



Section 19 Flood Investigation

July 19th 2017 Floods



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7 March 2018

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Executive Summary

This report has been prepared for the purpose of meeting the requirements of Section 19 of the Flood and Water Management Act 2010. Under Section 19 of the Flood and Water Management Act 2010 the Lead Local Flood Authority (Denbighshire County Council) on becoming aware of a flood in its area, must to an extent that it considers necessary or appropriate, investigate, prepare and publish a Flood Investigation Report.

On the 19th of July 2017, a period of very heavy rainfall led to the surface water flooding of a significant number of properties in the north of the county, both residential and commercial.

Officers from the Council's Flood Risk Management section have visited all of the locations affected by flooding and have, where possible, carried out interviews with residents and businesses to gain an understanding of the nature of the flood event based on first-hand accounts. In addition, meetings have taken place with officers from Dŵr Cymru Welsh Water and Natural Resources Wales and information has been shared between organisations.

Rainfall Event

The intensity and duration of the rainfall event led to significant surface water flooding across the north of Denbighshire as drainage systems were inundated and appeared unable to cope and water was unable to infiltrate into the ground. This was particularly problematic in the areas around Rhyl, Rhuddlan and Prestatyn leading to localised flooding of property. In many areas the surface water issues combined with sewer flooding.

Information recorded at rain gauges located in Pensarn, Llanasa, and St. Asaph during the event have helped to provide an indication of the storm intensity.

Data provided to us by Natural Resources Wales has been checked, and is deemed to be reliable against the totals collected from the adjacent storage check gauges for Pensarn, Llanasa and St Asaph. Unfortunately, the logger at Prestatyn had corrupted and there is no sub-daily data to analyse for this event. Further analysis of this data was carried out; the results are as follows:

- Pensarn raingauge (SH 95147 78859) experienced a 1 in 50-year event, with 40.4mm of rain falling in the 1 hour 15mins commencing 14:15 GMT.
- Llanasa raingauge (SJ 12429 83292) experienced a 1 in 24-year event, with 25.4mm of rain falling in the 30mins commencing 14:45 GMT.
- St. Asaph raingauge (SJ 03315 75159) experienced a 1 in 14-year event, with 21.4mm of rain falling in the 30mins commencing 14:14 GMT.

A second intense band of rainfall swept over the Pensarn area at 15:10 GMT, but appears to have missed the other rain gauges. HYRAD¹ (Figure 1) suggests this second band of rainfall would have affected Rhyl too, which could indicate a return period for the Prestatyn/Rhyl area broadly similar to that assessed for Pensarn rain gauge.

In addition, Dŵr Cymru Welsh Water requested an assessment of the rainfall event from the Met Office, using rainfall radar data. The Met Office concluded that the rainfall experienced on 19th July 2017 was a 1 in 54-year event. A copy of the Met Office reports for Pensarn and Rhyl are included in Annex B.

¹ <https://www.ceh.ac.uk/services/hyrad>

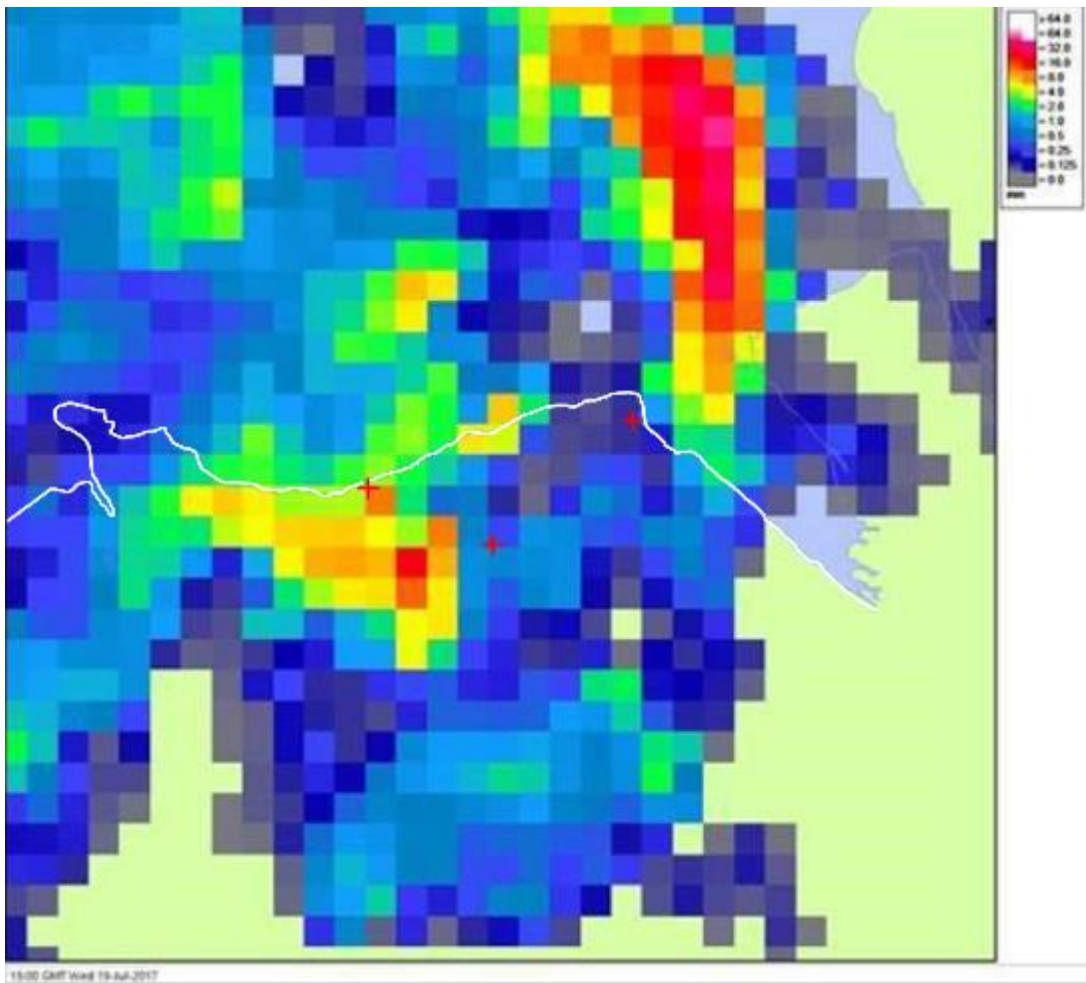


Figure 1: Rainfall intensity recorded at 3pm GMT 19TH JULY 2017 across North Wales

(These images are for illustration purposes only, and are intended to provide an indication of the distribution of rainfall intensity across the area)

Locations of 19th July Flooding

Internal flooding of property was recorded at the following locations:

Community Affected	Location	Residential / Commercial	Number of Properties Flooded
Rhyl	Ffordd Derwen	Residential	7
	Garford Road	Residential	6
	Coast Road	Residential	15
	Wellington Road	Residential	5
	Lake Avenue	Residential	6
	Palace Avenue	Residential	3
	Kingsley Avenue	Commercial	1
	Aspen Way	Residential	2
	Fern Walk	Residential	1
	Walford Avenue	Residential	1
Prestatyn	Highstreet	Commercial	27
	Trevor Road	Residential	1
	Garnett Drive	Residential	1
	Derwent Close	Residential	2
	Plas Avenue	Residential	2
Rhuddlan	Berllan Avenue	Residential	6
	Kerfoot Avenue	Residential	3
	Highlands Close	Residential	2
St Asaph	Caradoc Terrace	Residential	4
	Ruby Terrace	Residential	2
	The Roe	Residential	1
		Total	98

*The above table shows properties that are believed to have flooded, based on reports received by the Council from residents and the results of investigations.

**Dŵr Cymru Welsh Water's record of sewer flooding incidents is included in Annex A

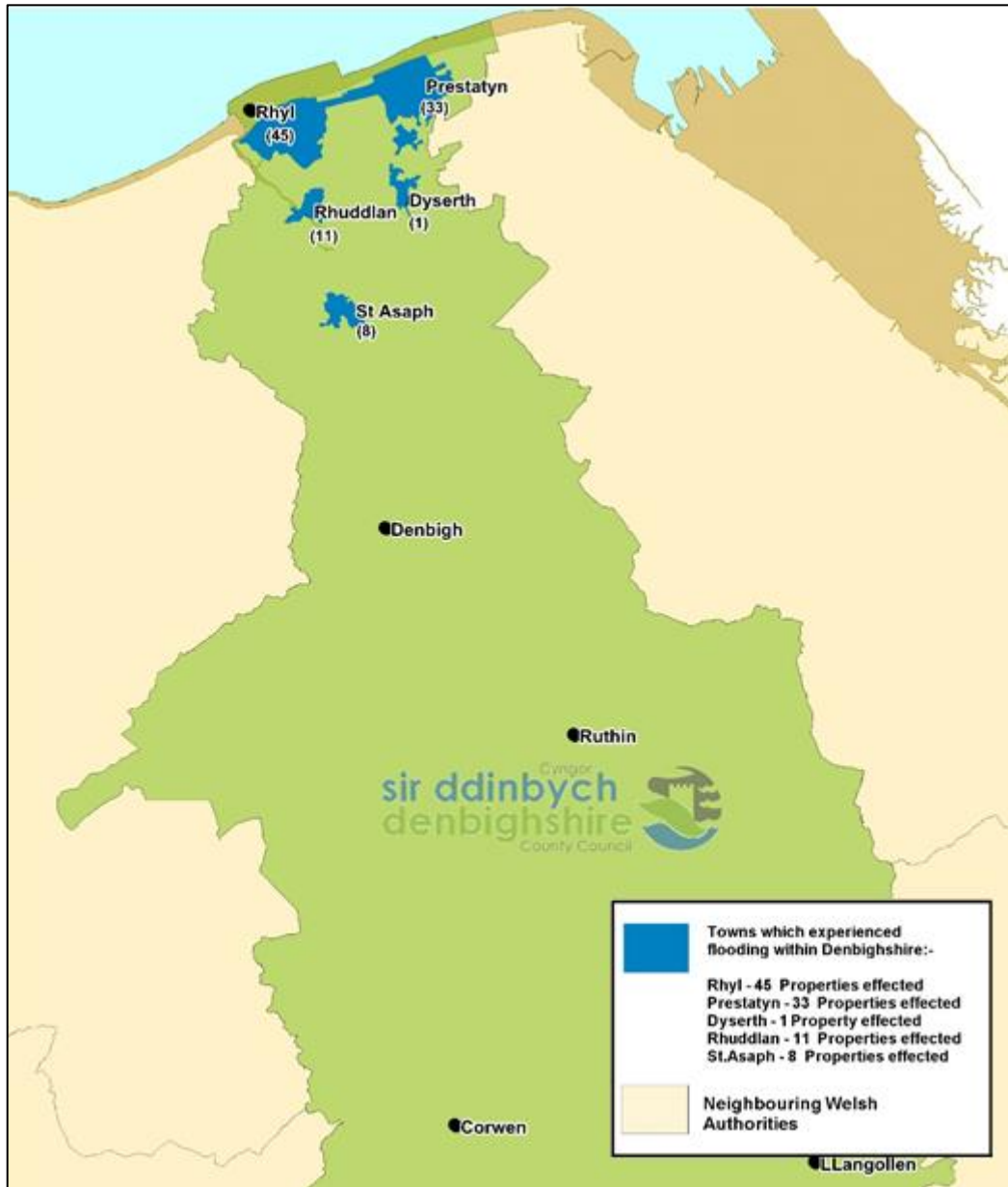


Figure 2 – Location of areas flooded across Denbighshire

Rhyl

Ffordd Derwen

Properties along Ffordd Derwen reported flooding at around 3.30pm, the heavy rainfall led to water accumulating quickly on the highway at the front of properties and to the rear in playing fields, in turn this led to the drainage systems serving the area becoming inundated, surcharging and consequently leading to a number of properties flooding internally.

Vehicles travelling through the flooded public highway exacerbated the flooding due to wave effects of pushing the water off the highway which leans on a gradient towards the properties, through into the properties' front gardens and drives.



Figure 3 – Surcharging manhole cover on Ffordd Derwen

Surface water flood maps provided by Natural Resources Wales show that Ffordd Derwen is at risk of surface water flooding, with properties being particularly susceptible due to their relatively low elevation compared to surrounding areas, including the highway. Improvements were made to the

highway drainage system following a similar flooding event in July 2016, however the scale of the rainfall caused the improved drainage system to be overwhelmed.

