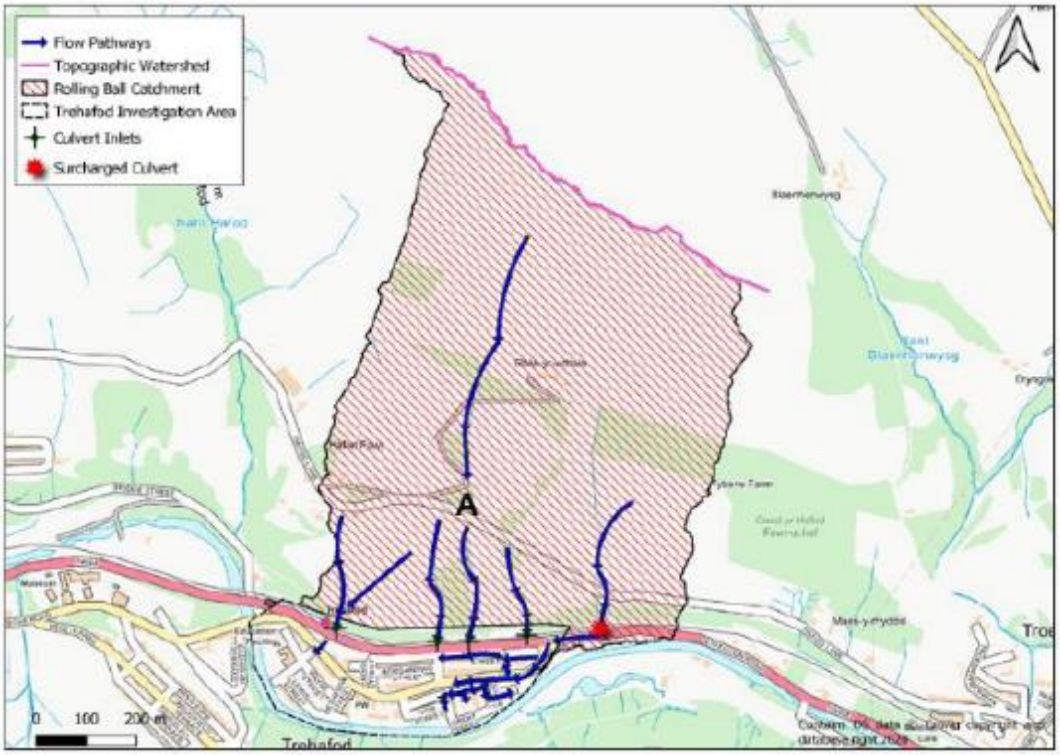

Figure 4: Topographic Catchment of RCT18 and corresponding flow pathways (1)

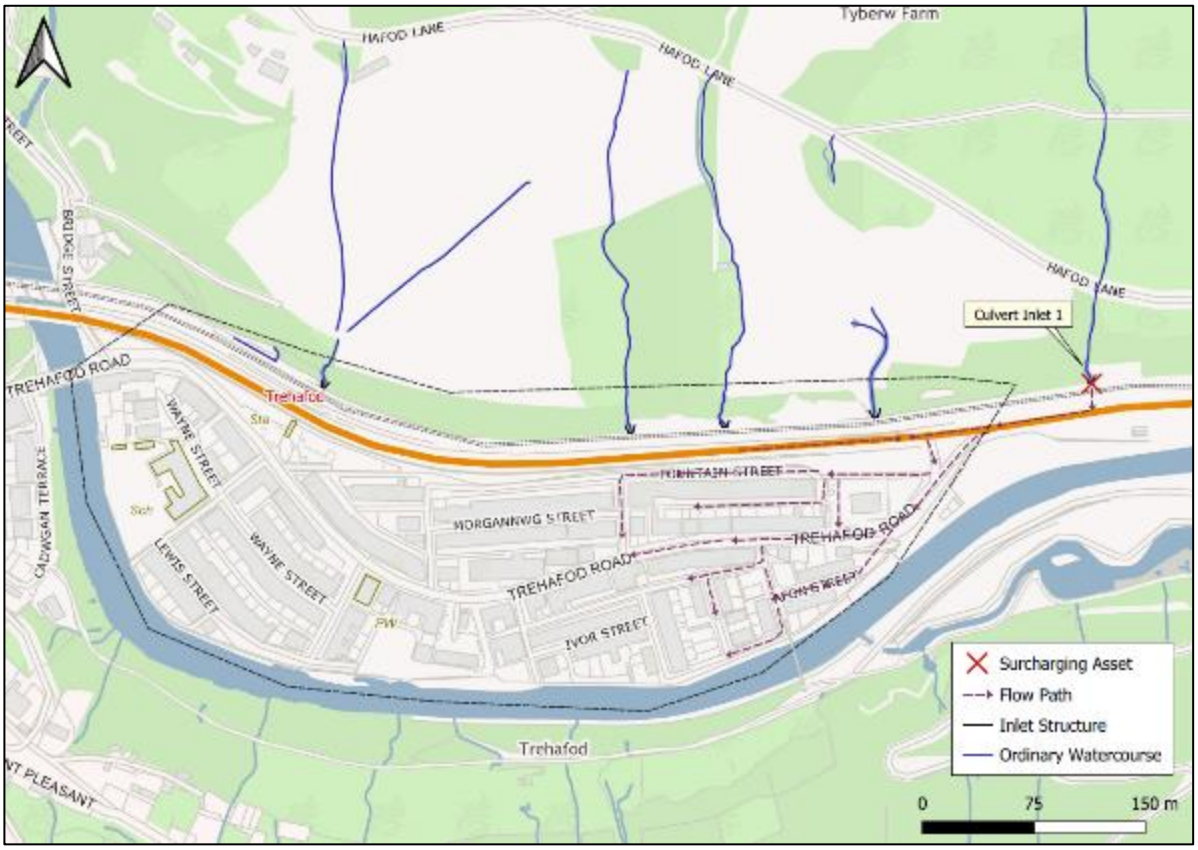

Figure 5: Observed flow paths within RCT18 during Storm Dennis (15-16th February 2020)

Several calls were received by residents within the village of Trehafod on 16th February 2020 referencing significant flooding to the highway along the A4058 (Gyfeillion Road) in addition to residential properties along Fountain Street, Trehafod Road and Afon Street, within the eastern half of Trehafod.

