North Yorkshire County Council

Flood Investigation Report

Richmondshire July 2019

Business and Environmental Services

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Acknowledgements

North Yorkshire County Council Flood Risk Management Team would like to thank the following for their cooperation and assistance in this investigation:

Richmondshire District Council

Yorkshire Water Services Ltd

The Environment Agency

North Yorkshire County Council Highways Department

North Yorkshire County Council Resilience & Emergencies Team

North Yorkshire County Council Major Incident Response Team

National Farmers Union

Copyright

Records of the public sewer system included are a facsimile of the statutory record provided by Yorkshire Water Services Ltd (YWSL). For the purposes of this report minor sewers and other non-relevant data have been omitted from the plans for clarity

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1.0 Executive summary

On the afternoon of Tuesday 30th July 2019 a storm formed over the central Pennines, and tracked north westerly over North Yorkshire. The storm was characterised by a prolonged, intense burst of rainfall which resulted in dispersed flooding across Richmondshire administrative area, with the Upper Dales settlements of Leyburn, Bellerby, Reeth, Fremington, Arkengarthdale, Grinton and Middleham being most seriously affected.

140% of the average July rainfall for Arkle Town rain gauge fell in under 3 hours. At its peak, the Arkle Town 1-minute rainfall rates were in excess of 150mm/hr, which indicates the exceptional nature of the storm cell which persisted for several hours. The equivalent of the typical average rainfall expected in July fell in just two hours, with a return period in excess of 1000 years.

Local watercourses responded rapidly, including Arkle Beck which recorded its highest ever level and was the source of flooding throughout Arkengarthdale, lower parts of Reeth and Fremington. Significant water levels were also observed in the minor tributaries, including Grinton Gill resulting in flooding of properties and a significant amount of erosion and disposition occurring within the channel. Drainage networks and culverts were overwhelmed in Leyburn, Bellerby and Middleham and Reeth resulting in flooding to commercial and residential properties and damage to infrastructure and the highway network.

Approximately 513 incidents of flooding to property and places were received during the event. This figure has been rationalised during the compiling of this report, and whilst it is typical that in the aftermath of a significant flood event, a definitive representation of individual property numbers is problematic, it is nevertheless understood that approximately 238 individual locations were affected by the event. This included residential and business property and schools. In Leyburn both the fire station and police station were impacted.

Yellow weather warnings had been issued for the 30th July which covered the majority of the United Kingdom. There was no further weather warning issued for the Dales for that day. The settlements of Leyburn, Bellerby and Middleham are not located within a Flood Warning or Flood Alert Area. The localised nature of the storm, coupled with the fast onset of flooding (Arkle Beck reaching peak flow within 2hours from the start of the event), meant that the event was not predicted and therefore limited warnings were issued, or issued following the onset of flooding in Arkengarthdale, Reeth, Fremington and Grinton.

This resulted in there being insufficient time to mobilise a co-ordinated multi-agency response. Nevertheless, North Yorkshire Fire and Rescue Service, Richmondshire District Council, North Yorkshire County Council's Highways and Resilience & Emergencies Teams, Yorkshire Water and the Environment Agency all responded to reports as they were received and contributed to the overall risk management authority response.

The sheer volume of water conveying through the watercourses was particularly remarkable and resulted in significant damage to infrastructure and the road network. This including the loss of two highway bridges and a number of landslides, one of which significantly impacted upon the highway network and accessibility.

Other than where sections of the public sewer network were lost due to erosion of river banks and pipe bridges, no major defects were reported on the drainage networks and the overall condition of the watercourses prior to the event was known to be adequate for typical flows. The cause of the flooding in all locations was fundamentally due to watercourses and drainage networks being overwhelmed by the volume of water which fell rapidly and was in excess of the available capacity within drainage systems are nationally designed for, and watercourses to convey.

Gunnerside, Grinton and Reeth have all been identified in the Humber Flood Risk Management Plan as being located within rapid response catchments and as such are particularly vulnerable to short, intense summer storms owing to the topography and geology the catchment. If climate change predictions are accurate there is an increased likelihood of further such flood events in the future.

Increasing the capacity of the existing drainage networks to a level where it could cope with this type of flood event is not realistic and to cope with the volumes of water experienced would require systems to be adjusted significantly beyond the present day design standard.

This report therefore makes a number of recommendations with the aim of improving preparedness, resilience and recovery. Given the event has highlighted the risk in the locations and climate change predictions indicating that intense storm events will become more frequent; it is also recommended that every opportunity is taken to ensure that regular maintenance of existing infrastructure is undertaken to ensure that drainage systems are functioning to their full capacity. These options may involve the use of surface water attenuation including working with land owners using natural flood management techniques.

1.1 Scope/purpose of report

This document has been prepared specifically for the purpose of meeting the requirements of Section 19 of the Flood and Water Management Act 2010.

The purpose of this report is to investigate which Risk Management Authorities (RMAs) had relevant flood risk management functions during the flooding on 30th July 2019, and whether the relevant RMAs have exercised, or propose to exercise, their risk management functions (as per section 19(1) of the Flood and Water Management Act 2010). It does not address wider issues beyond that remit. The report focusses on the flooding in the Upper Dales, and does not extend to other parts of the district or county.

The supporting data has been put together based on reports of flooding from a variety of sources. Whilst every effort has been made to verify the locations that were flooded, the nature of the data and the methods used to collate this information mean that it does not include every occurrence of flooding. Private individual properties which flooded are not identified in this report. This data only identifies general areas where flooding has been reported to the Lead Local Flood Authority (LLFA) and is indicative only.

1.2 Flood and Water Management Act (2010)

In his review of the summer 2007 floods, Sir Michael Pitt recommended that local authorities should be given a duty to investigate flooding.

The Flood and Water Management Act 2010 (FWMA), defines the roles and responsibilities of 'Risk Management Authorities' and designates the unitary or upper tier authority for an area as Lead Local Flood Authority (LLFA).

The LLFA has responsibility for leading and co-ordinating local flood risk management. Local flood risk is defined as the risk of flooding from surface water runoff, groundwater and small ditches and watercourses (collectively known as ordinary watercourses). The responsibility to lead and co-ordinate the management of tidal and fluvial flood risk remains that of the Environment Agency (EA).

The Act also implements the recommendations made by Sir Michael Pitt that local authorities should have a duty to investigate flooding from all sources.

1.3 Section 19 Investigation Requirement

North Yorkshire County Council (NYCC), as LLFA, has a responsibility under Section 19 of the FWMA to investigate significant flood incidents in its area. Section 19 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 response to the flood.

(2) Where 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 authorities.

Section 14 of the FWMA grants the LLFA power to request information associated with its functions. These powers have been exercised in the preparation of this report.

1.4 Trigger for Section 19 Report

The incident has been assessed in line with the criteria set out in Section 3 of the North Yorkshire County Council Local Flood Risk Strategy (2015) and has been judged to warrant a formal Section19 investigation on the basis of:

a. The relationship with the functions of other Risk Management Authorities.

b. Number of properties internally flooded.

c. The depth, area or velocity of flooding reported.

d. The nature and extent of critical infrastructure impacted by the flood.

2 Event background

2.1 Location of this investigation

Flooding incidents were recorded over a vast rural area of the Upper Dales, within Richmondshire District, in North Yorkshire. This report focuses on the primary settlements of Leyburn, Bellerby, Reeth, Arkengarthdale, Grinton and Middleham that were worst affected by the event.

2.1.1 Leyburn

Leyburn (central grid reference SE 11510 90569) is a market town of approximately 2,100 residents in Wensleydale, North Yorkshire. The town boasts two markets, several pubs, and many small specialty stores. The town is connected towards Bedale/Northallerton by the A684 and towards Bellerby and Richmond by the A6108. See Figure 1. The valley rises steeply away from the River Ure with Leyburn town centre located 1.3km to the north. Agricultural land used for both grazing and arable encompasses the town to the east, north and west.