Denbighshire County Council appointed consultants in November 2017 to carry out a drainage study which will examine the cause of flooding, the likelihood of reoccurrence, and make recommendations to reduce flood risk in future.



Figure 4 - Predominate source of flooding was surface water accumulating on highway as well as water coming in from rear of the lowest lying properties.

Garford Road and Coast Road, Rhyl

A combination of hydraulic overload exacerbated by Dŵr Cymru Welsh Water pumping station failure serving the combined sewer system coupled with the intense rainfall led to flooding along the front of properties on Coast Road and the southern end of Garford Road. As water accumulated on the highway in front of properties, the lowest parts of this area became inundated. Predominately water entered the properties via low lying garage door entrances and open air bricks. Internal flood damage to properties was minimal, however it is noted that the extent of the flooding was exacerbated by vehicles travelling along the flooded highway and creating waves. Dŵr Cymru Welsh Water has carried out hydraulic modelling investigations which have confirmed that the primary cause of flooding was that the sewer network was hydraulically overloaded and couldn't cope with flows. Flooding would still have occurred had the pumps been fully operational.

Currently Dŵr Cymru Welsh Water is reviewing the resilience of its pumping station assets and combined sewer network in this area. Dŵr Cymru Welsh Water has a duty to provide and maintain a system of public sewers so that the areas for which they are responsible are effectually drained (Water Industry Act, 1991). Sewerage systems are not, however, designed to accommodate flows from severe weather events.

There is evidence to suggest that flooding has been a problem in this area for the last decade.



Figure 5 – Accumulation of water on highway at Garford Road, Rhyl

Lake Avenue, Wellington Road and Palace Avenue, West Rhyl

Approximately 15 properties suffered internal flooding in West Rhyl due to a combination of factors which led to sewers surcharging in rear gardens along Lake Avenue, and on highways behind properties along Wellington Road as well as Palace Avenue.

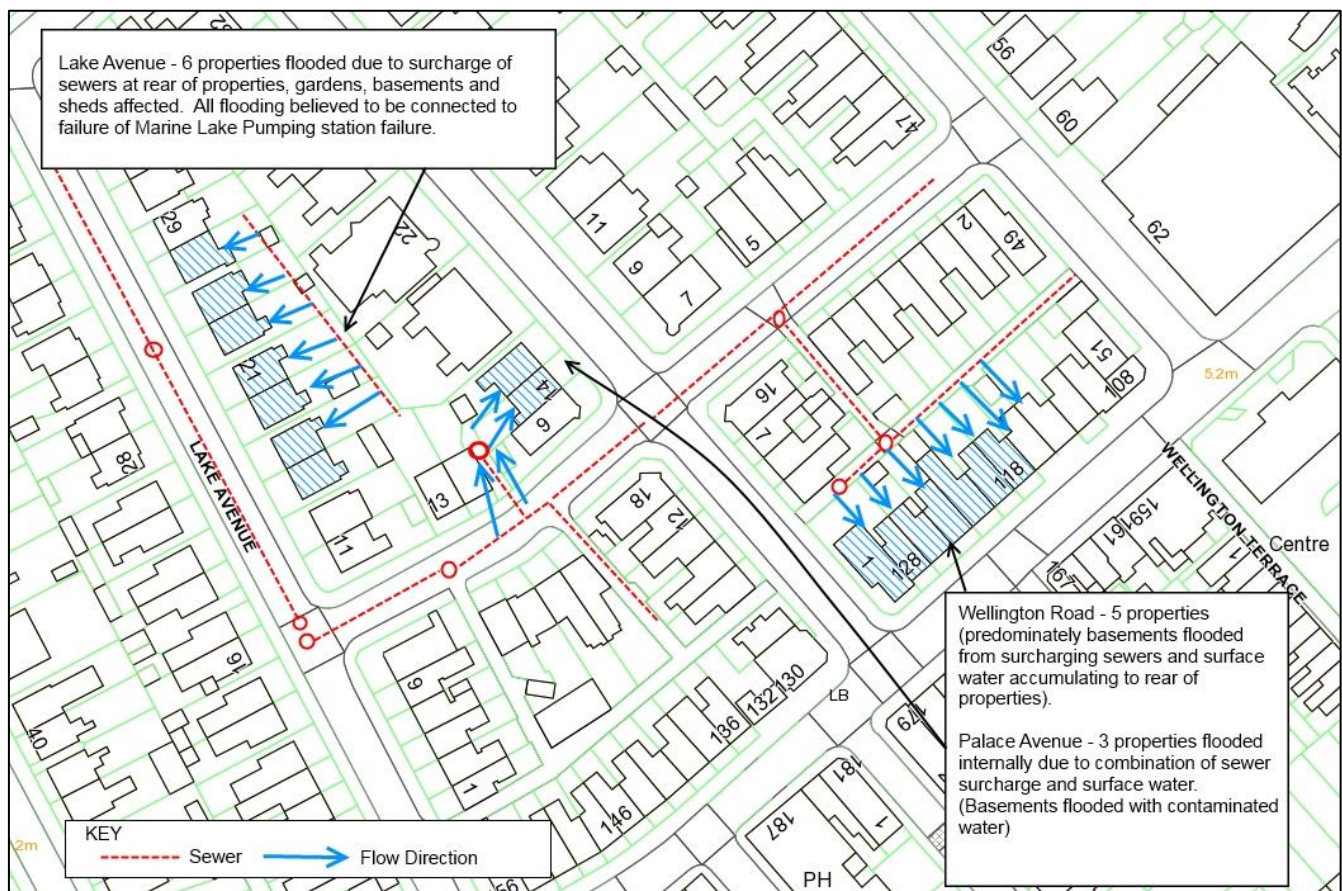


Figure 6 – Overview of combined sewer network which surcharged and caused flooding to properties

Upon investigation of the matter it was evident that the majority of flooding impacted upon properties through flood water entering lower ground basements and cellars. Dŵr Cymru Welsh Water has advised the Council that the primary cause of flooding was that the sewer network was hydraulically overloaded and couldn't cope with flows.

Dŵr Cymru Welsh Water has carried out works to address matters at these locations, and is continuing to improve the capacity of the combined sewer system to manage flood risk in the future.



Figure 7 – Rear of Properties along Wellington Road suffered flooding due to a combination of surcharging combined sewer systems and surface water.

Kingsley Avenue and Walford Avenue

A sheltered housing complex and dance studio flooded off Walford Avenue and Kingsley Avenue. From investigations carried out by the Council and Natural Resources Wales at this location, it was determined that one of the possible sources of the flood water affecting the dance studio was Rhyl Cut. As this watercourse is classed as Main River, NRW have carried out an investigation.

The Sheltered housing (Plas Cyril) is understood to have flooded from surface water alone, predominately flowing off Walford Avenue. Upon further investigation of the drainage here, no surface water connections were identified as connecting directly to the Rhyl Cut, however the entire area around Plas Cyril was drained by the combined sewer network which was overwhelmed during the storm event.

The report of the investigation carried out by NRW can be found in Annex C

Other locations in Rhyl

Widespread reports of highway flooding were reported to Denbighshire County Council across Rhyl and isolated locations of minor flooding to dwellings, such as gardens and garages, were reported on Aspen Way, Fern Walk and Eastville Avenue in East Rhyl. Following investigations at these locations, it is understood that the combined sewer system serving the highways at these locations was unable to convey flows effectively, resulting in the system backing up. Dŵr Cymru Welsh Water has employed consultants to review the performance of its sewer system and this work is ongoing at the time of writing.



Prestatyn **Figure 8 – (Top Left – Flooding on Fern Walk, Top Right Flooding on Pen Y Maes, Bottom left Flooding on Cefndy Road, Bottom Right, Flooding on Vale Road)**

Prestatyn High Street

Flooding was recorded at various locations along Prestatyn High Street, affecting a number of businesses and properties. The worst affected area, in terms of depth and extent of flooding, was at the lower end of the high street, where internal flooding was recorded as affecting 12 businesses.

A number of factors are believed to have contributed to the severity of flooding at this location. However, the overarching cause is likely to have been hydraulic overload of the surface water drainage system as a consequence of the intensity of the rainfall event.

The topography of Prestatyn High Street acts to convey floodwater to the open area at the northern end the high street which acts as a bowl. Here the water ponds and the drainage systems in place were unable to convey the excess water away quickly enough leading to flood water ingress via the doorways of properties.



Figure 9 – Lower Prestatyn High Street and Shopping Park – Properties Flooded



Figure 10 – Extensive accumulation of surface water on lower end of Prestatyn High Street



Figure 11 – Prestatyn High Street / Maes Y Groes – Properties Flooded

Incidences of flooding were also reported across other parts of the high street, to businesses and residential properties. Upon investigation, it was found that the businesses had flooded from private drainage systems failing, and excess surface water entering the properties from the rear.

On Maes y Groes road, excess surface water flowed directly into properties through front door entrances, due to the properties having floor levels at a lower elevation to the highway.

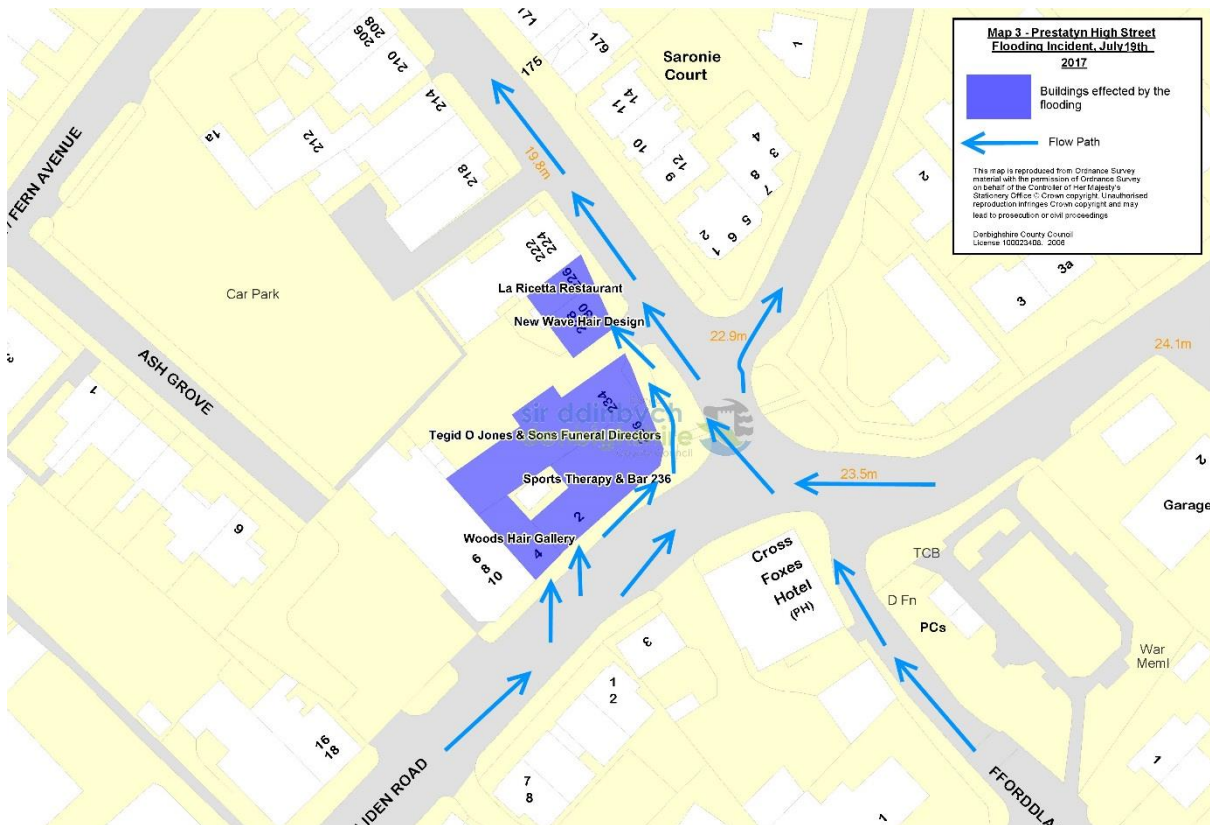


Figure 12 – Upper Prestatyn High Street – Properties Impacted by Flooding

Localised flooding also occurred at the top (south end) of Prestatyn High Street also. Upon investigation, it is considered likely that surface water accumulated on the footway between the highway and properties affected, as a result of the drainage system on Meliden Road becoming surcharged. Flood water entered properties through the front doors.