Upon an inspection carried out by RCT's Flood Risk Management officers in the days following the storm event it was reported that a localised landslip resulted in the obstruction of 'Culvert Inlet 1' (shown in Figure 5) to the north of the railway line. The obstruction subsequently led to the surcharging of 'Culvert Inlet 1', resulting in flooding to the railway line and the conveyance of flood water over the retaining wall and onto the highway (Figure 6 and 7).

Figure 6 also shows evidence of water breaching through the lower retaining wall indicating a surcharge of the ordinary watercourse culvert network downstream of 'Culvert Inlet 1'.

Figure 6: Image capturing water overtopping and breaching through the retaining wall below 'Culvert Inlet 1' and the A4058 during Storm Dennis (Source: Social Media)

Figure 7: Surface water accumulation along the A4058 near the Trehafod Road junction during Storm Dennis (Source: Social Media)

As illustrated in Figure 5, surface water flows accumulated along the A4058 (Gyfeillion Road) and conveyed towards Trehafod Road highway junction before travelling towards Fountain Street via a 50-metre-long pathway connecting the street with the adjacent road. Evidence of silt and debris deposited by the surface water flow path towards Fountain Street is shown in Figure 8.

Figure 8: Image capturing deposited mud and silt on a walkway connecting Fountain Street and the A4058 / Trehafod Road highway junction following Storm Dennis (Captured by a RCT Flood Risk Officer following Storm Dennis)

19 residential and 1 non-residential property experienced internal flooding on Fountain Street, with internal flooding being most severe at properties closest to the A4058 junction.

From the highway junction, flood water conveyed for approximately 200 metres in a southwesterly direction along Trehafod Road, resulting in the internal flooding of 28 residential properties along the street. Surface water flows also conveyed onto several streets south of Trehafod Road, including Colliery Street, Afon Street, Western Street, Great Street and Ivor Street. 11 properties (10 residential; 1 non-residential) on Afon Street, 5 residential properties on Western Street and 1 non-residential property on Ivor Street also reported internal flooding during Storm Dennis as a result of surface water flooding.

External flooding of up to 1.2 metres and internal flooding of up to approximately 1 metre was reported by the affected residents. Figures 9 and 10 depict the flood depths along Trehafod Road and Afon Street, respectively.

Figure 9: Flooding on Trehafod Road during Storm Dennis (Source: Social Media)

Figure 10: Flooding on Afon Street during Storm Dennis (Source: Social Media)

Two residential properties to the west of Trehafod Road also reported internal flooding. Both properties are situated directly opposite a railway underpass (Figure 11) allowing surface water to convey towards the highway and pool at localised low points.

Figure 11: Image capturing the route of surface water runoff towards the west of Trehafod Road (Captured by a RCT Flood Risk Officer following Storm Dennis)

As a result of intense rainfall falling across Trehafod during Storm Dennis, localised surface water accumulation is considered to have exacerbated the flooding experienced across several streets within RCT18.

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

There are several unnamed watercourses which drain the hillside to the north of Trehafod and many of these are culverted below RCT18 and the railway embankment at the northern boundary of the investigation area.

As depicted in Figure 12 there are 5 culvert inlets situated north of the investigation area above the railway track. The 5 culvert inlets are identified as falling under the ownership and responsibility of Transport for Wales (TfW). At the time of Storm Dennis in February 2020, prior to the transfer of ownership of the Core Valley Lines network to TfW in March 2020, the culvert inlets were the responsibility of Network Rail.

The culvert inlet known to have surcharged during the storm event is labelled 'Culvert Inlet 1' in Figure 12. 'Culvert Inlet 1' was last examined by Network Rail in August 2018 as per their 'detailed inspection' cycle.