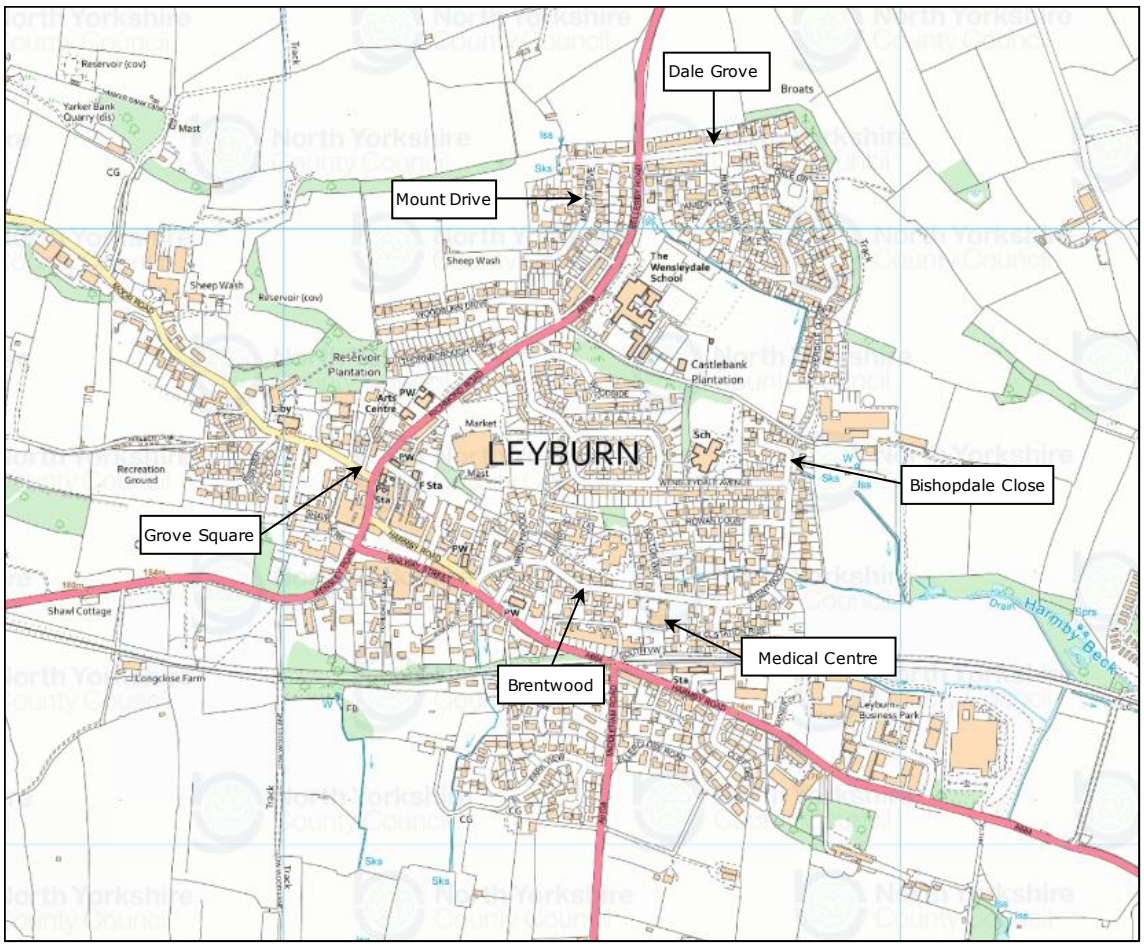


Figure 1: Leyburn Location Plan

It is commonly believed that the name Leyburn was derived from 'Ley' or 'Le' (clearing), and 'burn' (stream), meaning clearing by the stream. This is particularly pertinent given that there are a number of watercourses which run west to east across the town. These watercourses are steep, narrow and have been heavily modified and culverted. There are three distinct catchments through Leyburn as illustrated in the detailed river networks map presented in Figure 2.

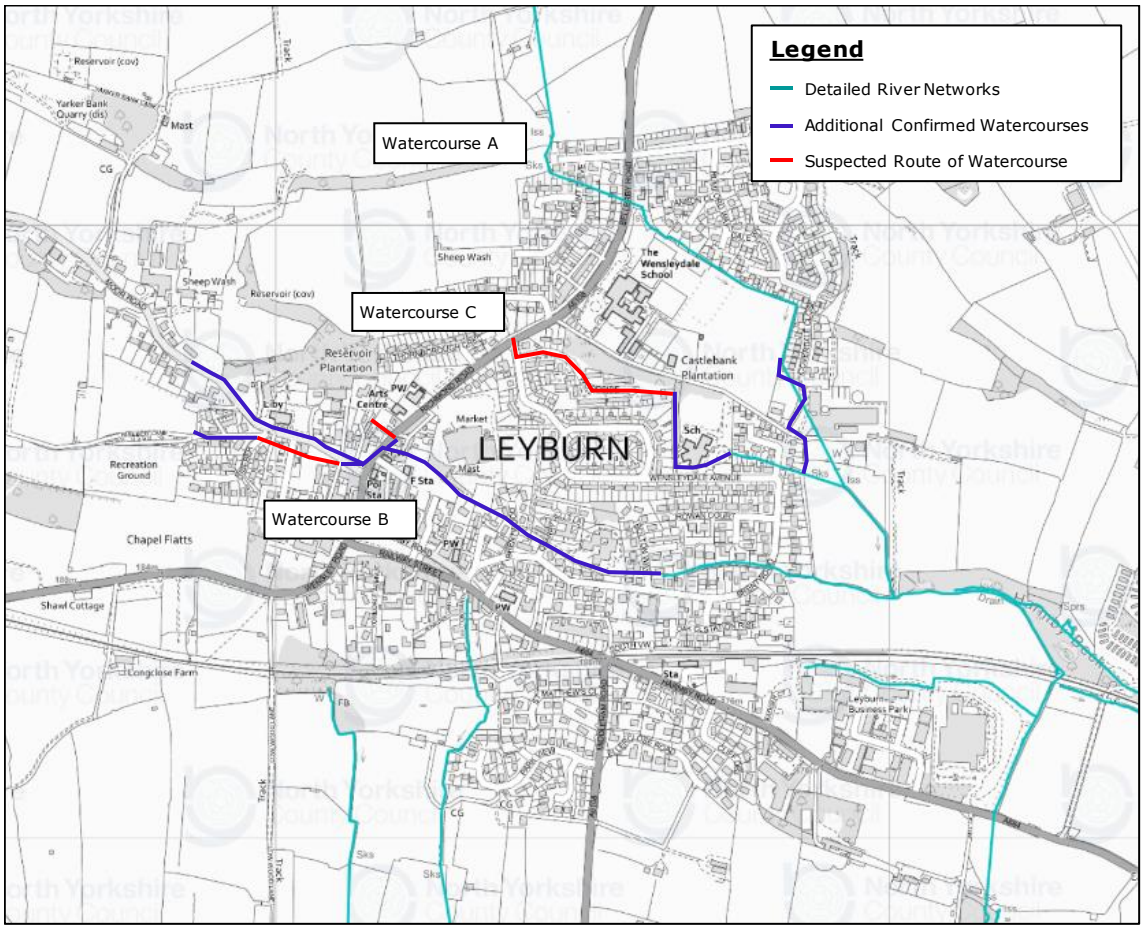


Figure 2 – Leyburn Town and Watercourses

Watercourse A flows in southerly direction from the north of the town before being culverted through gardens of properties on Mount Drive and Bellerby Road. The watercourse emerges as an open channel to the east of Bellerby Road and flows in an easterly and then southerly direction around the perimeter of the school field. The watercourse is once again culverted in the rear gardens of Coverdale Close. The configuration of the culvert has been traced and is known to discharge into the open watercourse to the east of Bishopdale Close, before it confluences with Watercourse B to form Harmby beck to the south.

Watercourse B appears to originate from land to the west or Risber Lane. Various grids and culverts have been identified on Risber Lane to confirm the route of the watercourse. The watercourse emerges in various manholes through Grove Square before performing a 'dog leg' around the Church Hall. The watercourse continues as a culvert along the northern boundary of the fire station carpark and down the rear of gardens of Brentwood. The watercourse finally emerges as an open, albeit heavily modified channel to the east of Bolton Way. This particular section has been significantly modified and primarily flows through a historic stone culvert. There are no publically available historic maps that show this culvert as an open watercourse, which leads to speculation that sections of the culvert could be over 150 years old. This would be consistent with the type of construction. In relative terms, the catchment for the watercourse is heavily urbanised and highly impermeable, and is dependent on the culvert for conveyance through the town.

A third watercourse (watercourse C) has been identified between the western boundary of Wensleydale Primary School and the rear gardens of properties on Maythorne. The watercourse flows culverted through the school ground before emerging as an open watercourse to the rear of properties between Bishopdale Close and Wensleydale Avenue.

Leyburn's other drainage systems, which includes both highways and domestic (private property) drainage networks is shown to be supported predominantly by separate surface water and foul water sewers.

The foul sewers serving the northern extent of Leyburn generally flow in a southerly direction through Leyburn to the Sewage Treatment works adjacent to mill beck 750m south east of the town. Foul sewerage from the Brentwood, Wensleydale Avenue, Rowan Court and Bolton Way areas flows to a pumping station in the south eastern corner of the Brentwood. From there, sewerage is pumped to the aforementioned sewer.

The highway drainage and domestic systems are also separate and drain to the various watercourses.

The local geology predominantly comprises limestone and sandstone of various formations. There are limited superficial deposits (soils) recorded for Leyburn. This is typical of areas with very shallow to minimal depth of the soils or peat on top of the solid geology (bedrock) or where exposed bedrock is present. Where the superficial deposits have been recorded these are shown to comprise Devensian Till of glacigenic origin.

Leyburn receives 820mm of rain annually on average.

2.1.2 Bellerby

Bellerby (central grid reference SE 11542 92866) is a village approximately 1.5 miles north of Leyburn. The village is connected by the A6108 towards Leyburn to the south, and towards Richmond to the North. The village is encompassed by moorland and agricultural land. A location plan is presented in *Figure 3*.