A significant contributing factor to the flooding issue affecting the bottom (north end) of Prestatyn High Street is the volume of water flowing into the high street from higher land to the south, conveyed by open drainage systems on Fforddlas. The Council is in discussions with Dŵr Cymru Welsh Water regarding the development of a hydraulic model of the catchment and possible measures to intercept flows during heavy rain.

Other locations in Prestatyn

Flooding was reported at numerous other locations in Prestatyn, including Trevor Road and Prestatyn High School. There were multiple reports of ‘near miss’ incidences of highway flooding, including Garnett Drive, Oakhill Drive, Charleston Avenue and Glan y Gors.

Natural Resources Wales is, at the time of writing, carrying out an investigation into reported flooding from Prestatyn Gutter (main river) which affected Highbury Avenue.

Rhuddlan

Surface water flooding occurred across numerous parts of Rhuddlan with a number of highways inundated by the intense rainfall. Investigations carried out by Dŵr Cymru Welsh Water and Denbighshire County Council have focused mainly on areas where properties have flooded internally.

Of particular note in Rhuddlan was flooding to Bro Berllan. Following the flooding to properties here, extensive surveying was carried out by Dŵr Cymru Welsh Water and Denbighshire County Council to establish the cause of the issues here, and whether drainage system was adequate or whether the intensity of the rainfall event simply exceeded the design capacity of the system.

Anecdotal evidence collected through speaking to affected residents and Council officers suggests that a significant source of flood water was surface water accumulating and flowing into the back of the properties from Rhyl Road (see Figure 13). Further to this to the front of the properties, there are a minimal number of road gullies located along Berllan Avenue, and as there is minimal slope; surface water accumulates quickly on the highway at the front also. Consequently due in large part to the properties of Bro Berllan sitting at a lower elevation when compared to the surrounding area, surface water settles here. The problem is exacerbated by a large area of hardstanding sloping towards the properties at the front. The properties are served by soakaways, and upon investigation a soakaway connection was found to have collapsed, which might have contributed to the flood.



Figure 13 – Surface Water accumulating on Rhyl Road, Rhuddlan

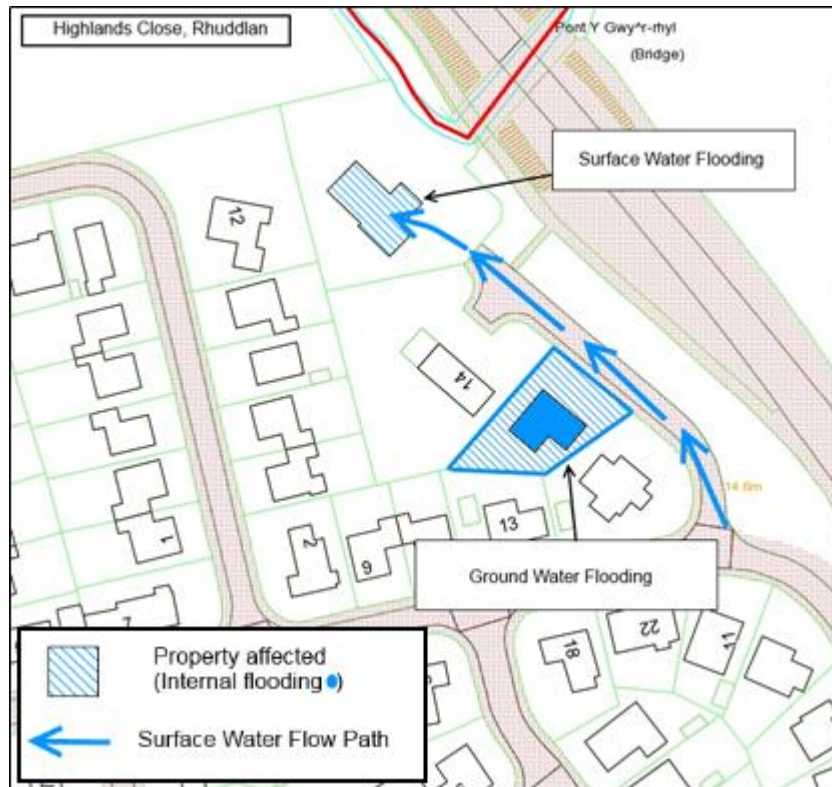


Figure 14 – Two properties suffered internal flooding from different sources

Properties off Highlands Close suffered internal flooding. On investigation it was identified that flooding had occurred from two different sources. Flooding from groundwater was identified as affecting the lower ground floor in one property, whilst another property was impacted directly by the flow of surface water from the highway, which is at a higher level than the property.

Following the 19th July 2017 flood, the Council has installed a new highway drain to help alleviate the problem.

Elsewhere in Rhuddlan, flooding was reported on Clwyd Avenue and upon investigation it appeared that the extensive pooling of surface water was due to a lack of formal drainage at this location. Flooding to multiple garages and near misses was also reported on Kerfoot Avenue. Upon investigation it was apparent that the volume of water exceeded the capacity of the drainage system, and surface water flowed into garages from the highway. This view is supported by Dŵr Cymru Welsh Water’s findings following its post-event investigations into the area, which identified a number of sources of surface water connections entering the combined sewer system. Denbighshire County Council and Dŵr Cymru Welsh Water have agreed to take a collaborative approach to alleviate the future risk of surface water flooding at this location and work is ongoing in this regard.

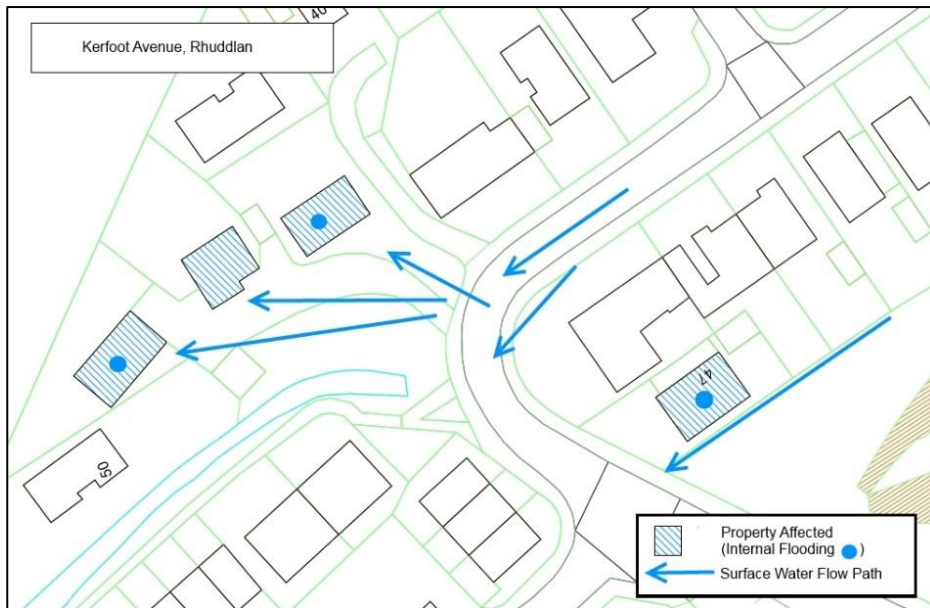


Figure 15 – Significant build-up of surface water led to garages of properties flooding on Kerfoot Avenue

St Asaph

There were reports of minor incidents of surface water flooding in St Asaph.

Approximately 5 properties on Caradoc Terrace flooded internally via front doors due to surface water failing to drain away at the front of the properties. The Council’s investigation has found that there is a possibility that highway drains at this location had become blocked during the flood event



Figure 16 - Low lying properties suffered internal flooding via front doors, other properties flooded due to private drainage systems failing.

Conclusion

The flooding that affected north Denbighshire on 19th July 2017 was the result of a significant rainfall event, with around a 1 in 50 likelihood of occurring in any one year. Whilst this was a statistically rare event, its impacts covered a wide area and around 100 properties were flooded internally as a consequence. This report provides an overview of the Council's current understanding of what caused the flooding, but it isn't able to provide an indication of the likelihood of a flood occurring again at the locations affected in July 2017, or make recommendations regarding measures to reduce the risk. This is because the flood event was complex in nature; sources of flood water included water running off hard surfaces, land drainage, highway drainage, Dŵr Cymru Welsh Water combined and surface water sewers and Rhyl Cut, which is under the jurisdiction of Natural Resources Wales.

The report describes several ongoing activities which will lead to a better understanding of flood risk, for example, the study being carried out by Natural Resources Wales in partnership with Denbighshire County Council and Dŵr Cymru Welsh Water looking at the interaction between Rhyl Cut, Prestatyn Gutter and the various drainage features that discharge into them. Denbighshire County Council has received Welsh Government grant to carry out a drainage study at Ffordd Derwen. The findings of these studies will be published in due course.

Annex A

DCWW Record of Sewer Flooding Incidents

Dŵr Cymru Welsh Water

19th July 2018 Flood Locations

Key to Acronyms:

B = Blockage

HO = Hydraulic Overload

SPS = Sewerage Pumping Station

NA = Not Applicable

Location	Type	Cause	Details	x	y
LUKE STREET, ST. ASAPH, LL170SL	External	B	Debris	3036	3744
PALACE AVENUE, RHYL, LL181HR	Internal	HO	SPS	3002	3809
PALACE AVENUE, RHYL, LL181HS	Internal	HO	SPS	3001	3809
LAKE AVENUE, RHYL, LL181HY	Internal	HO	SPS	3001	3809
LAKE AVENUE, RHYL, LL181HY	Internal	HO	SPS	3001	3809
LAKE AVENUE, RHYL, LL181HY	Internal	HO	SPS	3001	3809
LAKE AVENUE, RHYL, LL181HY	Internal	HO	SPS	3001	3809
LAKE AVENUE, RHYL, LL181HY	Internal	HO	SPS	3001	3809
WELLINGTON ROAD, RHYL, LL181LH	Internal	HO	SPS	3003	3809
WELLINGTON ROAD, RHYL, LL181LH	Internal	HO	SPS	3002	3809
WELLINGTON ROAD, RHYL, LL181LH	Internal	HO	SPS	3002	3809
WELLINGTON ROAD, RHYL, LL181LH	Internal	HO	SPS	3002	3809
WELLINGTON ROAD, RHYL, LL181LH	Internal	HO	SPS	3002	3809
WELLINGTON ROAD, RHYL, LL181LH	Internal	HO	SPS	3002	3809
WELLINGTON ROAD, RHYL, LL181LH	Internal	HO	SPS	3003	3809
SANDRINGHAM AVENUE, RHYL, LL181NG	External	HO	SPS	3000	3808
SYDENHAM AVENUE, RHYL, LL181NS	External	HO	SPS	2999	3808
SYDENHAM AVENUE, RHYL, LL181NS	External	HO	SPS	2999	3808
RIVER STREET, RHYL, LL181PT	Internal	HO	SPS	3003	3810
RIVER STREET, RHYL, LL181PT	Internal	HO	SPS	3003	3810
BUTTERTON ROAD, RHYL, LL181RF	External	HO	SPS	3002	3810
BUTTERTON ROAD, RHYL, LL181RF	External	HO	SPS	3002	3810
NETLEY ROAD, RHYL, LL182AN	External	HO	SPS	3006	3807