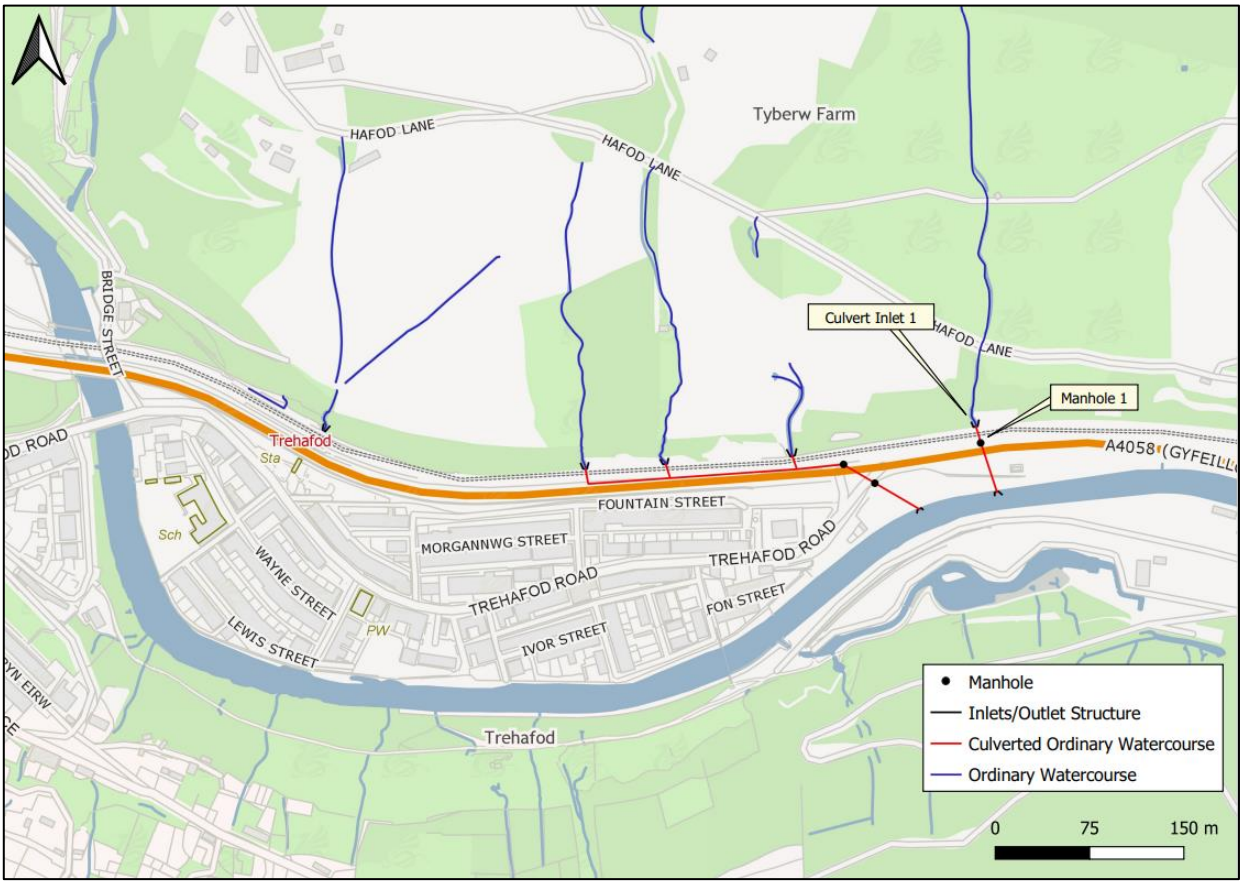

Figure 12: Map of the known culverted ordinary watercourse infrastructure within RCT18

The culvert inspection report provided by TfW on behalf of Network Rail (Completed August 2018), reported no significant defects present at ‘Culvert Inlet 1’ however it was noted that the internal condition of ‘Culvert Inlet 1’ structure was unable to be surveyed due to access restrictions.

Based on the inspection photos provided by Network Rail (Figure 13) it is considered likely that the safety grid above the culvert is susceptible to the accumulation of debris (settled deposits and bar damage evident).

Figure 13: Images of 'Culvert Inlet 1' captured during Network Rail’s culvert inspection in August 2018

According to the culvert inspection records, recommendations made by Network Rail were not carried out and have been carried over from previous detailed inspections in some cases. One of these recommendations is to “carry out a detailed examination of the culvert using specialist techniques to examine the barrel, to confirm that the structure is still fit for purpose”.

The next inspection due date is 2024 and will be undertaken by Amey Infrastructure Wales (AIW) on behalf of TfW as the Infrastructure Manager of the Core Valley Lines network. According to TfW the culverts above RCT18 will be inspected in 2022 under new proposals.

During Storm Dennis, there were reports of a landslip (residents and DCWW report) on the hillside above ‘Culvert Inlet 1’ which is considered to have contributed material towards the inlet, which contributed to its blockage and subsequent surcharge over the railway track, onto the A4058 and onwards towards the investigation area.

Following Storm Dennis, RCT undertook a CCTV survey inspection of the culverted ordinary watercourse networks illustrated in Figure 12 to ascertain both the operational condition of the networks and its structural integrity, however, the extent of the surveys were limited due to high-water levels within the downstream network and access restrictions within the upstream sections.

The results however, identified significant debris deposition within sections of the culvert network illustrated in Figure 12. Figure 14 shows the volume of debris, consisting primarily of silt and stonewash, within ‘Manhole 1’ (highlighted in Figure 12). The debris depicted at ‘Manhole 1’ shows an 80% reduction in cross sectional area within the culvert network downstream of ‘Culvert Inlet 1’. 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 however, it is considered that the reported landslip on the hillside above ‘Culvert Inlet 1’ contributed to the accumulation of debris within the culvert network, and the associated loss in hydraulic capacity to manage the flow of water.

Notably, no structural defects were identified within the surveyed sections. No flooding was observed to have originated from the downstream culvert network during the storm event.

Figure 14: Debris accumulation within the culvert network downstream of 'Culvert Inlet 1' (view looking upstream from Manhole 1) captured post event during CCTV surveying operations

Based on the available evidence presented within this investigation, the significant volume of material within the culvert network downstream of ‘Culvert Inlet 1’ is considered to have contributed to its surcharge however, in addition to this, debris mobilised from the hillside is also considered to have accumulated at the inlet structure (Figure 13), contributing to the surcharging flows which conveyed over the railway line towards Trehafod Road.

3.2. ORDINARY WATERCOURSE CONDITIONS

As outlined in Section 2.1, there are several unnamed ordinary watercourses that drain the upper catchment and convey towards the investigation area (Figure 12). The watercourses descend into the culvert inlets as a series of waterfalls above the railway line which runs parallel to the A4058 to the northern perimeter of RCT18 (Figure 15).

Figure 15: An exemplar ordinary watercourse that conveys towards the railway line at the northern boundary of the investigation area in a waterfall formation. (Captured by a RCT Flood Risk Officer)

Reports provided by DCWW of a localised landslip on the hillside above 'Culvert Inlet 1' indicate that areas of potential scour and associated mobilisation of material via the unnamed watercourse upstream of 'Culvert Inlet 1' likely occurred during the event however, access to inspect the condition of the ordinary watercourses above RCT18 was severely restricted given the steep nature of the ordinary watercourse sections above the railway line.