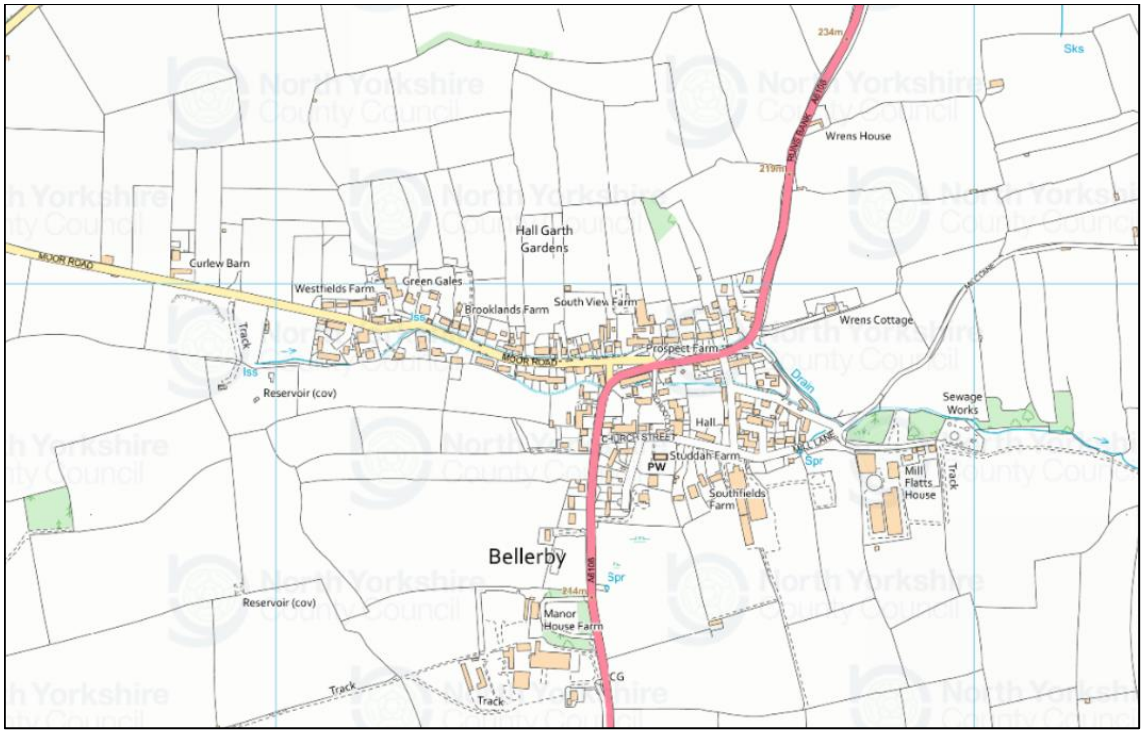


Figure 3 - Bellerby Location Plan

Bellerby is characterised by the two watercourses that flow in an easterly direction through the village (see Figure 4).

The catchment for its primary watercourse extends west along Moor Road up to the military ranges to the north west (see Figure 5) and flows adjacent to the southern side of Moor Road. The watercourse flows primarily as an open channel, but is culverted in some sections as it makes its way through gardens. The watercourse flows in a culvert under the A6108 and behind the Cross Keys Inn public house. The Watercourse then emerges briefly before being

culverted under the Olde Wynd and then Mill Lane. The culverts are circular pre-cast concrete pipes, pre-cast box culverts and older stone construction culverts.

An overflow system comprising of two stone culverts diverts water to an old mill race adjacent the northern extent of Moor Road. The mill race also flows predominantly as open channel, but is spanned at a number of locations with low bridges for access to properties on the north side of Moor Road. The race continues along the village green before crossing under Richmond Road to the east of the village. The mill race confluences with the main watercourse immediately downstream of The Water Mill on Mill Lane (private access).

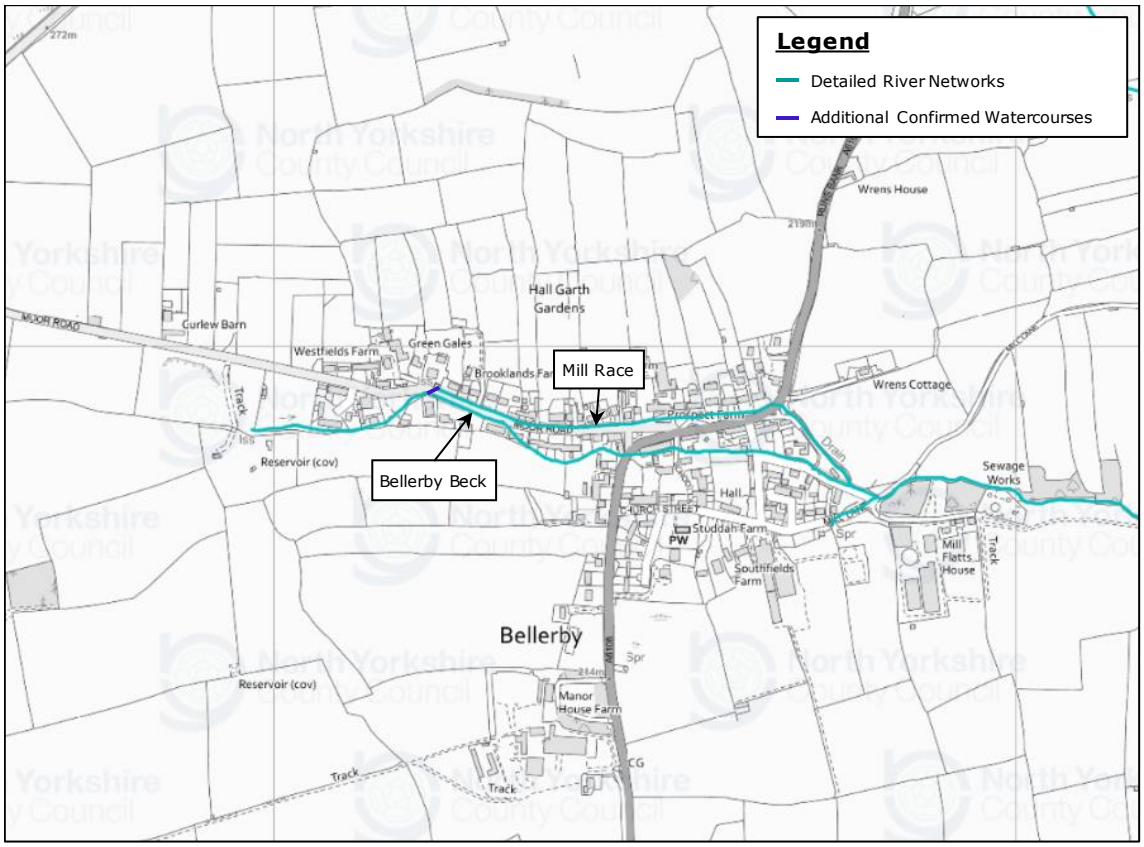


Figure 4 – Bellerby Watercourses

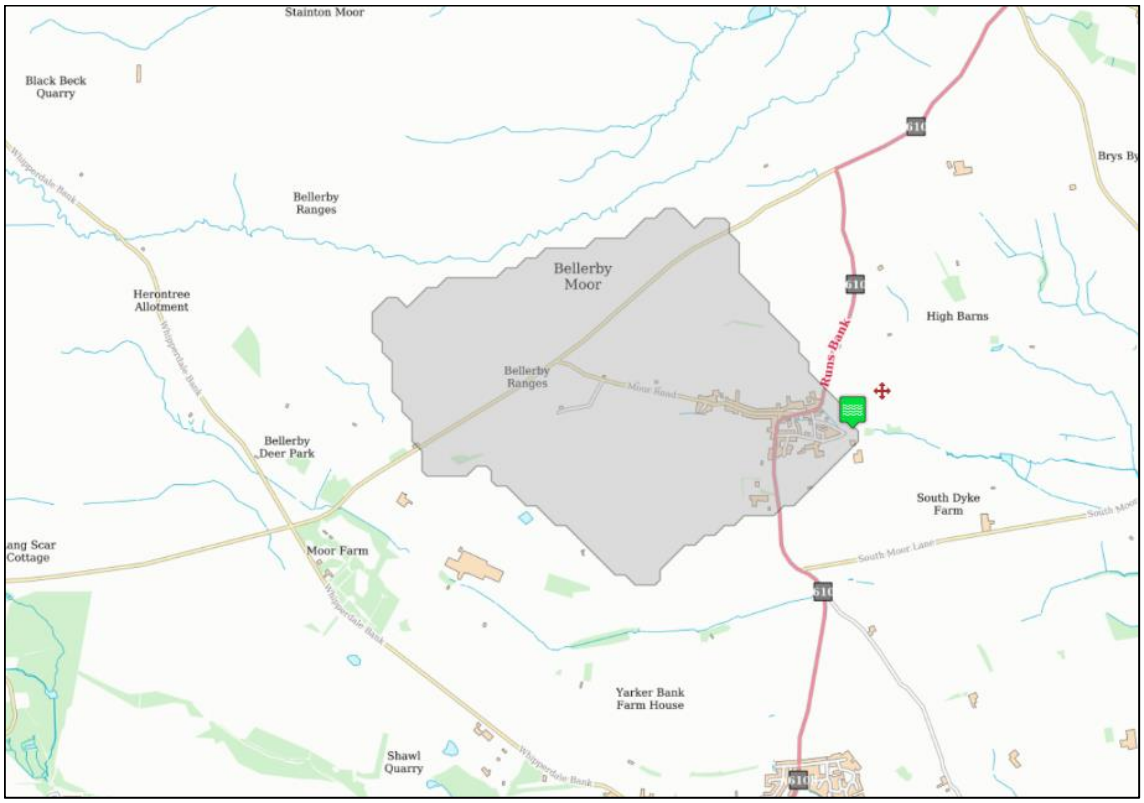


Figure 5 - Bellerby Catchment

Bellerby's drainage network is predominantly separate private surface water sewers and public foul water sewers. The foul sewers drain by gravity (not pumped) in an easterly direction to the sewerage treatment works located 450 m east of the village centre.