RHYDWEN DRIVE, RHYL, LL182AU	External	B	Fat	3004	3805
RHYDWEN DRIVE, RHYL, LL182AU	External	B	Fat	3004	3805
GWYNFRYN AVENUE, RHYL, LL182BB	External	HO	SPS	3008	3807
KINGSLEY AVENUE, RHYL, LL182ET	External	HO	SPS	3012	3806
CEFNDY ROAD, RHYL, LL182HG	External	HO	SPS	3012	3805
CHATSWORTH ROAD, RHYL, LL182JJ	External	HO	SPS	3005	3805
FFORDD DERWEN, RHYL, LL182LS	External	HO	SPS	3020	3797
DERWEN DRIVE, RHYL, LL182PB	External	HO	SPS	3021	3797
FFORDD FFYNNON, RHUDDLAN, RHYL, LL182SP	External	B	Roots	3023	3789
FFORDD CAE GLAS, RHUDDLAN, RHYL, LL182TA	External	B	Roots	3025	3789
FAIRLANDS CRESCENT, RHUDDLAN, RHYL, LL182TH	Internal	B	Roots	3026	3784
KERFOOT AVENUE, RHUDDLAN, RHYL, LL182UR	External	HO	NA	3021	3782
GWINDY STREET, RHUDDLAN, RHYL, LL182US	External	HO	NA	3021	3782
RHYL COAST ROAD, RHYL, LL183PR	External	HO	SPS	3023	3822
RHYL COAST ROAD, RHYL, LL183PR	External	HO	SPS	3023	3822
RHYL COAST ROAD, RHYL, LL183PR	External	HO	SPS	3023	3822
Location	Type	Cause	Details	x	y
RHYL COAST ROAD, RHYL, LL183PR	External	HO	SPS	3023	3822
RHYL COAST ROAD, RHYL, LL183PR	External	HO	SPS	3023	3822
OAKVILLE AVENUE, RHYL, LL183TF	External	HO	SPS	3025	3821
OAKVILLE AVENUE, RHYL, LL183TG	External	HO	SPS	3024	3820
OAKVILLE AVENUE, RHYL, LL183TG	External	HO	SPS	3024	3820
GARFORD ROAD, RHYL, LL183UF	External	HO	SPS	3024	3822
GARFORD ROAD, RHYL, LL183UF	External	HO	SPS	3024	3822
GARFORD ROAD, RHYL, LL183UF	External	HO	SPS	3024	3822
GARFORD ROAD, RHYL, LL183UF	External	HO	SPS	3024	3822
GARFORD ROAD, RHYL, LL183UF	External	HO	SPS	3024	3822
GARFORD ROAD, RHYL, LL183UF	External	HO	SPS	3024	3822
BRYNHEDYDD ROAD, RHYL, LL183UH	External	HO	SPS	3026	3820
BRYNHEDYDD ROAD, RHYL, LL183UH	External	HO	SPS	3026	3820
BRYNHEDYDD ROAD, RHYL, LL183UH	External	HO	SPS	3026	3820
BRYNHEDYDD ROAD, RHYL, LL183UH	External	HO	SPS	3026	3820
SHOLING DRIVE, RHYL, LL183UR	External	HO	SPS	3025	3819
EDGBASTON ROAD, RHYL, LL183UW	External	HO	SPS	3026	3820
EDGBASTON ROAD, RHYL, LL183UW	External	HO	SPS	3026	3820
PENDYFFRYN ROAD, RHYL, LL184DD	External	HO	SPS	3020	3813
FERN WALK, RHYL, LL184GD	External	HO	SPS	3025	3815
ASPEN WALK, RHYL, LL184GH	External	HO	SPS	3024	3818
ASPEN WALK, RHYL, LL184GH	External	HO	SPS	3024	3818
LON WEN, RHYL, LL184JG	External	HO	NA	3029	3819
MERFYN WAY, RHYL, LL184UL	External	B	Other	3026	3808
ROWAN DRIVE, RHYL, LL184UN	External	HO	NA	3027	3802
ST. ASAPH AVENUE, KINMEL BAY, RHYL, LL185HA	External	HO	NA	2990	3792
CLWYD GARDENS, KINMEL BAY, RHYL, LL185NB	External	HO	NA	2982	3801
ST BARBARAS AVE, BODELWYDDAN, RHYL, LL185ST	External	B	Unknown	2992	3757
MARION ROAD, PRESTATYN, LL197DG	External	HO	SPS	3043	3824
VICTORIA ROAD WEST, PRESTATYN, LL197DY	External	B	Silt	3039	3824
CHARLESTON AVENUE, PRESTATYN, LL197EB	External	HO	NA	3040	3824
STEPHEN ROAD, PRESTATYN, LL197EH	External	HO	NA	3044	3825

STEPHEN ROAD, PRESTATYN, LL197EH	External	HO	NA	3044	3825
STEPHEN ROAD, PRESTATYN, LL197EH	External	HO	NA	3044	3825
STEPHEN ROAD, PRESTATYN, LL197EH	External	HO	NA	3044	3825
STEPHEN ROAD, PRESTATYN, LL197EH	External	HO	NA	3044	3825
VICTORIA ROAD, PRESTATYN, LL197SW	External	HO	NA	3063	3832
VICTORIA ROAD, PRESTATYN, LL197UT	External	HO	NA	3049	3829
FFORDD PENRHWYLFA, PRESTATYN, LL198AH	Internal	HO	SPS	3054	3821
FFORDD PENRHWYLFA, PRESTATYN, LL198AH	External	HO	SPS	3054	3821
FFORDD PENRHWYLFA, PRESTATYN, LL198AH	External	HO	SPS	3054	3821
FFORDD PENRHWYLFA, PRESTATYN, LL198BP	External	HO	SPS	3054	3821
FFORDD PENRHWYLFA, PRESTATYN, LL198BP	External	HO	SPS	3054	3821
FFORDD PENRHWYLFA, PRESTATYN, LL198BP	External	HO	SPS	3054	3821
FFORDD PENRHWYLFA, PRESTATYN, LL198BP	External	HO	SPS	3055	3820
WINCHESTER DRIVE, PRESTATYN, LL198DA	External	HO	SPS	3054	3822
WINCHESTER DRIVE, PRESTATYN, LL198DB	External	HO	SPS	3053	3822
WINCHESTER DRIVE, PRESTATYN, LL198DB	External	HO	SPS	3053	3822
Location	Type	Cause	Details	x	y
FFORDDISA, PRESTATYN, LL198DY	External	HO	SPS	3058	3818
FFORDDISA, PRESTATYN, LL198DY	Internal	HO	SPS	3058	3818
FFORDDISA, PRESTATYN, LL198DY	External	HO	SPS	3058	3818
FFORDDISA, PRESTATYN, LL198EB	Internal	HO	SPS	3061	3822
ST. BRELADES DRIVE, PRESTATYN, LL198EQ	External	HO	NA	3060	3823
HEATHER CRESCENT, PRESTATYN, LL198HD	External	HO	NA	3058	3818
MELYD AVENUE, PRESTATYN, LL198RN	External	HO	NA	3063	3818
MELYD AVENUE, PRESTATYN, LL198RN	Internal	HO	NA	3063	3818
MELIDEN ROAD, PRESTATYN, LL199SE	Internal	B	Silt	3066	3822

Annex B

DCWW / Met Office Radar Rainfall Report

Storm Analysis



Met Office FitzRoy Road Exeter EX1 3PB United Kingdom
 Tel: 0870 900 0100 Fax: 0870 900 5050 www.metoffice.gov.uk

WELSH WATER

Ref: MO19

Page 1
 of 2

F.A.O Rebecca Hiscock

Tel:

email: Rebecca.Hiscock@dwrcymru.com and Nick.holt@dwrcymru.com

Full Report

Location	Grid Reference	Date	Event Start	Event End
Rhyl	(SJ) 000 810	19 th July 2017	1300GMT/19 th	1800GMT/19 th

Return Period of Most Significant Event (yrs)

54* (FIFTY-FOUR)

Rainfall Type

Convective (Showers)

Rainfall Amount

Data Source	mm
UK Composite Rainfall Radar – 1km resolution	28.1

Most Significant Amount

mm	Duration
27.5	3 hours from 1300GMT/19 th

Return Periods for Standard Durations (UK Composite Radar)

Amount (mm)	Duration	Years
7.7	15 mins	2*
8.6	30 mins	1*
14.7	60 mins	3*

Confidence: **HIGH**



Event at: **Rhyl**

Date of event: **19th July 2017**

Rainfall Stations used in assessment.

Station	Distance (miles) & Direction	19/07/17	20/07/17	21/07/17		
Pensam W Wks	3.3 WSW	50.0	0.8	3.0		
Rhyl No2	4.0 S	40.8	1.2	7.8		
Prestatyn	4.1 ENE	48.5	0.3	9.8		
UK Composite Rainfall Radar – 1km resolution	-	30.9	1.2	4.3		

Rainfall measurements in mm

Table represents daily 24hr totals from 0900GMT on the date shown

Opinions and conclusions on likely significance of the event

Rainfall event at Rhyl on 19th July 2017

A large area of thunderstorms spread across southern England through the early hours of the 19th. There was frequent lightning in places, and some torrential downpours too, with some gusty winds. It was a warm and muggy start across the south, but a little cooler across the north, where it stayed largely dry.

Thundery showers cleared East Anglia into the North Sea through the early morning. Further heavy thundery showers then developed across western Wales through the rest of the morning, and persisted during the afternoon, reaching parts of north-west England by evening. Showers also edged into south-west England by evening, turning heavy in places.

There were cloudy skies across England, Wales and Scotland through the early hours of the 20th, with patchy rain, accompanied by isolated thunder and lightning. It was humid too, under the cloud and rain.

Further west, Northern Ireland saw a fairly dry and bright start to the day. The cloudy skies and patchy rain gradually cleared to the east as the day progressed, taking with it isolated heavier bursts of rain, and some thunderstorms across the east of England and Scotland.

The nearby stations at Pensam W Wks, Rhyl No2, and Prestatyn gave 24 hour rainfall totals (0900-0900GMT) of 50.0mm, 40.8mm, and 48.5mm respectively on the 19th. Pensam W Wks recorded **46.0mm** in 3 hours, whilst Rhyl No2 recorded **36.8mm** in 2 hours.

Data from the UK Composite Rainfall Radar, 1km resolution, gave an estimated 24 hour total (0900-0900GMT) of 30.9mm on the 19th.

To provide guidance on how unusual the rainfall event at Rhyl on 19th July 2017 may have been, return periods were calculated for various events, using the UK Composite Rainfall Radar data, and data recorded at the nearby rain-gauges at Pensam W Wks and Rhyl. The highest return period for this event was **54*years**.

Prepared by	Date
Chris Pilkington	6 th September 2017

It is not always the case that the nearest available data site is the most representative of the incident site.

*The return period assigned to this radar rainfall value is calculated in accordance with the method described in the Flood Estimation Handbook (FEH). The FEH method used to determine return periods is based on analysis of rain gauge data only. Hence, this return period estimate is for guidance only.

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Storm Analysis



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WELSH WATER

Ref: MO19

Page 1
 of 2

F.A.O Rebecca Hiscock

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Full Report

Location	Grid Reference	Date	Event Start	Event End
Pensarn	(SH) 940 780	19 th July 2017	1300GMT/19 th	1800GMT/19 th

Return Period of Most Significant Event (yrs)
54* (FIFTY-FOUR)

Rainfall Type
Convective (Showers)

Rainfall Amount	
Data Source	mm
UK Composite Rainfall Radar – 1km resolution	29.4

Most Significant Amount	
mm	Duration
26.5	3 hours from 1300GMT/19 th

Return Periods for Standard Durations (UK Composite Radar)		
Amount (mm)	Duration	Years
13.4	15 mins	13*
16.3	30 mins	9*
20.1	60 mins	8*

Confidence:	HIGH
-------------	-------------



Event at: **Pensarn**

Date of event: **19th July 2017**

Rainfall Stations used in assessment.

Station	Distance (miles) & Direction	19/07/17	20/07/17	21/07/17		
Pensarn W Wks	0.9 NE	50.0	0.8	3.0		
Rhyl No2	4.0 ESE	40.8	1.2	7.8		
Colwyn Bay	5.1 W	39.9	1.9	6.8		
UK Composite Rainfall Radar – 1km resolution	- -	31.7	2.4	3.8		

Rainfall measurements in mm

Table represents daily 24hr totals from 0900GMT on the date shown

Opinions and conclusions on likely significance of the event

Rainfall event at Pensarn on 19th July 2017

A large area of thunderstorms spread across southern England through the early hours of the 19th. There was frequent lightning in places, and some torrential downpours too, with some gusty winds. It was a warm and muggy start across the south, but a little cooler across the north, where it stayed largely dry.

Thunder showers cleared East Anglia into the North Sea through the early morning. Further heavy thundery showers then developed across western Wales through the rest of the morning, and persisted during the afternoon, reaching parts of north-west England by evening. Showers also edged into south-west England by evening, turning heavy in places.

There were cloudy skies across England, Wales and Scotland through the early hours of the 20th, with patchy rain, accompanied by isolated thunder and lightning. It was humid too, under the cloud and rain. Further west, Northern Ireland saw a fairly dry and bright start to the day. The cloudy skies and patchy rain gradually cleared to the east as the day progressed, taking with it isolated heavier bursts of rain, and some thunderstorms across the east of England and Scotland.