Based on the available evidence presented within this report there is anecdotal evidence to suggest that the condition of the unnamed ordinary watercourses contributed to the surcharging at 'Culvert Inlet 1' and the recorded flooding of properties within RCT18 during Storm Dennis.

3.3. MAIN RIVER

The designated main River Rhondda flows through the village of Trehafod from west to east along the southern boundary of the investigation area (Figure 1).

The hydrograph in Figure 16 illustrates the rapid rise in levels of the River Rhondda in response to rainfall, captured at NRW's Trehafod station. The River Rhondda at Trehafod reached its highest peak recorded at approximately 05:00 on 16th February 2020, reaching 3.977 metres.

The green bar displayed on the hydrograph shows the typical level of the River Rhondda at Trehafod station, ranging between approximately 0.2 and 0.8 metres. At its peak, the Rhondda River was over 3 metres higher than its average level, stressing the extreme and unprecedented levels that RCT's rivers rose to during the storm's peak intensity.

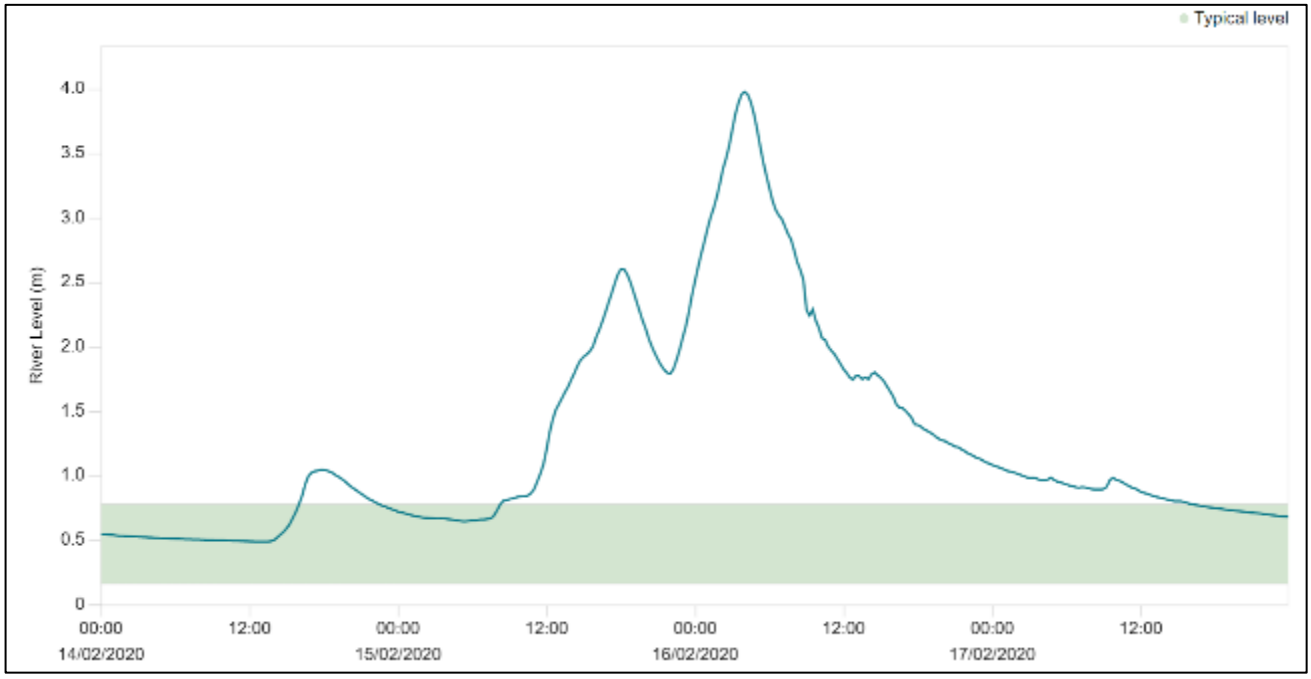

Figure 16: The River Rhondda levels at Trehafod station between the 14th and 17th February 2020 (Natural Resources Wales)

There is no evidence from this investigation to suggest that the River Rhondda significantly contributed to the recorded flooding of properties in investigation area RCT18 during Storm Dennis, however, based on the relative high levels recorded within the River Rhondda during the storm event, it is considered likely that the outfall conditions of the culverted ordinary watercourse, surface water and sewer structures

became restricted. This is considered to have contributed to the observed surcharging of the surface water drainage network however, there is limited evidence to outline this interaction.

3.4. HIGHWAY DRAINAGE CONDITIONS

Several streets including Trehafod Road, Fountain Street and Colliery Street were observed as flooded during the storm event as a result of ordinary watercourse and surface water flows overwhelming the existing highway drainage. These flows deposited mud, silt and debris across the investigation area which are assumed to have entered the highway drainage system, leading to blockages and a reduction in the hydraulic capacity of the surface water network. Several surface water manholes along Trehafod Road and Fountain Street were also reported as surcharging during the storm event.

CCTV inspections undertaken post storm event confirm this, with surveys completed on Fountain Street and Trehafod Road identifying large silt and debris deposits within many sections of the highway drainage network. Figure 17 depicts the operational condition of the highway drainage at Fountain Street before and after cleansing operations took place in April 2020. A total of 5 tonnes of silt and debris was removed by a Council appointed contractor during cleansing operations.

Figure 17: Photo of a manhole at Fountain Street captured before (left) and after (right) surveying and cleansing operations during April 2020

Highway drainage is not designed to manage overland flows from private areas, parks or open space, nor is it designed to accommodate fluvial flows that may arise during

storm events. In this instance, the capacity of the highway drainage in RCT18 was exceeded as a result of ordinary watercourse flows entering the network at different locations throughout the investigation area. The maintenance condition of the highway drainage infrastructure is not considered to have significantly impacted the flooding experienced during Storm Dennis.