Private surface water from the properties and highway drainage connect directly to the watercourses.

The local geology predominantly comprises of limestone and sandstone of various formations. Superficial deposits recorded in Bellerby are shown to be Devensian Till of glacigenic origin.

Bellerby receives 843mm of rain annually on average.

2.1.3 Reeth

Reeth (central grid reference SE 03796 99328) is a village of approximately 734 residents and is the principle settlement in upper Swaledale, North Yorkshire. It is a popular tourist destination within the Yorkshire Dales National Park. The town is situated on Arkle Beck close to its confluence with the River Swale. The study area of Reeth also includes High and Low Fremington, 650 m east of the village. The town is connected to Richmond 11miles to the east via the B6270 and Kirby Stephen to the west (see *Figure 6*).

Reeth and Fremington receives 1021mm of rain annually on average.

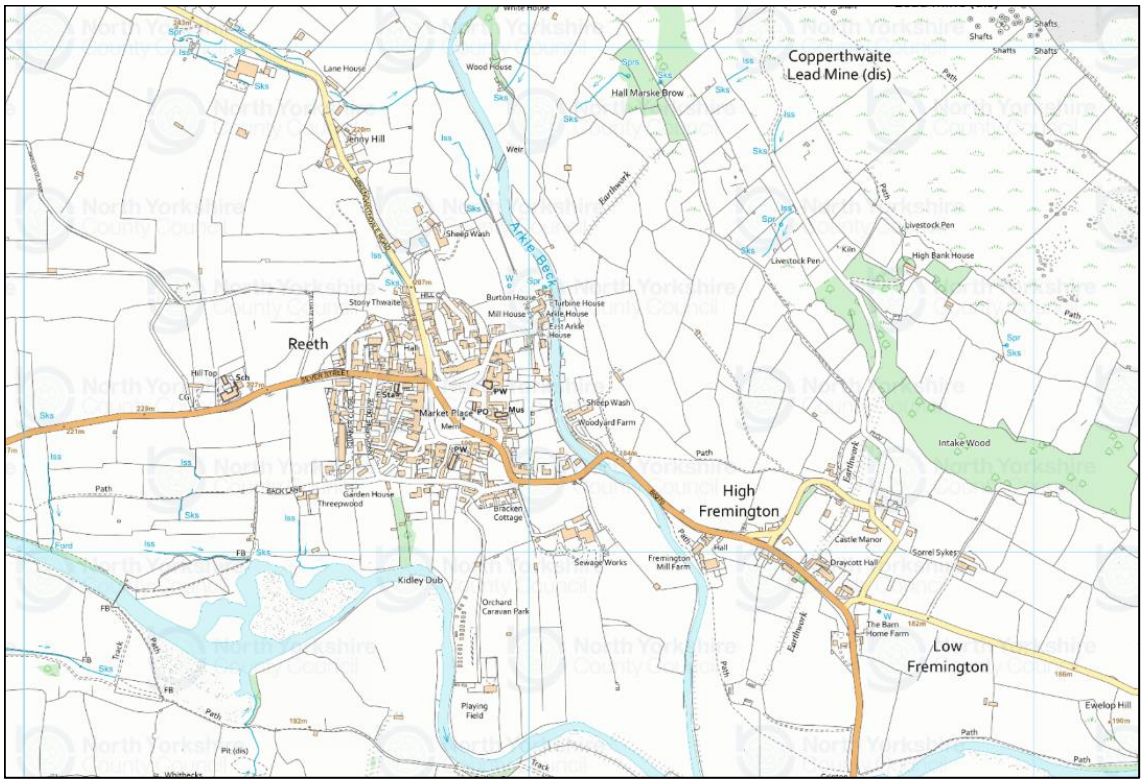


Figure 6 - Reeth and Fremington Location Plan

2.1.4 Arkengarthdale

Arkengarthdale is a dale (valley) on the east side of the Pennines and is the northernmost of the Yorkshire Dales. It is approximately 7 miles in length and is characterised by steep valley sides, with Arkle Beck flowing its length. The Arkengarthdale report area comprises all the settlements, including Arkle Town, Langthwaite, Eskeleth and Whaw as shown in Figure 7.

Arkle Beck has a significant number of smaller tributaries, all of which are steep and fast flowing as they come down the valley sides. The most notable of the tributaries are (from downstream to upstream) Slei Gill, Fore Gill, Shaw Beck, Whaw Gill, West Syke, Great Punchard Gill, Roe Beck, Annaside Beck, William Gill. A detailed river networks map is presented in Figure 8. The figure has been derived from remote sensing (satellite and topography data) as consequently not all of the Gills and becks will be shown on the plan.

Arkengarthdale receives 1078mm of rain annually on average.