The nearby stations at Pensarn W Wks, Rhyl No2, and Colwyn Bay gave 24 hour rainfall totals (0900-0900GMT) of 50.0mm, 40.8mm, and 39.9mm respectively on the 19th. The rain-gauge at Pensarn W Wks recorded **46.0mm** in 3 hours, whilst Rhyl No2 recorded **36.8mm** in 2 hours.

Data from the UK Composite Rainfall Radar, 1km resolution, gave an estimated 24 hour total (0900-0900GMT) of 31.7mm on the 19th.

To provide guidance on how unusual the rainfall event at Pensarn on 19th July 2017 may have been, return periods were calculated for various events, using the UK Composite Rainfall Radar data, and data from the rain-gauges at Pensarn and Rhyl. The highest return period for this event was **54*years**.

Prepared by	Date
Chris Pilkington	6 th September 2017

It is not always the case that the nearest available data site is the most representative of the incident site.

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Annex C

Natural Resources Wales Section 19 Report



**Cyfoeth
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**Natural
Resources**
Wales

Flood Investigation Report: North Wales Flooding July 2017

The Cut, Rhyl

Final report October 2017



Document Control Sheet

Written by:	Name: Matthew Williams	Date: 21/07/2017
Checked by:	Name: James Williams	Date: 12/10/2017
Approved by:	Name: Keith Ivens	Date: 24/10/2017

Version History

Date	Version No.	Status	Summary of Changes
07/09/2017	2	Draft	Re-wording due to new information to give more of a fluvial focus
12/10/17	3	Draft	Edited the recommendations. Explanation of the purpose of this report
24/10/17	4	Final	Final amendments, minor formatting.

Distribution

Name	Date	Version
Keith Ivens	12/10/2017	3
Paula Harley	12/10/2017	3
Wayne Hope	17/10/2017	3
Wayne Hope	24/10/2017	4

Contents

Executive summary.....	5
1. Location	7
2. Flooding History.....	8
3. Flood Risk.....	8
Surfacewater Flooding	9
Fluvial Flood Zones	10
4. Flood Risk Assets / Property Level Protection.....	11
5. Flood Event (19/07/17)	13
Inferno Dance Studio.....	13
Plas Cyril – Sheltered Housing.....	15
Surface Water Flooding.....	15
LiDAR Data	18
6. Flood Outlines and Flood Flow Routes.....	19
Survey Data	21
7. Details of Warnings and Alerts issued	22
8. Response	22
9. Conclusion.....	25
Fluvial Flooding	25
Surfacewater Flooding	25
Groundwater Flooding.....	25
10. Recommendations.....	26
Short Term Measures.....	26
Longer Term Measures	26
Appendix 1	27

List of Figures

Figure 1: Location Map	7
Figure 2: Surfacewater Flood map.....	9
Figure 3: Modelled Fluvial Flood Zones	10
Figure 4: Outfall leading into The Cut, next to the dance studio.....	11
Figure 5: Drainage network around Inferno Dance Studio	12
Figure 6: Flooding to Inferno Dance Studio. Front of the property	13
Figure 7: Flooding to Inferno Dance Studio. Rear of the property	14
Figure 8: Wrack mark to Inferno Dance Studio rear yard wall	14
Figure 9: Rainfall intensity 15:00 GMT 19th July 2017 (red crosses denote location of Pensarn, Llanasa and St Asaph rain gauges).....	16
Figure 10: Rainfall intensity 15:15 GMT 19th July 2017 (red crosses denote location of Pensarn, Llanasa and St Asaph rain gauges).....	17
Figure 11: LIDAR data showing the topography of Inferno Dance Studio and Plas Cyril, in relation to The Cut.	18
Figure 12: Surface water flow routes.....	19
Figure 13: Flood Outline and Flow Routes.....	20
Figure 14: Visual profile along low spot on left bank of Rhyl Cut.....	21
Figure 15: Rhyl Survey Data: Inferno Dance Studio and The Cut.....	21
Figure 16: Chamber after the outfall de-silt.....	23
Figure 17: Inspection chamber directly upstream of outfall	23
Figure 18: Post de-silt with metal flap valve visible	24
Figure 19: Outfall after minor silt removal	24
Figure 20: Welsh Water Piped System	27

Executive summary

Under Section 19 of the Flood and Water Management Act 2010 the Lead Local Flood Authority (Local Authority) on becoming aware of a flood in its area, must to an extent that it considers necessary or appropriate, investigate, prepare and publish a Flood Investigation Report. Natural Resources Wales have agreed to investigate all main river flooding as part of this process.

When a Lead Local Flood Authority carries out an investigation, the report must be published and any relevant risk management authorities notified. The official Section 19 will be written by Denbighshire County Council with this report used as an appendix, to identify the wider impacts.

This investigation report is a best estimate representation of the July 2017 flood incident in Rhyl, written as a formal way for Natural Resources Wales to record the incident. It is based on evidence gathered by Natural Resources Wales' officers through several sources and is deemed as fit for purpose at the approved date.

It was considered appropriate to carry out an investigation as The Rhyl Cut internally flooded one business property. This report provides details of the investigation with conclusions.

The area flooded due to a band of short, but intense summer thunderstorms which tracked across the North Wales coastline from east to west between 3pm and 6pm on the 19th July 2017. Surface-water flooding inundated the drainage systems for many low-lying impermeable roads in Rhyl, Prestatyn, and Abergele.

Two properties within close proximity of The Cut were flooded: Inferno Dance Studio and Plas Cyril Sheltered Accommodation. The dance studio and the sheltered accommodation are at the lowest points in the area.

Surface water inundated Kingsley Avenue at 3.40pm, and flowed downhill towards the Dance studio. A section of pathway which runs parallel to The Cut and the dance studio is noticeably lower than the surrounding area. The hydrological capacity of The Cut was exceeded at this low point causing floodwater to spill out and inundate the dance studio. Floodwater entered the dance studio via the front and side doors.

The high tide was at 7pm, so the tide would have been rising during the rainfall events. This could have possibly prevented the floodwater from draining out of The Cut.

There is an outfall next to the dance studio which drains surfacewater from the surrounding area (the drive leading up to the dance studio and the car park behind the dance studio). Whilst surveying the Cut, after the flood event, it was found that this outfall was completely silted up, which would have prevented any surfacewater from being drained away from the dance studio, and the surrounding area. This would have exacerbated the surfacewater flooding to the dance studio.

Surface water also flowed down Walford Avenue towards Plas Cyril and ponded outside the property. Water entered five ground-floor flats at Plas Cyril reaching a few millimetres internally and approximately 200mm externally. It is believed that Plas Cyril was exclusively affected by surfacewater flooding, which does not come under NRW's jurisdiction.

1. Location

Rhyl is a seaside town in the county of Denbighshire. The Cut crosses Rhyl roughly east-west and drains into the River Clwyd. Plas Cyril Sheltered Accommodation and Inferno Dance Studio are at the lowest points in the local vicinity. The dance studio is only a couple of meters away from The Cut. The map below shows the location of Inferno Dance Studio and Plas Cyril.



Figure 1: Location Map

2. Flooding History

NRW has no recorded flood events to this area. From discussion; the business owner has been in the property for 6 years and has had issues with surface water in the previous years. Denbighshire County Council (DCC) have carried out works to the surface water drainage here in the last couple of years.

3. Flood Risk

The day after the flood event, representatives from NRW met with the business owners of the Inferno dance studio for initial discussions to identify possible causes. During initial discussions the business owners of the dance studio had observed water flowing along Kingsley Avenue towards The Cut, then flowing down the driveway in front of the studio and into The Cut.

The business owners also observed water coming into the property via the flooring, however after a second visit to the dance studio the owner found that the flooring was solid concrete. This would therefore suggest that there is not an issue with groundwater. However, it is possible that there is a void between the floor slab of the original building and the floor of the newer extension, thus allowing groundwater to enter the building.

The property owner observed the drains at the front and rear of the property were surcharging during the event. Upon inspection after the event, debris from foul water was still evident at the rear of the studio but not at the front of the building or in The Cut.

After Denbighshire County Council inspected the gulley network, they found the entire system was very silted up and the outfall which leads into The Cut was blocked. This would explain the surcharging drains and manholes around the dance studio. NRW have cleaned the apron of the outfall for the purposes of level surveying and to investigate alignments, but the structure is not an NRW maintained flood risk management structure. DCC have instructed further survey to establish the condition and alignment of drainage in the area.

The Cut flows east to west and can drain north towards the Rhyl foreshore via Rhyl Pumping Station and eastwards into the River Clwyd via a gravity outfall. The pumping station was fully operational during the flood event but was unlikely to have influenced water levels this far along The Cut system.

It is presumed that the water from The Cut raised to a level higher than the threshold of the dance studio, causing it to flood. It is unclear which source of flooding breached the threshold first but it is highly likely the issue was compounded by all sources.

Vegetation in The Cut, the day after the flood event was not flat against the bank and there was no debris or wrack marks present. This would suggest that the water did not flow in any direction, but instead drained away once water levels in the area subsided. The lack of flowing water in The Cut was possibly a combination of;

- Low gradient
- A rising tide
- Excess vegetation

- Non-operational surface water drainage network

From the site visit it was evident that there is an issue with fly-tipping in the area as there was a shopping trolley in The Cut, just before the culvert which ran under Kingsley Avenue. Fly-tipping in watercourses is usually an issue because debris can block culvers and bridges, causing the local area to flood. It is unlikely that the fly-tipping exacerbated the flooding, for this flood event, as the water was not flowing in any direction.

Surfacewater Flooding

Surface water flooding happens when rainwater does not drain away through the normal drainage systems or soak into the ground, but lies on or flows over the ground instead.

The two properties, which flooded in Rhyl on the 19th July 2017, both have a medium chance of flooding from surfacewater. Medium means that each year, this area has a chance of flooding between 1 in 100 (1%) and 1 in 30 (3.3%), as shown in Figure 2. The shading on the map shows the risk of flooding from surface water in this area.



Figure 2: Surfacewater Flood map

Fluvial Flood Zones

Flood zones are areas which would naturally be affected by flooding from rivers and the sea. Therefore, the presence of flood defences is not considered. Flood Zone 3 is defined as the extent of a flood from rivers with a 1% (1 in 100) chance or greater of happening in any given year. Both properties which were affected by flooding are in Flood Zone 3, as shown in Figure 3.

Water from Kinglsey Avenue and the un-adopted road in front of the dance studio inundated The Cut. Water could not drain away as the drainage outside the dance studio was completely silted up and therefore ineffective. This excess water caused The Cut to overflow onto the lowest point along the pathway. The pathway runs parallel between the side of the dance studio and The Cut. This floodwater came around the dance studio and flooded it internally through the side and front doors.