3.5. DŴR CYMRU WELSH WATER APPARATUS

Several responses received by residents during the public engagement exercise expressed concern that the flooding experienced during Storm Dennis was caused wholly or partially by DCWW's surface water pumping station, labelled 'Trehafod Road Pumping Station' in Figure 18, located in the southeast of the investigation area.

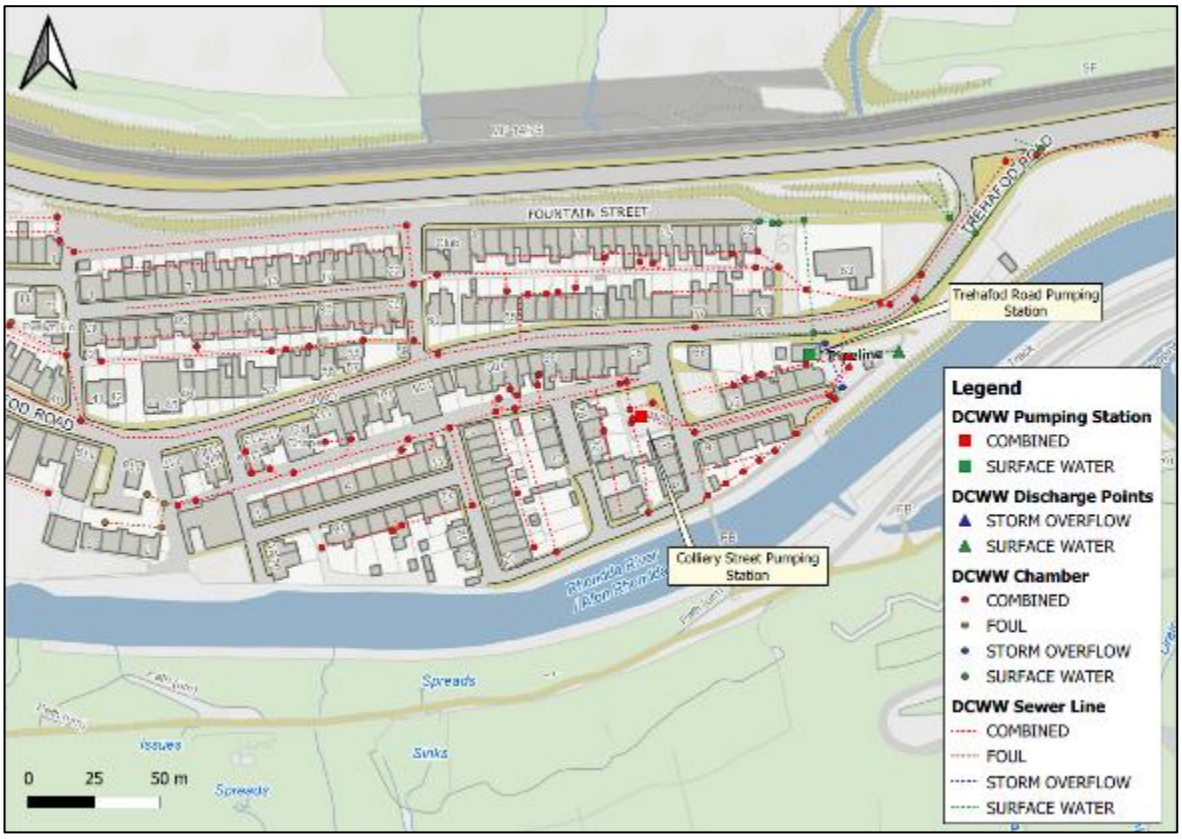

Figure 18: DCWW infrastructure within the eastern half of RCT18

Members of the local community inferred that the pumping station did not function adequately during the storm event resulting in surface water surcharging through several combined sewer and surface water manholes in the area. Public engagement responses also noted the receding of surface water soon after a DCWW operative attended the pumping station at approximately 07:30 on the 16th February 2020.

DCWW confirmed that they received no pump failure alarms for the 'Trehafod Road Pumping Station' asset during Storm Dennis and their telemetry data confirm that both the 'Trehafod Road and Colliery Street Pumping Stations' continued to operate for the duration of the storm event.

Figure 19 shows the levels within the 'Trehafod Road Pumping Station' during the strom event. This information has been provided by DCWW.

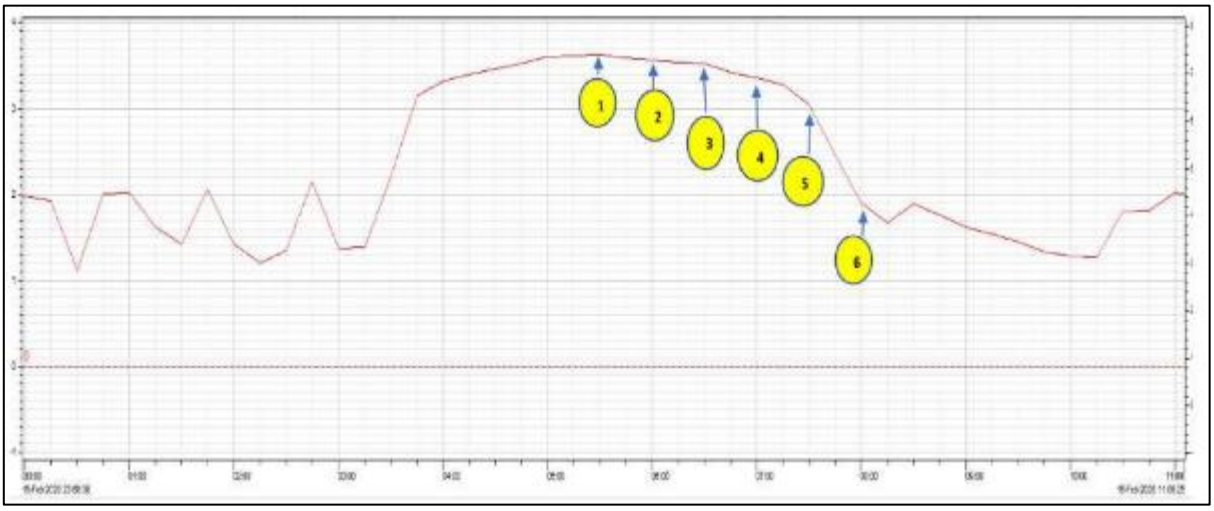

Figure 19: Graph showing pumping station levels at 'Trehafod Road Pumping Station' during Storm Dennis (Supplied by DCWW)