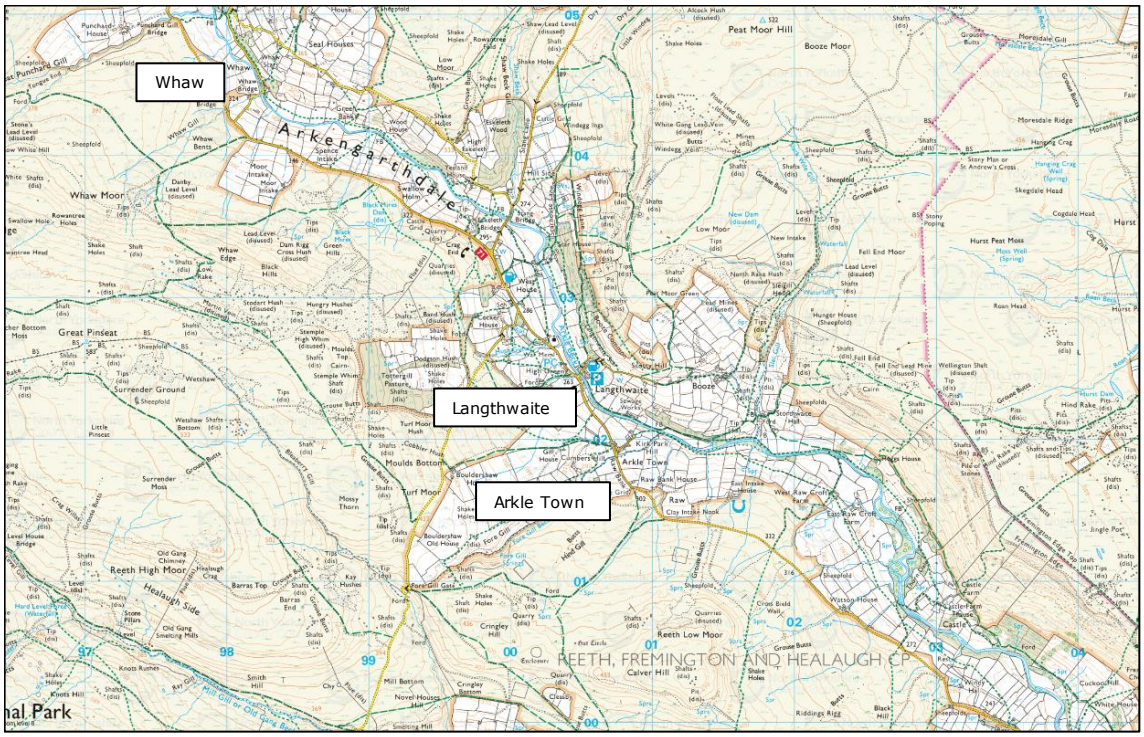


Figure 7 – Arkengarthdale Location Plan

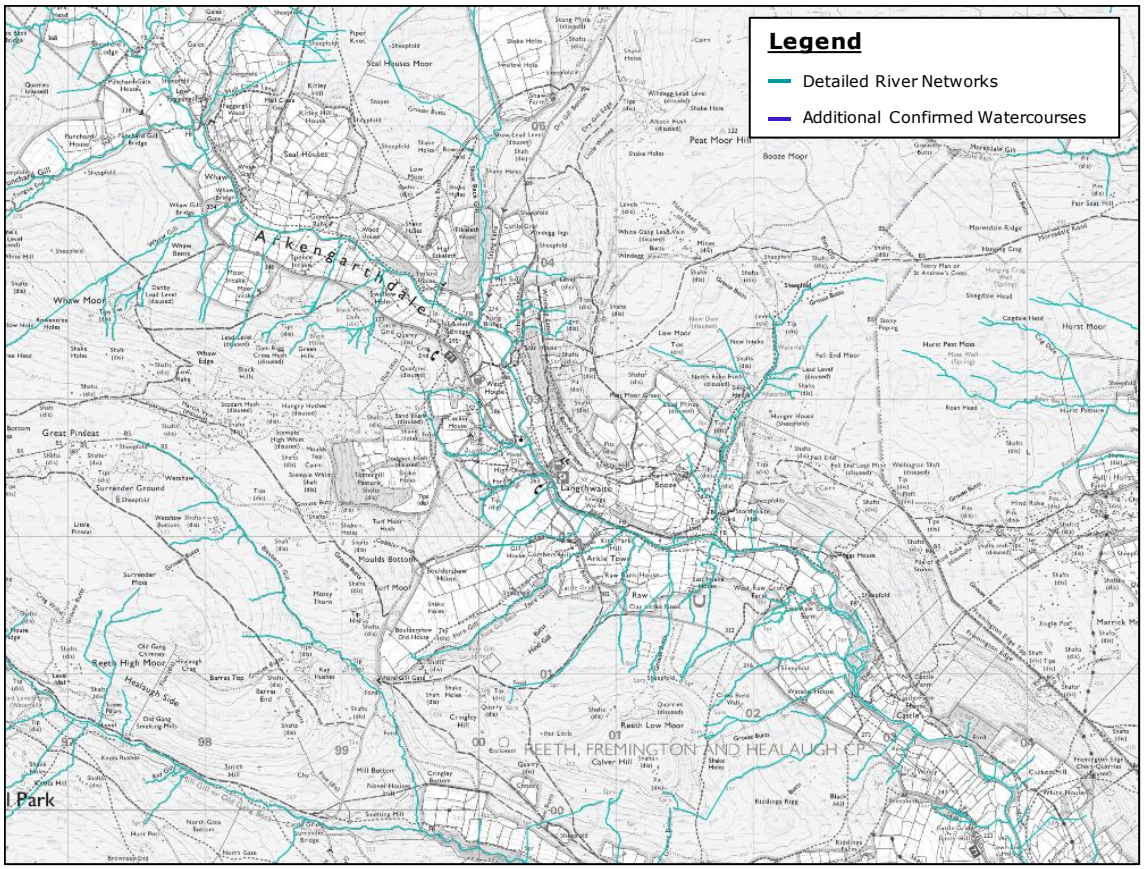


Figure 8 - Arkengarthdale Watercourses Map

2.1.5 Grinton

Grinton (central grid reference SE04665 984040) is a small village in Swaledale, approximately 1 mile south east of Reeth. Grinton comprises a number of cottages and dwelling houses built along the course of Grinton Gill, down to the confluence with the River Swale. Grinton is connected to Reeth by the B6270 to the north west and Richmond to the east. Leyburn is located to the south via the Moor Road and Whipperdale Bank as shown in Figure 9.

Figure 9: Grinton Location Plan

Grinton Gill flows in northerly direction and is a steep, fast flowing and dynamic stream that falls from Grinton Moor to the south.

Grinton receives 1010mm of rain annually on average.

2.1.6 Middleham

Middleham (central grid reference SE 12734 87746) is a market town of approximately 825 residents in Wensleydale, North Yorkshire. The town is connected towards Leyburn by the A6108 to the north west and Masham/Ripon to the south east (see figure 1). Middleham is located on the opposite side of the valley to Leyburn, on the southern slopes of Wensleydale. The valley rises up from the river Ure with Middleham town centre located 500m to the south. Agricultural land used for both grazing and arable encompasses the town to the east, north and west.

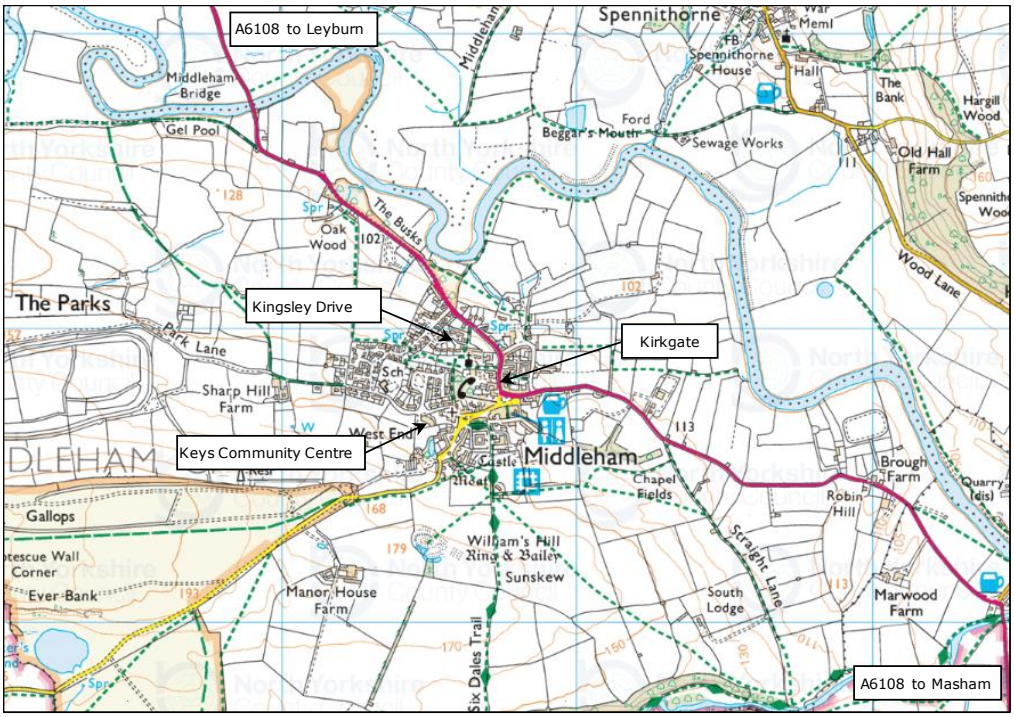


Figure 10 – Middleham Location Plan

The Detailed River Networks Map demonstrates one watercourse that flows through Middleham. The watercourse is shown to rise from the rear of properties on Hillside, before flowing in a northerly direction to its confluence with the Ure some 620m from where it issues. A walkover of the area revealed that the watercourse actually flows towards Kirkgate and flows down the road rather than through the properties as shown in Figure 11. Another watercourse that is periodically wet was identified to the west of the Community Centre. Middleham receives 859mm of rain annually on average.

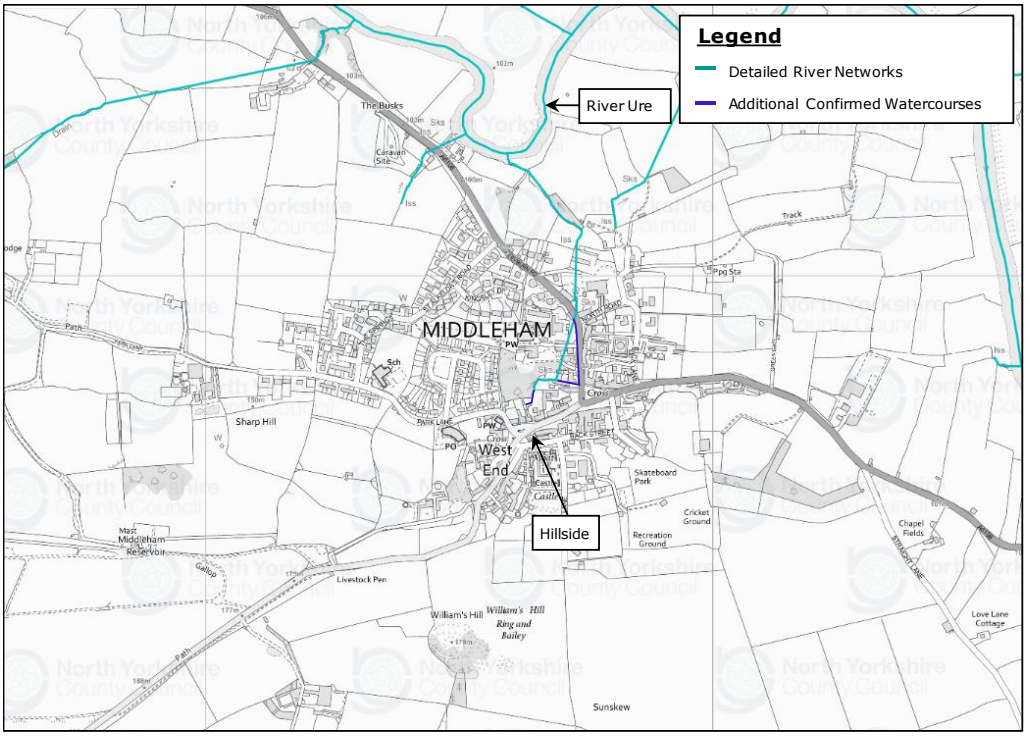


Figure 11 – Middleham Watercourses Plan

2.2 History of flooding

A review has been undertaken of existing records of historical flooding including, NYCC highways and Lead Local Flood Authority records, the EA's historic flood event outlines, the Humber District Flood Risk Management Plan (FRMP) and various correspondence from members of the public. The following flood history has been compiled from the information that has been made available to NYCC