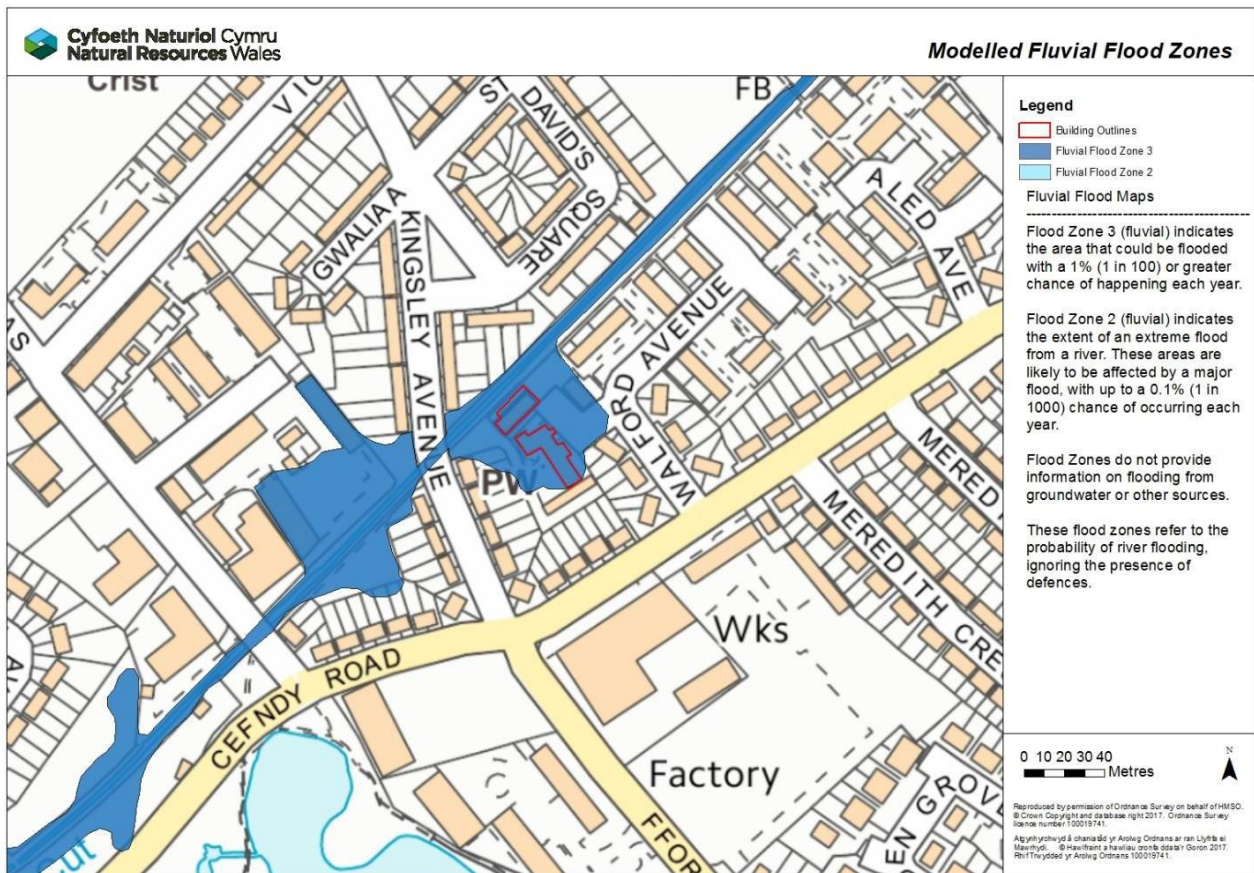


Figure 3: Modelled Fluvial Flood Zones

4. Flood Risk Assets / Property Level Protection

As mentioned earlier, there is an outfall next to the dance studio which drains surfacewater from the surrounding area of the un-adopted road in front of the dance studio and the garages behind the dance studio (Figure 5). Whilst surveying the Cut, after the flood event, it was found that this outfall was completely silted up (Figure 4), which would have prevented any surfacewater from being drained away from the dance studio, and the surrounding area. This would have exacerbated the surfacewater flooding to the dance studio



Figure 4: Outfall leading into The Cut, next to the dance studio.

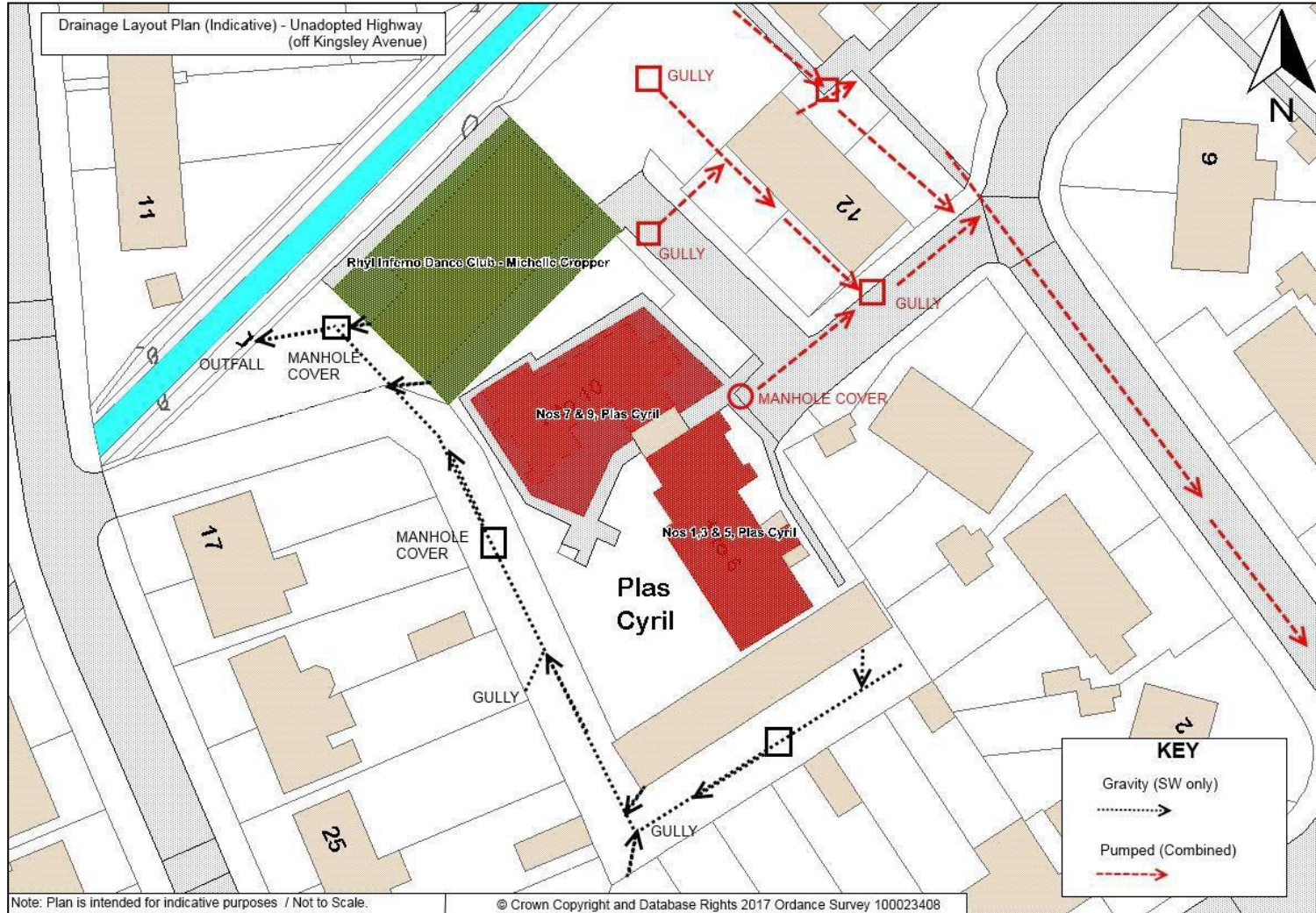


Figure 5: Drainage network around Inferno Dance Studio

5. Flood Event (19/07/17)

Inferno Dance Studio

Kingsley Avenue flooded at approximately 3.40pm after heavy rain. Surface water flowed from Kingsley Avenue, down into The Cut. At 4.00pm water entered the property, reaching a depth of approximately 50mm internally. The drains at the front and rear of the property were silted up and the outfall was blocked, so it could not cope with the volume of water and surcharged. At 5.30pm water, from The Cut, came in through the back doors and surrounded the building. At this point, the car park behind the property had also flooded from surface water flowing down Walford Avenue.

During the initial topographic survey the silt level within the headwall structure was 3.01m AOD with a water level of approximately 2.70m AOD.

After digging out the outfall, the invert level on the flap valve was observed to be 2.30m AOD and the apron was approximately 2.20m AOD, although there was no solid apron observed, only a rough brick bed.



Figure 6: Flooding to Inferno Dance Studio. Front of the property



Figure 7: Flooding to Inferno Dance Studio. Rear of the property



Figure 8: Wrack mark to Inferno Dance Studio rear yard wall.

Plas Cyril – Sheltered Housing

Plas Cyril is a block of sheltered accommodation owned and managed by Denbighshire County Council. The property consists of ten flats, five of which are on the ground floor. All the ground-floor flats were affected by the flooding.

Surface water flowed down Walford avenue and pooled outside the homes in the lowered gardens and entered the properties via the front doors. The gardens in front of the properties are lower than the threshold of the properties. Plas Cyril was exclusively affected by surfacewater flooding, which does not come under NRW's jurisdiction.

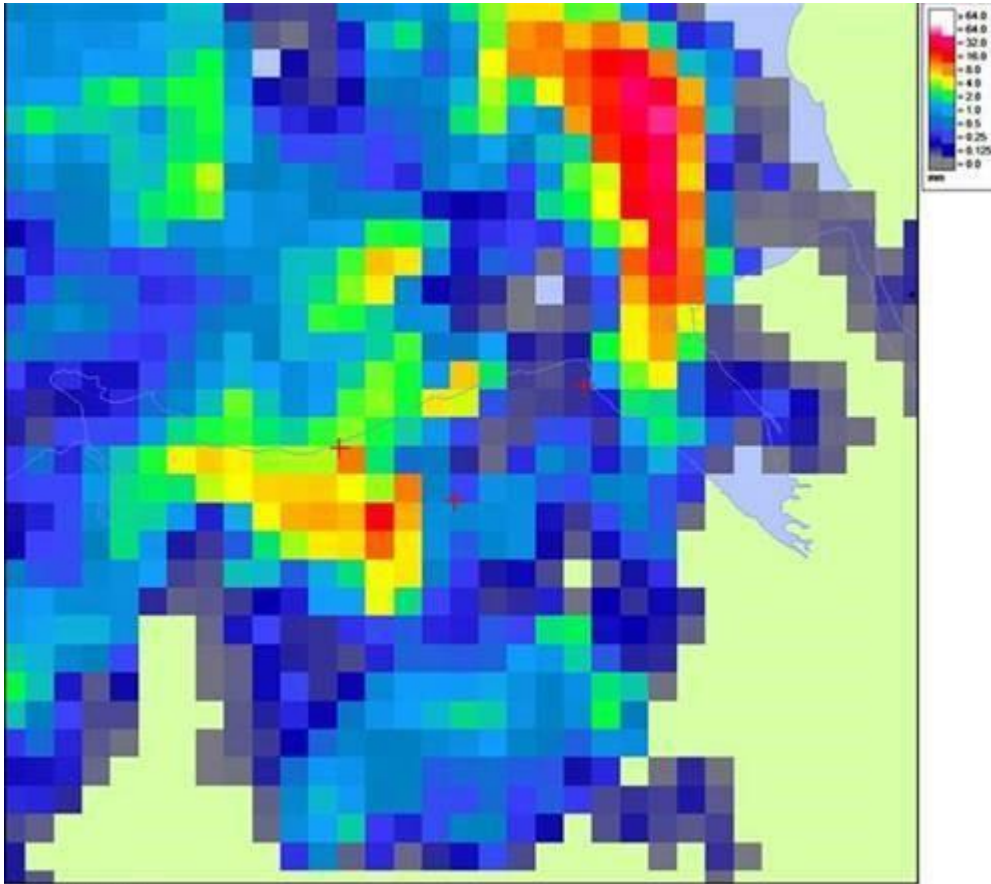
Surface Water Flooding

Rain gauges located in Pensarn, Llanasa, and St. Asaph provide an overview of the storm severity across North Wales during the event.

Data has been checked, and is deemed to be reliable against the totals collected from the adjacent storage check gauges for Pensarn, Llanasa and St Asaph. Unfortunately, the logger at Prestatyn had corrupted and there is no sub-daily data to analyse for this event. Further analysis of this data was carried out; the results are as follows:

- Pensarn raingauge (SH 95147 78859) experienced a **1 in 50-year** event, with 40.4mm of rain falling in the 1 hour 15mins commencing 14:15 GMT.
- Llanasa raingauge (SJ 12429 83292) experienced a **1 in 24-year** event, with 25.4mm of rain falling in the 30mins commencing 14:45 GMT.
- St. Asaph raingauge (SJ 03315 75159) experienced a **1 in 14-year** event, with 21.4mm of rain falling in the 30mins commencing 14:14 GMT.

A second intense band of rainfall swept over the Pensarn at 15:10 GMT, that appears to have missed the other raingauges. HYRAD (Figure 9 & Figure 10) suggests this second band of rainfall would have affected Rhyl too, which could indicate a return period for the Prestatyn/Rhyl area broadly like that assessed for Pensarn raingauge.