A high-level alarm at the 'Trehafod Road Pumping Station' was received at 03:37 on the 16th February 2020; at which point the level within the pumping station was approximately 2.7 metres according to telemetry data illustrated in Figure 19.

The highest level recorded at the pumping station was 3.63 metres recorded at 05:30 on 16th February 2020 (Point 1, Figure 19). By the time a DCWW investigating officer attended site at 07:30, levels within the pumping station had decreased by 0.63 metres from the highest recorded level (Point 5, Figure 19).

The DCWW operative confirmed that there were no faults, and the pumping station was operating as expected with no failures. Since Storm Dennis DCWW have surveyed and carried out connectivity tests on their surface water sewer network in the area. No blockages or restrictions were identified within the system nor was there any evidence that DCWW's surface water sewer had surcharged or discharged through any manhole covers during the storm.

National standards of protection outline that sewers should be designed and constructed to withstand flooding up to the equivalent of a 1 in 30-year storm event[4]. Storm Dennis in Rhondda Cynon Taf has been estimated as a 1 in 200 annual probability (Q200) flood event, indicating that DCWW's assets became overwhelmed during such an extreme event. DCWW accept that their surface water drainage assets

[4] WRC., 2012. Sewers for Adoption: 7th edition

were likely unable to cope with the storm event, resulting in surface water being unable to reach the pumping station to be discharged.

Whilst this overwhelming of the surface water sewer network and pumping stations is likely to have exacerbated the flooding experienced across eastern sections of RCT18, it is not considered that DCWW apparatus was the cause of the flooding during Storm Dennis. Based on the evidence provided within this report, in addition to DCWW's own investigations, the primary cause of flooding to properties within RCT18 was ordinary watercourse and surface water flows originating from a surcharging culvert inlet (as outlined in Section 2.2) situated above the railway line.

3.6. SURFACE WATER

Surface water flooding as a result of a surcharged ordinary watercourse culvert and overwhelmed highway drainage infrastructure was identified as the primary source of flooding to properties throughout the investigation area.

The surface water flooding that occurred within investigation area RCT18 during Storm Dennis is largely consistent with the modelled outputs of NRW's Flood Risk Assessment Wales (FRAW) mapping.

Properties impacted by surface water flooding at Fountain Street, Trehafod Road, Afon Street, Western Street and Colliery Street are identified at high and medium risk of surface water and ordinary watercourse flooding, as depicted within Figure 20, which is an extract from NRW's FRAW mapping exercise and depicts the surface water and ordinary watercourse flood extents. The darker shading identified 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).

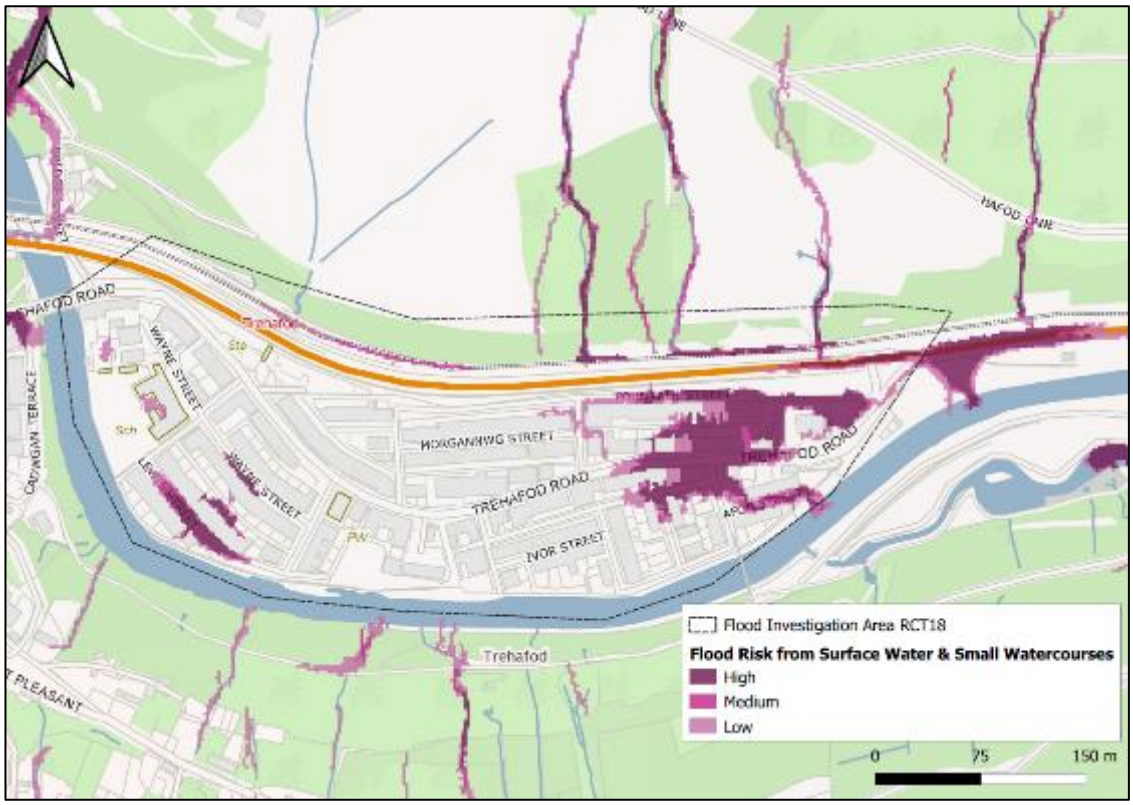

Figure 20: Natural Resources Wales' Flood Risk Assessment Wales (FRAW) map for Surface Water and Ordinary Watercourse sources at RCT18. Contains Natural Resources Wales information © Natural Resources Wales and database right. All rights reserved.