- Bellerby 1930 – References in various literature to the big flood of 1930.
- Historic Flooding Bellerby – Letter from North Riding of Yorkshire Council dated 1946 referencing upsizing of historic culvert under the highway and behind the Cross Keys Inn to alleviate flooding issues.
- Hurricane Charlie 1986 – This event is considered to be largest flood in recent memory to affect Swaledale and Arkengarthdale.
- Historic Flood Outline 1995 Flood Event – Flood Outlines suggests that parts of Lower Fremington and Reeth were affected.
- Flooding 2002 – Historical evidence provided by resident of flooding in Mount Drive area of Leyburn.
- Flooding in September 2008 [1] - Extensive flooding across the North East and Yorkshire. Flooding Reported in Bellerby and Mount Drive, Leyburn.
- Flooding in October 2012[2] – Widespread flooding in 2012 with flooding reported in Leyburn and Bellerby. Yorkshire 2012 was the wettest year since at least 1910. Between the 23rd and 25th September the residual elements of Hurricane Nadine saw two months of rainfall (over 100mm) falling over Yorkshire resulting in high groundwater and river levels.
- Reports by Bellerby Parish Council of flooding in winter 2013 from surface water.

2.3 Current understanding of flood risk

This section focuses on the perceived level of flood risk based on the current best available data and flood mapping.

The Rivers Swale and Ure flow in a south-easterly direction, draining large linear Pennine catchments of Swaledale and Wensleydale respectively. The River Swale is the most northerly of these catchments and joins the River Ure to the east of Boroughbridge. The difference in elevations between the north and south of the catchment has a strong influence on the flood generating capacities of its rivers. In the steeper north rainfall will turn rapidly into surface runoff flowing quickly down steep watercourses. Steeper river gradients and therefore higher flow velocities in the upper parts of the catchment also give greater erosive power to the rivers [3]. In contrast the flat nature of the south of the catchment will generally mean that the onset of any flooding will be less rapid and flow velocities lower.

As a consequence, the upland areas of the Yorkshire Dales respond rapidly to heavy rainfall and as such seven rapid response catchments have been identified: **Gunnerside,** Bainbridge, **Reeth, Grinton**, Boltby, Thirlby and Sutton under Whitestonecliffe.

A review of the North West Yorkshire Level 1 Strategic Flood Risk Assessment (Volume ii – Technical Report) 2010 has been undertaken – Leyburn and Bellerby have not been identified as areas fulfilling the criteria of being recorded as at risk.

The flood map for planning, is a publically available tool and provides the best available information on fluvial and tidal flooding. Given the considerable distance from any tidally dominated watercourse, it is a sound assumption that

[1] https://www.thenorthernecho.co.uk/news/3651759.residents-evacuated-as-floods-hit/
[2] https://www.darlingtonandstocktontimes.co.uk/news/9985792.action-over-floods-discussed-in-village/
[3] Humber River Basin District FRMP (Flood Risk Management Plans) 2015 to 2021

the flood map for planning for each location is purely fluvial (river) dominated. The flood map for planning is available to see online at https://flood-map-for-planning.service.gov.uk/

The flood map for planning Flood Zones have been created by the Environment Agency to be used within the planning process as a starting point in determining how likely somewhere is to flood rivers or sea. There are 3 flood zones as defined by the EA; Flood Zone 1 – an area at risk of flooding with a frequency of less than once every 1,000 years, Flood Zone 2 – an area at risk of flooding with a frequency of less than once in a 100 years but greater than once in a 1,000 years, and Flood Zone 3 – an area at risk of flooding with a frequency greater than once every 100 years.

These areas have been defined following a national scale modelling project for the EA and are regularly updated using recorded flood extents and local detailed modelling. The mapping is largely based on modelled data and the information it therefore provides is indicative of the expected flood extent. The information is not sufficiently detailed to demonstrate risk at individual property level, primarily because the Environment Agency do not hold details about properties and their door thresholds and floor levels. Properties with higher floor levels may not always face the same chance of flooding as the areas that surround them. The mapping is also limited to watercourses with a catchment area generally greater than 2km^2. This means that some of the smaller watercourses may not have an indicative flood extent recorded on the system.

It should also be noted that locations may also be at risk from other sources of flooding, such as overland (surface water) runoff from heavy rain, or failure of infrastructure such as sewers and storm drains.

Areas at risk of surface water flooding are more difficult to understand and demonstrate than areas at risk from tidal or fluvial flooding. Small changes such as raising or lowering a kerb can alter the way surface water flows through a town or village. Notwithstanding this, where smaller watercourses have not been included in the national generalised modelling on the flood map for planning, the risk of surface water flooding maps give an indication of flood risk based upon LiDAR imaging.

Surface water risk and risk from reservoirs maps are available to see online at https://flood-warning-information.service.gov.uk/long-term-flood-risk

Water held and flowing within permeable rocks and within the soil below the normal ground level is termed groundwater. Groundwater flooding occurs when the level of the water in the ground – sometimes referred to as the water table - rises above the ground level, or infiltrates underground structures which are designed to be dry. Groundwater flooding would not typically occur unless sustained periods of heavy rainfall over several months is experienced.

In North Yorkshire, groundwater flooding has occurred on the southern flank of the North York Moors, where water levels in the underlying rock can lead to the activation of springs. Groundwater flooding has also been experienced adjacent to some of the larger rivers in the county. Groundwater flow is highly efficient in the limestone, gritstones and sandstone areas of the Dales, and a number of springs are known to be present in on the Mooreland above Bellerby and Leyburn. Given the shallow superficial deposits, surface water can quickly penetrate through the soil and hit bedrock resulting in the activation of springs. Although the springs were prominent during subsequent site visits through September and October, groundwater flooding is not considered to have been a significant factor in this flooding on 30th July given the rapid onset of flooding. Any flows from the springs will run across the surface as overland flows and will be assessed as part of the surface water flood risk.

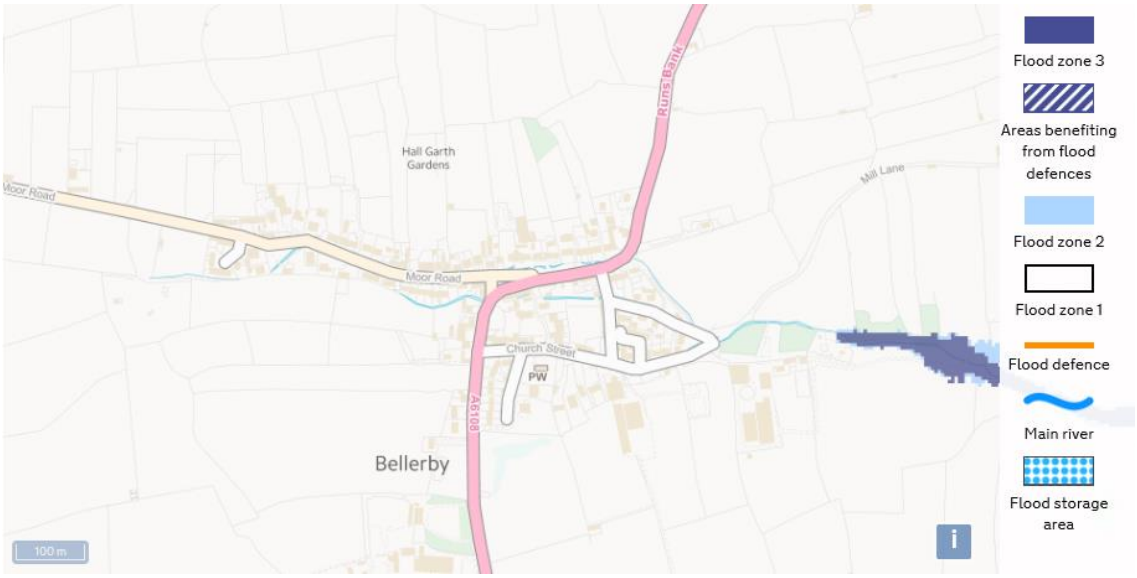
An assessment of risk for each of the investigation areas are set out below.