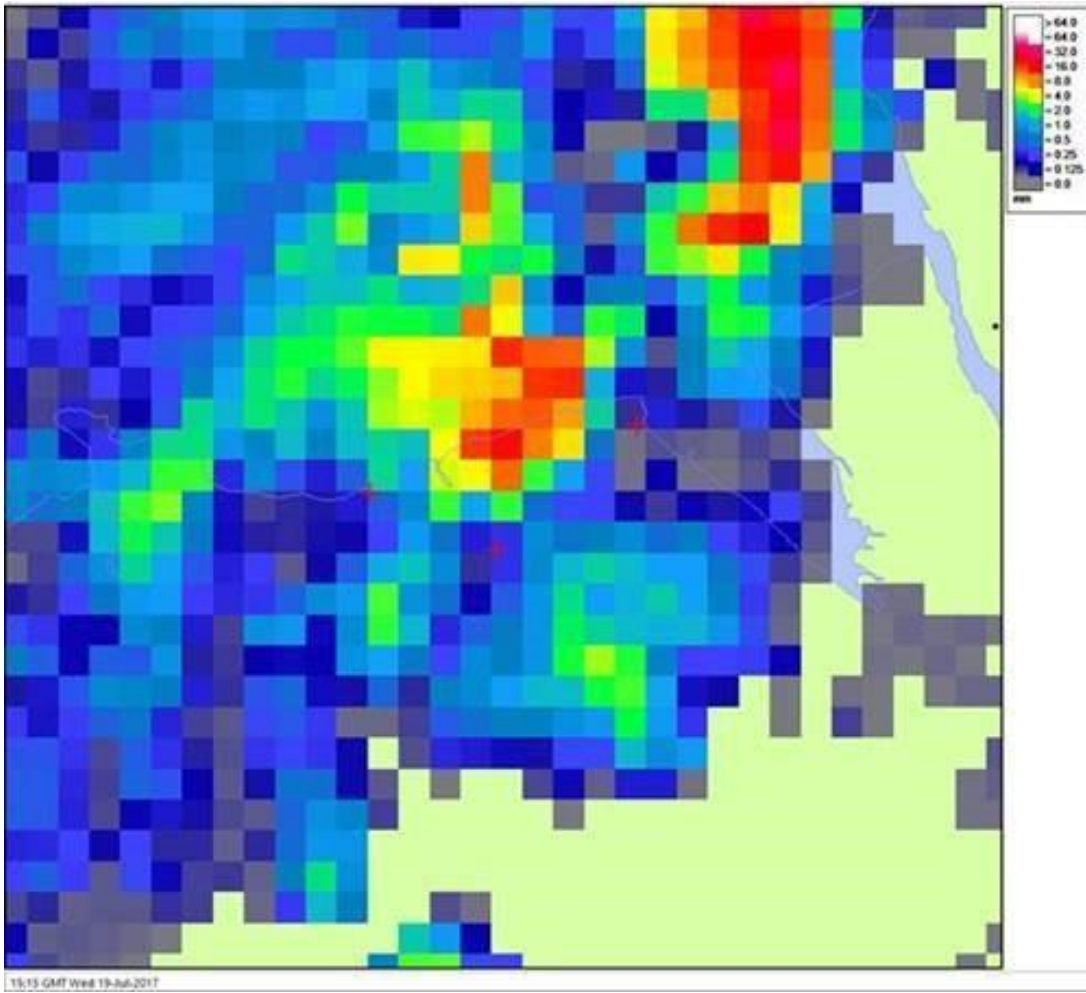


Figure 10: Rainfall intensity 15:15 GMT 19th July 2017 (red crosses denote location of Pensarn, Llanasa and St Asaph rain gauges)

LiDAR Data

The LiDAR data used has a spatial resolution of 1m. From Figure 11, shown below, it is evident that Kingsley Avenue slopes downwards towards The Cut. Walford Avenue slopes downwards towards Plas Cyril. Within a 0.5km radius, and excluding The Cut, the dance studio is the lowest point in the neighbourhood at 3.37m AOD.

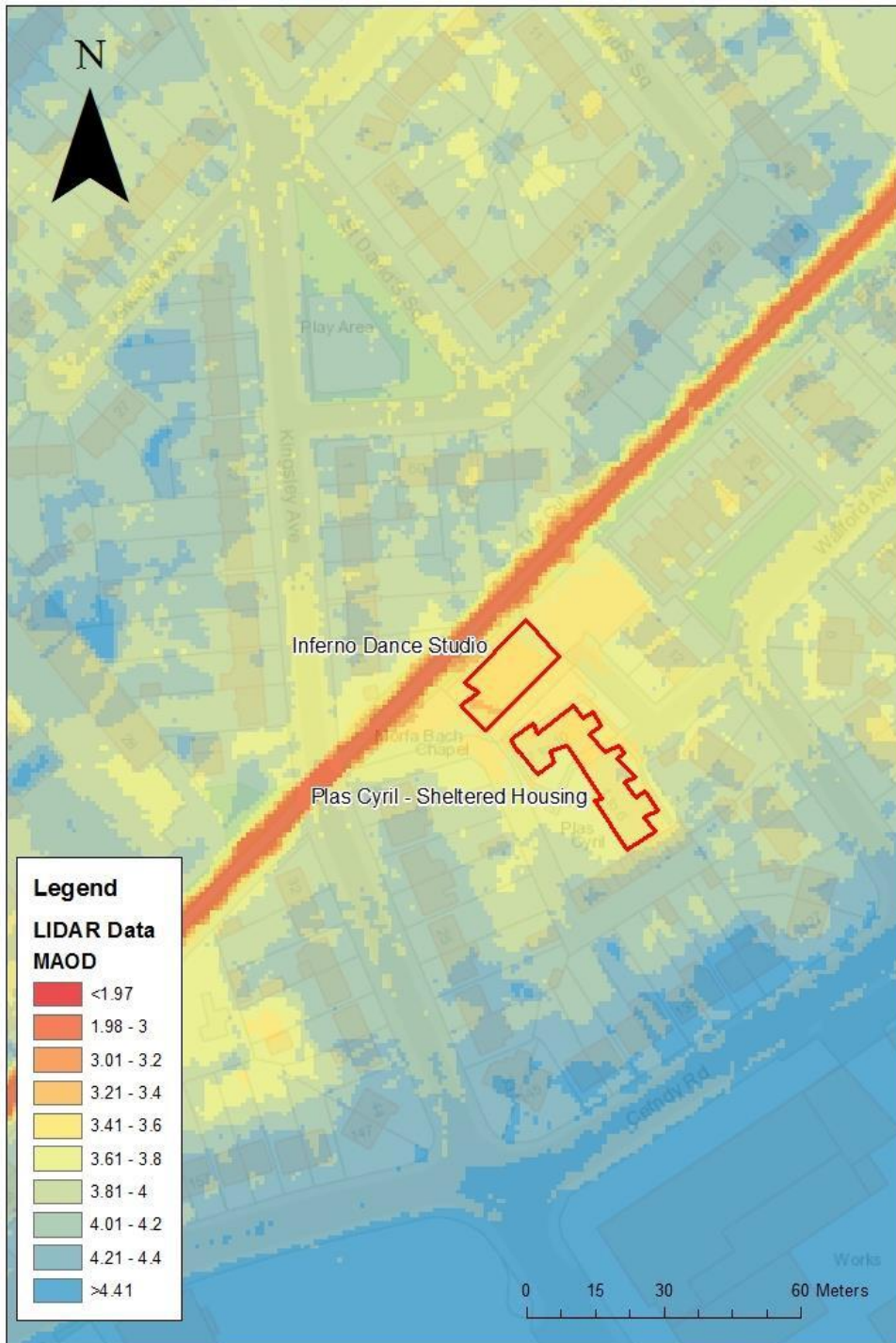


Figure 11: LiDAR data showing the topography of Inferno Dance Studio and Plas Cyril, in relation to The Cut.

6. Flood Outlines and Flood Flow Routes

Surface water on Kingsley Avenue overwhelmed the drainage systems causing it to flow downhill towards The Cut (Figure 12). The floodwater flowed down the driveway in front of the dance studio and entered The Cut at this point (Figure 13). The water from The Cut pooled in front of the dance studio and raised to the same level as the dance studio causing floodwater to enter the property. Surface water on Walford Avenue also overwhelmed the silted-up drainage systems causing it to flow downhill towards Plas Cyril and towards the carpark behind the dance studio.