A high risk of flooding means that an area has a chance of flooding 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 of between 1 in 100 (0.1%) and 1 in 100 (1%) each year.

It is noted that Figure 20 does not depict surface water and ordinary watercourse flood risk at the western areas of Trehafod Road where two residential properties reported internal flooding. The primary cause of flooding to both properties has been attributed to the highway drainage network becoming overwhelmed by surface water and rainfall accumulated at localised low points.

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

3.8.1. Surface Water Highway Drainage Network

A CCTV survey and capacity assessment for the surface water drainage network at Fountain Street was undertaken as part of Redstart's FIR. The assessment found that the surface water drainage network at Fountain Street provided a standard of protection (SOP) up to 1 in 30 annual probability (Q30) flood event which is in accordance with current indicative design standards for highway drainage infrastructure.

In blocked conditions the hydraulic capacity of the surface water network at Fountain Street is reduced to accommodate flood events up to 1 in 2 annual probability (Q2) flood events. Based on the identified silt and debris within the surface water network (Section 3.4) it is considered that the capacity of the highway drainage across RCT18 was significantly reduced during Storm Dennis as a result of the influx of ordinary watercourse flows and the associated deposition of silt and debris.

Despite the limited capacity data for the culverted ordinary watercourse infrastructure in RCT18, there is no evidence to suggest that the four culvert inlets situated west of 'Culvert Inlet 1' surcharged during the storm event, indicating that the networks were able to manage the flow of water. The blockages caused by a reported local landslip to 'Culvert Inlet 1' is considered to have significantly reduced the performance of the culvert structure to manage the flow of water from the hillside, resulting in surcharge over the railway line and onto the highway.

3.9. SUMMARY OF POSSIBLE CAUSES

The above sections have identified and described the possible causes of flooding within investigation area RCT18 during Storm Dennis which occurred on the 15 and 16th of February 2020. A summary of the identified source(s) and possible cause(s) of flooding (issue) has been outlined below in Table 3.

Table 3: Summary of source(s) and possible cause(s) of flooding investigation area RCT18 during Storm Dennis (15-16th February 2020)

Ref No	Asset (Source)	Issue	Asset Owner	Type of Flooding
1	Culvert Inlet 1	An ordinary watercourse culvert inlet (labelled 'Culvert Inlet 1, Figure 5) to the northeast of RCT18 surcharged during Storm Dennis following a reported local landslip on the hillside above Trehafod. Surcharging flows conveyed towards Trehafod Road via the railway line and the A4058, resulting in internal flooding to 63 residential and 3 non-residential properties.	Transport for Wales (formerly Network Rail)	Surface Water & Ordinary Watercourse
2	Surface water drainage network across RCT18	Intense rainfall across RCT combined with ordinary watercourse flows from 'Culvert Inlet 1' severely overwhelmed highway and surface water drainage infrastructure, resulting in the accumulation of surface water on many streets throughout the investigation area.	Rhondda Cynon Taf 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 responsible Risk Management Authority in relation to flood type is provided in Table 4. For further details of the roles and responsibilities of individual Risk Management Authorities in managing flooding, refer to the 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'[2].

Table 4: Risk Management Authority responsible for different flood types

Type of Flooding	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 Water Resources Act 1991, Land Drainage Act 1991 and the Highways Act 1980. Through analysis of the flooding that impacted RCT18, the flood risk management functions exercised or proposed to be exercised by relevant RMAs were recorded pursuant to Section 19 of the Flood and Water Management Act 2010, which states:

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

"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 RCT18 during Storm Dennis have been previously identified and summarised within Table 2. The Risk Management Authorities responsible for managing that flooding have been listed in Table 5 below, along with a series of recommendations put forward by the LLFA.

Table 5: Recommendations provided by the LLFA to be considered by the relevant Risk Management Authority identified in response to the source(s) of flooding in RCT18 (as per Table 3)

Ref No	Asset (Source)	Asset Owner	Type of Flooding	Relevant Risk Management Authority	Recommendations	
1	Culvert Inlet 1	Transport for Wales (formerly Network Rail)	Ordinary Watercourse	Lead Local Flood Authority and Land Drainage Authority	R1A	The LLFA and LDA to identify drainage asset ownership and responsibility.
					R1B	The LLFA and LDA to investigate the condition of the impacted culvert network.
					R1C	The LLFA and LDA to investigate the standard of protection of the culvert network.
					R1D	The LLFA to jet and cleanse the ordinary watercourse culvert network.

					R1E	The LLFA and LDA to review the risk of scour potential within the upstream ordinary watercourse channel.
					R1F	The LLFA and LDA to work with riparian landowners to identify suitable management methods to reduce the risk of scour within the ordinary watercourse.
					R1G	The LLFA and LDA to engage with the asset owner to undertake regular maintenance of all drainage infrastructure and assets that pose a risk to flooding.
2	Surface water drainage network across RCT18	Rhondda Cynon Taf Highway Authority	Surface Water	Highway Authority and Lead Local Flood Authority	R2A	The Highways Authority to jet and cleanse the highway drainage network and action repairs accordingly.
					R2B	The LLFA, Highway Authority and DCWW to evaluate surface water management options to alleviate pluvial flooding at locations across the investigation area.