2.3.1 Leyburn

Source of Flooding	Assessment of Risk
Fluvial Flood Risk (River Flooding)	 The flood map for planning indicates that all of Leyburn is located entirely within Flood Zone 1 and is not at risk of fluvial flooding. It is noted that none of the watercourses identified in the introduction of this section of the report have been captured within the national generalised model.
Pluvial Flood Risk (Surface Water)	 The pluvial flood risk in Leyburn follows the natural topography of the town with the three distinct flood pathways that strongly correlate with the three watercourses identified in Section 2.1.1. The highest area of risk is shown to be the in the vicinity of the watercourse around part of Mount Drive, Bellerby Road, Coverdale Close and Bishopdale Close, where the flood risk is shown to be high (events that occur more frequently than 1 in 30-years). Other notable areas at high risk include Wensleydale Primary School and the Medical Centre off Brentwood. The flood risk relating to the watercourse originating in Risber Lane is predominantly shown to be low risk (events that occur less frequency than 1 in 100-years), with increased areas of risk

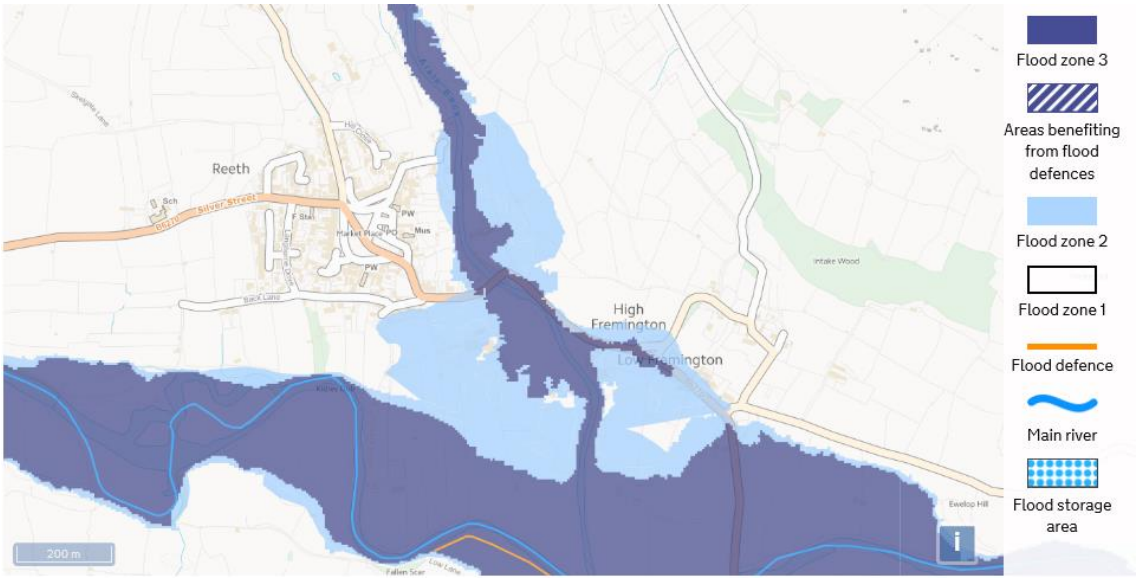
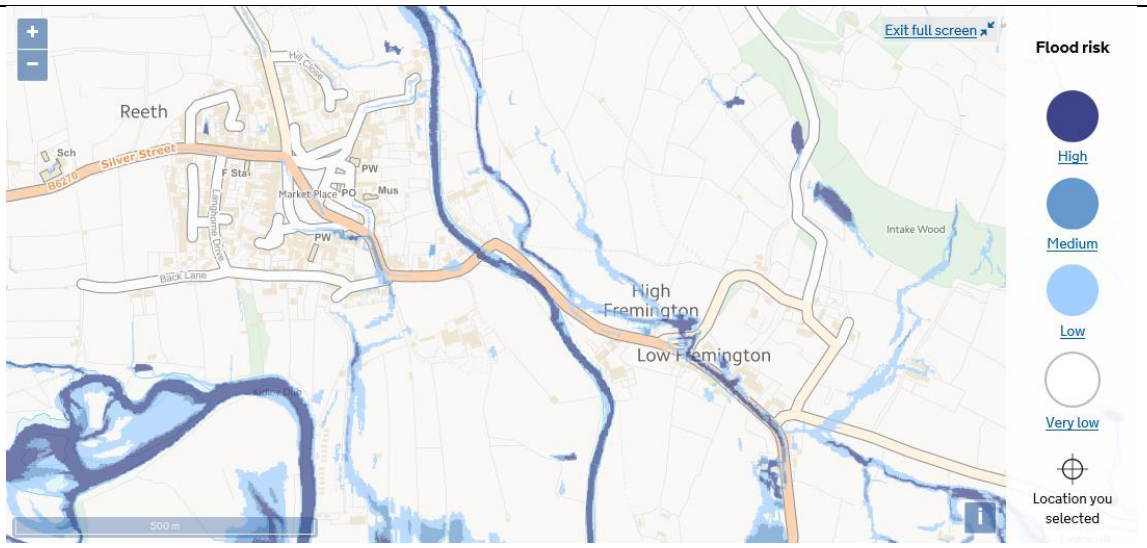
	(medium – events that are expected to occur with a frequency between 1 in 30 and 1 in 100-years) in the vicinity of the fire station, rear or properties off the nurseries and Brentwood.
Reservoir Flooding	Leyburn is not shown to be at risk of flooding from any reservoirs.
Flood Alert and Warning Areas	There are currently no flood alerts or warning available for Leyburn.
Current Flood Defences	There are no recorded flood defences within Leyburn. Leyburn is not shown to benefit from defences.

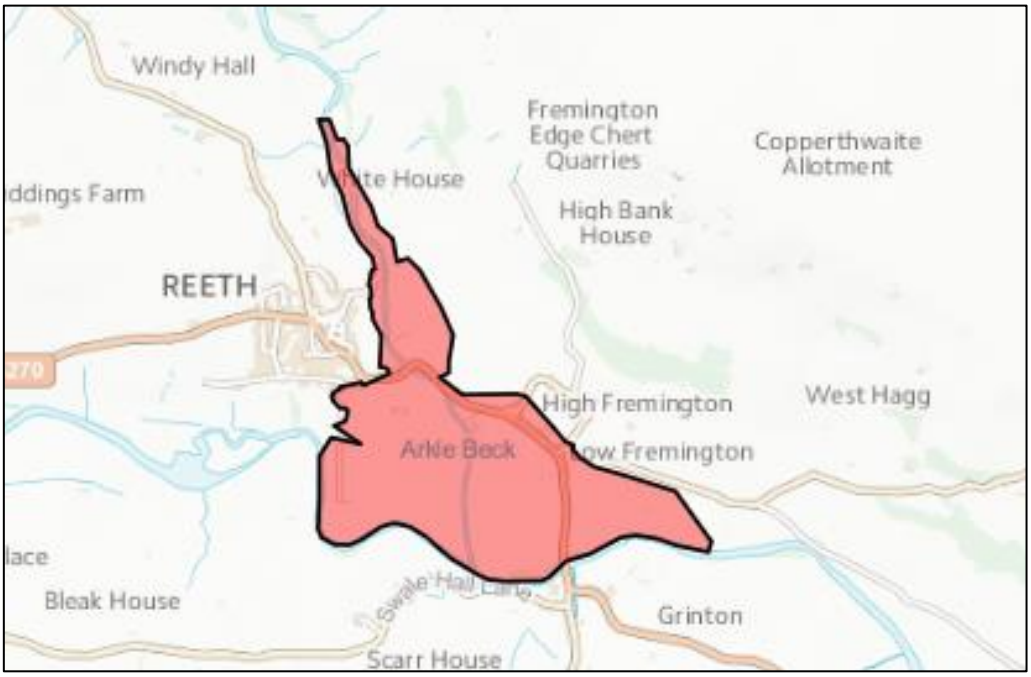
2.3.2 Bellerby

Source of Flooding	**Assessment of Risk**
Fluvial Flood Risk (River Flooding)	 The flood map for planning indicates that all of Bellerby is located entirely within Flood Zone 1. It is noted that none of the watercourses identified in Section 2.1.2 of this report have been captured within the national generalised model. The abrupt start of flood zone 3 extent shown to the east of the village suggest that the catchment for the watercourse upstream of this point is less than the threshold for it to been assiged a flood zone designation.