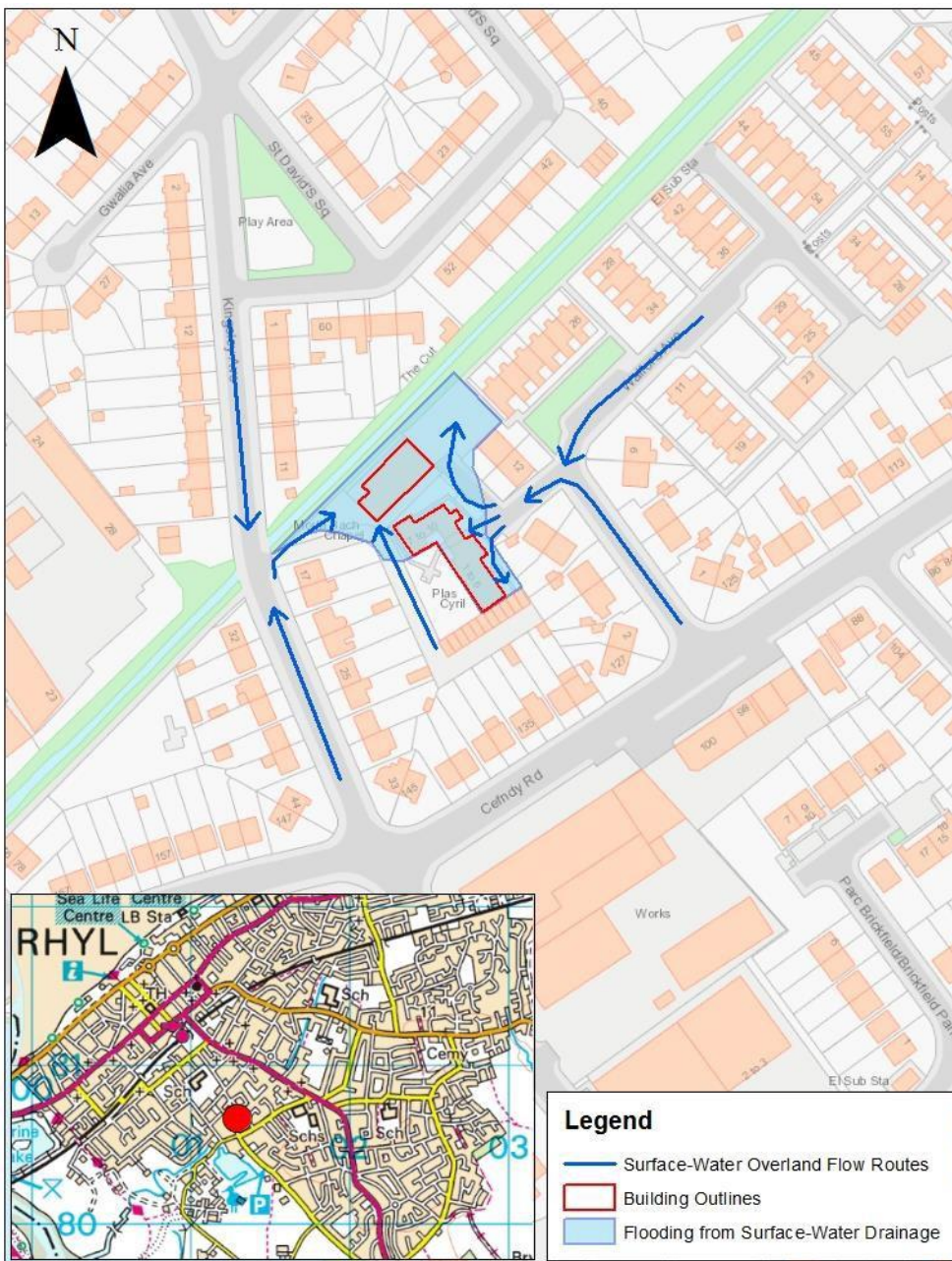


Figure 12: Surface water flow routes

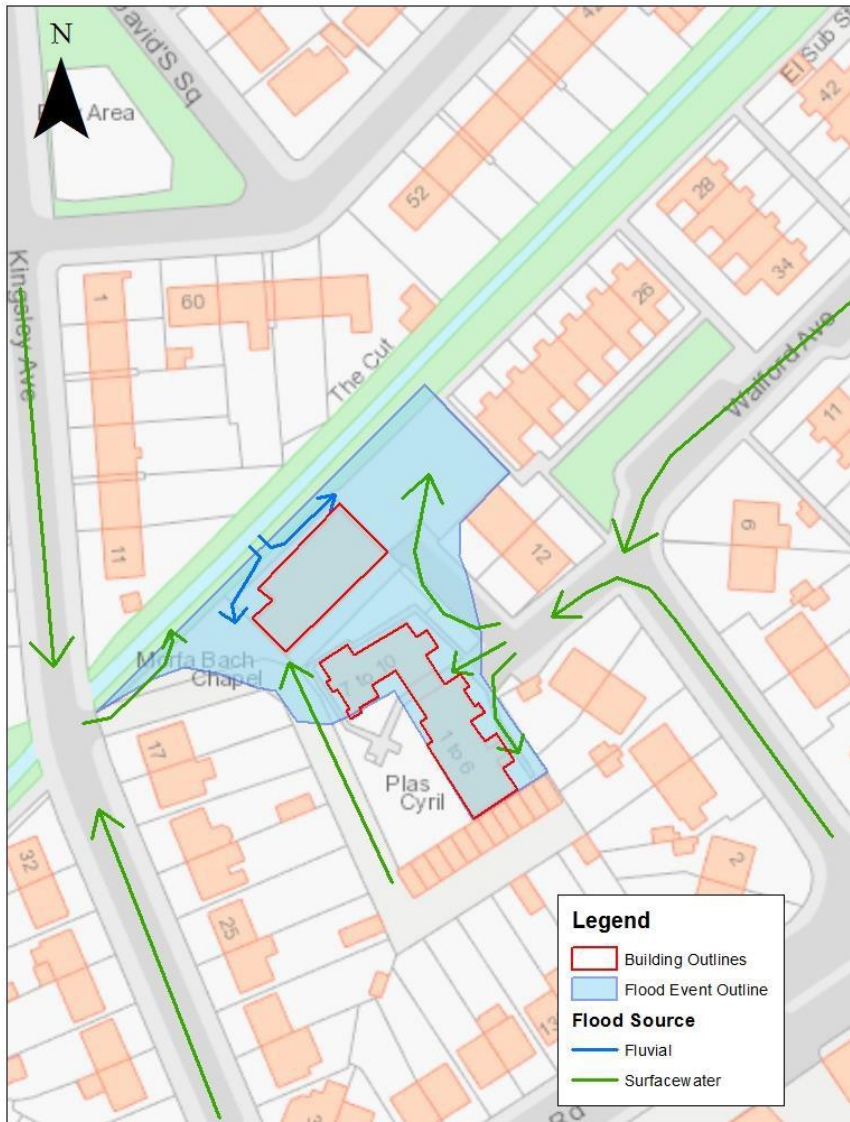


Figure 13: Flood Outline and Flow Routes

Survey Data

On the 4th August 2017, The Cut and its surrounding area was surveyed using a Leica GPS Surveying Kit; the results of which are shown in Figure 15 below. It is evident that Kingsley Avenue and the rear road, behind Plas Cyril, are both sloping downward towards The Cut and the Dance Studio. There is a low spot along the pathway which runs parallel between the side of the dance studio and the Cut. It is likely that this low point caused water to pool down the side of the dance studio causing internal flooding, the bank profile along the suspected low spot is shown in Figure 14.

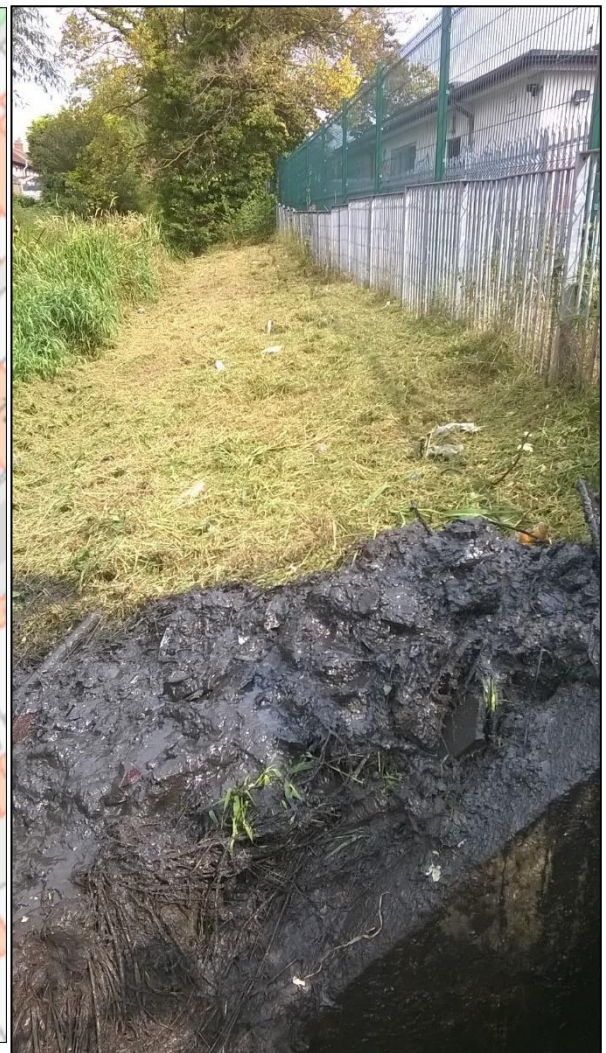
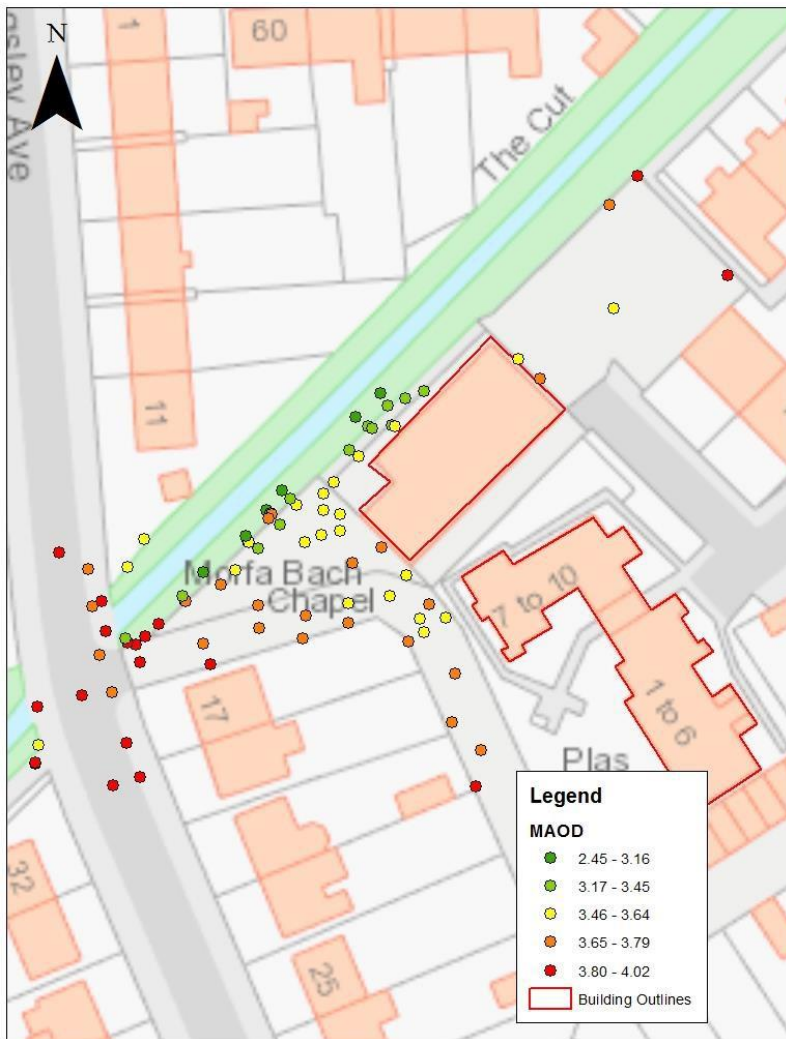


Figure 15: Rhyll Survey Data: Inferno Dance Studio and The Cut

Figure 14: Visual profile along low spot on left bank of Rhyll Cut

7. Details of Warnings and Alerts issued

The Rhyl Cut is not serviced by a fluvial flood warning. A yellow warning of rain was issued for the area by the Met Office on the 18th July.

8. Response

At 17:45pm on 19th July 2017 the NRW Communications Centre received a call from the owner of the Inferno Dance Studio. This was relayed to the on-call Flood Incident Duty officer (FIDO) for North East Wales. The owner reported that they were ankle deep in flood water and that they had turned the electric off for safety. FIDO informed the owner that NRW Operatives were checking and clearing grids in the Rhyl and Prestatyn area and would ask them to visit site if they could, plus passed on the DCC general number as requested by the owner.

At 18:50 and 19:48 19th July 2017, the FIDO received two further calls from the area behind the dance studio reporting high water levels in The Cut behind their properties on Walford Avenue and St David's Square. When the FIDO spoke to the reporters they both observed water levels to be receding slowly and no water had entered their properties.

On the 20th July 2017 at 07:18 the owner of the Dance studio contacted the Communications Centre again to complain that they felt that they had flooded due to the lack of maintenance on The Cut. Officers from NRW FRM teams visited this site on the 20th July 2017 to carry out an initial investigation as to possible flow routes and causes of this flooding.

At 16:35 on 20th July 2017 the FIDO received a further call from the owner of the Dance Studio, who was very upset as they had just had a call from their insurance company stating that they were not insured against flooding. The company had changed their policy on flooding the previous year. The FIDO provided the owner with the details of The National Flood Forum, who can offer practical advice and help on how to recover after a flood. Again, the owner blamed the flooding on the Cut not being weed cut yet his year.

On Wednesday 16th August 2017 three NRW operatives attended site to locate the invert level for the outfall. Two inspection chambers were opened, both of which were full of water and silt (Figure 17). The outfall was dug out by hand as far as was possible (Figure 19) with further de-silting undertaken at a later date to obtain accurate survey levels. After the flap was exposed (Figure 18), the water level in the three inspection chambers quickly reduced (Figure 16), signifying that the surface drainage network does all discharge from this flap into The Cut.



Figure 17: Inspection chamber directly upstream of outfall



Figure 16: Chamber after the outfall de-silt



Figure 19: Outfall after minor silt removal



Figure 18: Post de-silt with metal flap valve visible

9. Conclusion

It is likely that flooding to the Inferno Dance Studio was from three sources; surface water flooding, fluvial flooding and groundwater flooding.

Fluvial Flooding

The Cut has weed growth and fly-tipping within its river bed, especially along the stretch between Kingsley Avenue and Vale Road. This weed growth may make it difficult for water to drain away from the local area, especially during an intense, heavy rainfall event such as this. On 19 July 2017, a band of short, but intense summer thunderstorms tracked across the North Wales coastline. These heavy rainfall events caused The Cut to exceed its capacity and overtop its banks at some very localised points. The lowest point of The Cuts banks is along the concrete pathway which runs parallel between the watercourse and Inferno Dance Studio. It was at this point that The Cut overtopped its banks.

Surfacewater Flooding

The outfall which drains the road in front of the dance studio was completely blocked with silt. Surface water which flowed down Kingsley Avenue and the un-adopted road in front of the dance studio, could not drain away. The surface water drains where filled beyond their capacity causing them to surcharged onto the roads.

Groundwater Flooding

The owner of the dance studio gave anecdotal evidence suggesting that there were also groundwater issues. The property flooring is partly solid concrete and partly wooden, with a void underneath. The property owner said that water came through the wooden flooring, which would suggest an issue with groundwater flooding.

10. Recommendations

Short Term Measures

- Historically NRW and their predecessors have weed cut the Rhyl Cut once or twice a year dependent on growing season, this regime will continue with reactive maintenance concentrated in isolated flood risk areas along the Rhyl Cut.
- NRW will investigate the potential benefit of locally raising the bank adjacent to the dance study. This measure would only raise the localised low spot by approximately 200mm to align with bank levels upstream and downstream.
- NRW will update the fluvial flood model for The Rhyl Cut incorporating various parameters to mimic dense weed growth and differing levels of siltation to further understand the dynamics of the drainage system in this area.

Longer Term Measures

- NRW in partnership with DCC and DCWW will undertake a comprehensive study of flood risk along the full length of the Rhyl Cut. Upon completion, the outputs of this study will further influence the maintenance regime on the Cut and may highlight proportional long term options for managing flood risk in the area.

Appendix 1



Figure 20: Welsh Water Piped System

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Llwyn Brain

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