4.1. LEAD LOCAL FLOOD AUTHORITY

In review of Ref 1 and 2 Table 5, the LLFA has been determined as the relevant Risk Management Authority in relation to the ordinary watercourse and surface water flooding which occurred in investigation area RCT18 during Storm Dennis.

The LLFA exercised the following functions in response to the flooding at investigation area RCT18:

- 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 culvert structures and network conditions and its impact on the flooding within the investigation area. **(R1B)**
- An estimated 173 metres of ordinary watercourse culvert network length and 150 metres of surface water drainage network length within RCT18 has been surveyed following Storm Dennis to ascertain both the operational condition and structural integrity along sections of the network. **(R1B, R1C, R2A)**
- An estimated 5 tonnes of debris was removed from the surface water drainage network within RCT18 during cleansing operations. **(R2A)**
- The LLFA have commissioned Redstart to investigate the standard of protection of the surface water drainage network in RCT18 to determine its hydraulic capacity following the observed surcharging of surface water manholes during Storm Dennis.
- The LLFA has exercised its powers, under Section 13 of the FWMA, to request information and co-operation from the relevant risk management authorities (DCWW) in relation to their responsibilities as RMAs in response to Storm Dennis.
- The LLFA has exercised its powers, under Section 14 of the FWMA, to request information and co-operation from Network Rail and Transport for Wales in relation to their responsibilities as significant asset and infrastructure owners within RCT18.

- 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 propose to exercise the following functions in response to the flooding at investigation area RCT18:

- Following the surveying of the surface water network in RCT18, the LLFA propose to input and update all relevant asset data. **(R1A)**
- 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.
- 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. 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 Trehafod catchment are 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 aim to encourage whole catchment measures, including working with natural processes, to alleviate flood risk in those areas of highest risk. **(R1E, R1F, R2B)**
- The LLFA and LDA propose to undertake Geomorphological assessments of the upper catchments in Trehafod 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 watercourses. **(R1E, R1F)**
- The LLFA propose to work with the Highway Authority and DCWW to evaluate surface water management options to alleviate pluvial flooding at locations across the investigation area. **(R2B)**
- The LLFA and LDA will engage with Transport for Wales as asset owner of the Core Valley Lines network to undertake regular maintenance of all drainage infrastructure and assets that pose a risk to flooding. **(R1G)**

4.2. NATURAL RESOURCES WALES

Whilst NRW were not identified as a relevant Risk Management Authority in relation to the flooding at investigation area RCT18 during Storm Dennis, NRW undertook the following functions in response to the flooding within RCT18:

- NRW completed repair works to sections of main river flood wall damaged during the storm event, including the resetting of construction joints.
- 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 improve how live flood warning and water level data is shared before and during flood events.
- Following the flooding events of February 2020, NRW published a review of its incident response to Storm Ciara and Dennis in October 2020[6]. 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, including a review of the Flood Warning Area thresholds for the River Rhondda at Trehafod.

NRW also propose to exercise the following actions in response to the flooding at investigation area RCT18:

- NRW have commissioned a Rhondda flood modelling project programmed for completion by Spring 2022.
- Following the completion of NRW's Rhondda 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

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

4.3. WATER COMPANY

Following the investigation into the flooding at Trehafod, DCWW were not identified as a relevant Risk Management Authority in relation to the flooding at investigation area RCT18 during Storm Dennis, however, DCWW undertook the following functions in response to the flooding within investigation area RCT18:

- DCWW carried out their own investigations in response to incidences of flooding that were reported by residents directly to DCWW.
- DCWW investigated and tested the performance of their network and pumping stations within RCT18 to ensure their assets were operating with no issues.
- DCWW surveyed and undertook connectivity tests on the surface water sewer network surrounding the pumping station.
- DCWW undertook a topographical survey to identify the low points within the village of Trehafod and compare the findings with the water levels within the 'Trehafod Road Pumping Station' during Storm Dennis to better understand the potential impact on the catchment.
- DCWW carried out model simulations on DCWW-owned assets to confirm the successful conveyance of flows during a 1 in 30 annual probability storm event. DCWW also utilised this information to determine the performance of the network in a storm equivalent to Storm Dennis and concluded that their assets would have struggled to cope with the volume of water.
- DCWW provided residents impacted by internal flooding within the vicinity of the 'Trehafod Road Pumping Station' with an emergency payment to provide assistance in the aftermath of the storm event.

DCWW propose to exercise the following function in relation to the flood event at investigation area RCT18;

- DCWW will work with the LLFA and the Highway Authority to evaluate surface water management options to alleviate pluvial flooding at locations across the investigation area. **(R2B)**

4.4. HIGHWAY AUTHORITY

During the investigation into the flooding at investigation area RCT18 during Storm Dennis, the Highway was identified as flooding as a result of a surcharging ordinary watercourse culvert inlet and associated surface water accumulation.

Ref 2 of Table 5 identifies the Highway Authority as a relevant Risk Management Authority in relation to the surface water flooding that occurred along the highway across RCT18.

RCT as the Highway Authority have exercised the following functions in response to the flooding within investigation area RCT18:

- The Highway Authority assisted with the emergency response during the event by supplying equipment and sandbags, some to individual properties and 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 ordinary watercourse and surface water to ensure the safety of the highway post event. **(R2A)**
- 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 drainage infrastructure.

RCT as the Highway Authority propose to undertake the following function in relation to the storm event at RCT18:

- The Highway Authority to work with the LLFA and DCWW to evaluate surface water management options to alleviate pluvial flooding at locations across the investigation area. **(R2B)**
- The Highway Authority intend to carry out further jetting and cleansing operations of their infrastructure associated to the culverted ordinary watercourse networks within Trehafod. **(R1D)**

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