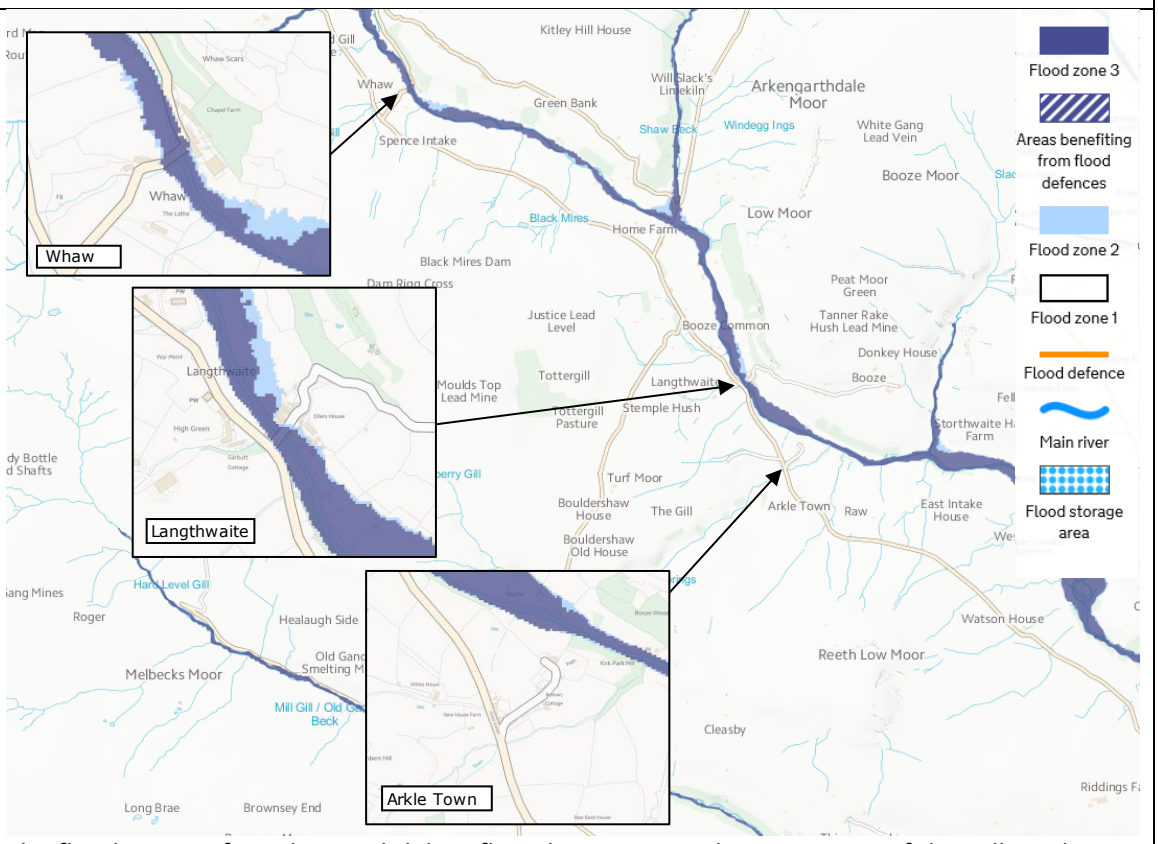
Pluvial Flood Risk (Surface Water)	 The Risk from Surface Water Flood Map shows the entire length of Moor Road, across the A6108 and to the rear of the Cross Keys to be to be at high risk (occur more frequently than 1 in 30-years) of surface water flood events. This high risk flow pathway continues along the course of the beck through the village. It is noted that properties on the southern side of Moor Road are not shown to be at risk. This could be for a number of reasons, for example, highway kerbs may give an inaccurate representation of the drop of the road surface level when in reality, Moor Road is in some instances higher than the property thresholds. Furthermore, the surface water flood maps do not account for the presence of any culverts and the dimensions of any channels which may impact upon surface water risk.
Reservoir Flooding	Bellerby is not shown to be at risk of flooding from any reservoirs.
Flood Alert and Warning Areas	There are currently no flood alerts or warnings available for Bellerby.
Current Flood Defences	There are no recorded flood defences within Bellerby.

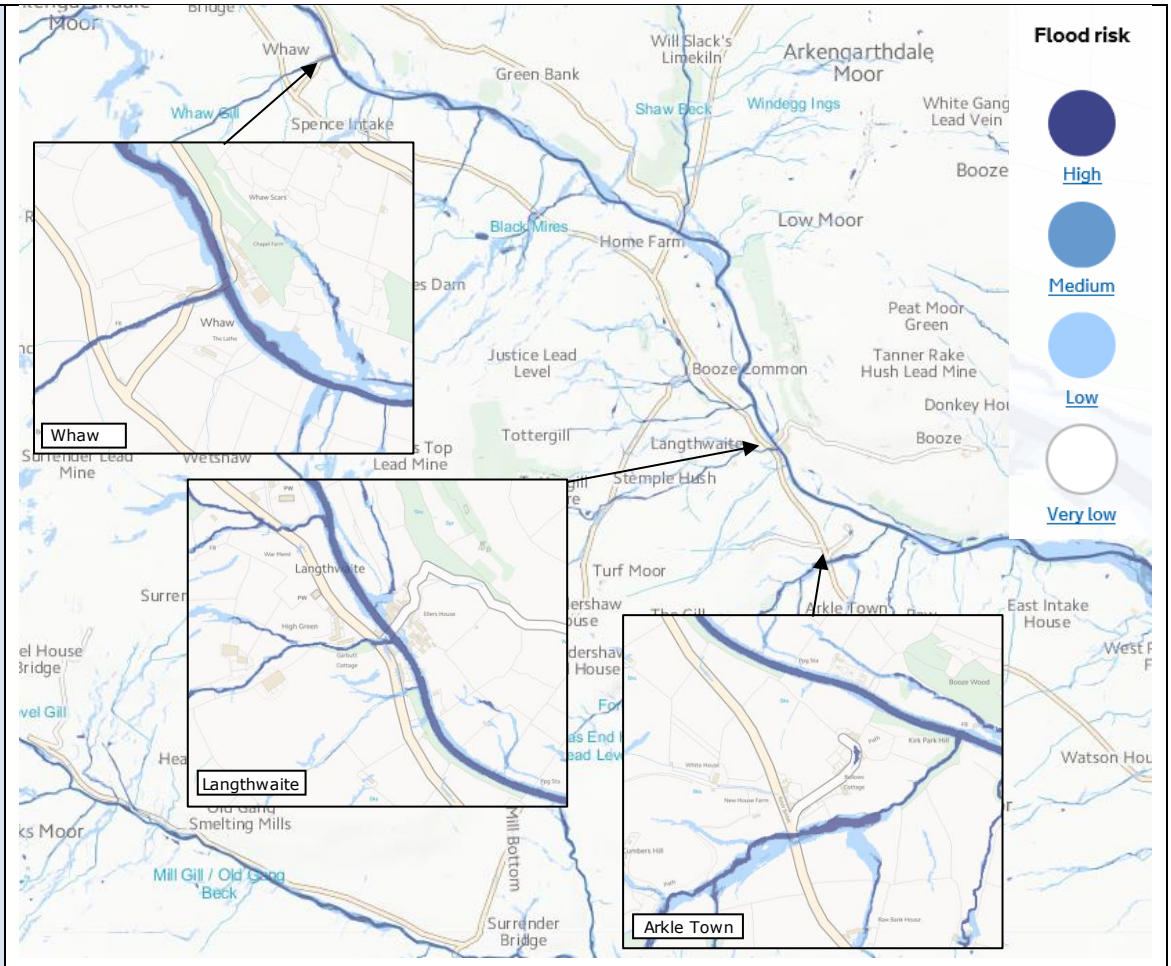
2.3.3 Reeth

Source of Flooding	Assessment of Risk
Fluvial Flood Risk (River Flooding)	 Reeth is shown to be predominantly in Flood Zone 1, with some properties in the vicnity of Arkle Beck being in Flood Zone 2 and 3. Low Fremington is predominantely located in Flood Zone 2 with an area along the B6270 in Flood Zone 3.
Pluvial Flood Risk (Surface Water)	 Areas of high risk have been identified within Reeth, primarily to the southern end of Market Place and down the hill towards Fremington. Areas of low risk have also been identified on Mill Hill (from the village green to Arkle House). Anecdotal evidence confirms that these areas were impacted during the event. Low Fremington is also shown be at high risk of surface water flooding, with a surface water flow path shown to convey from above Low Fremington, flowing in a south easterly direction along the B6270. The extent is narrow, suggesting that flows would be confined to the highway. As explained earlier in the report, the role of the highway as a conveyance route may be overstated in the mapping due to the level of features such as kerbs which may indicate in Lidar imaging a more significant drop than exists. Whilst the indicated flow path demonstrates the approximate route of conveyance observed in the July 2019 event, its extent significantly exceeded that demonstrated on the indicative maps.

Reservoir Flooding	Reeth and Low Fremington are not shown to be at risk of Reservoir Flooding
Flood Alert and Warning Areas	 The lower section of Arkle beck to the east of Reeth and Low Fremington are included within a Flood Warning Area. The warning area known as 122FWF713 Arkle Beck at Reeth and Low Fremington is a new flood warning (since Nov2018) and is triggered from river levels observed at the Reeth river gauge.
Current Flood Defences	The only recorded flood defence in located on the left bank of the river swale adjacent to Swale Hall Lane. Reeth is not shown to benefit from any defences.

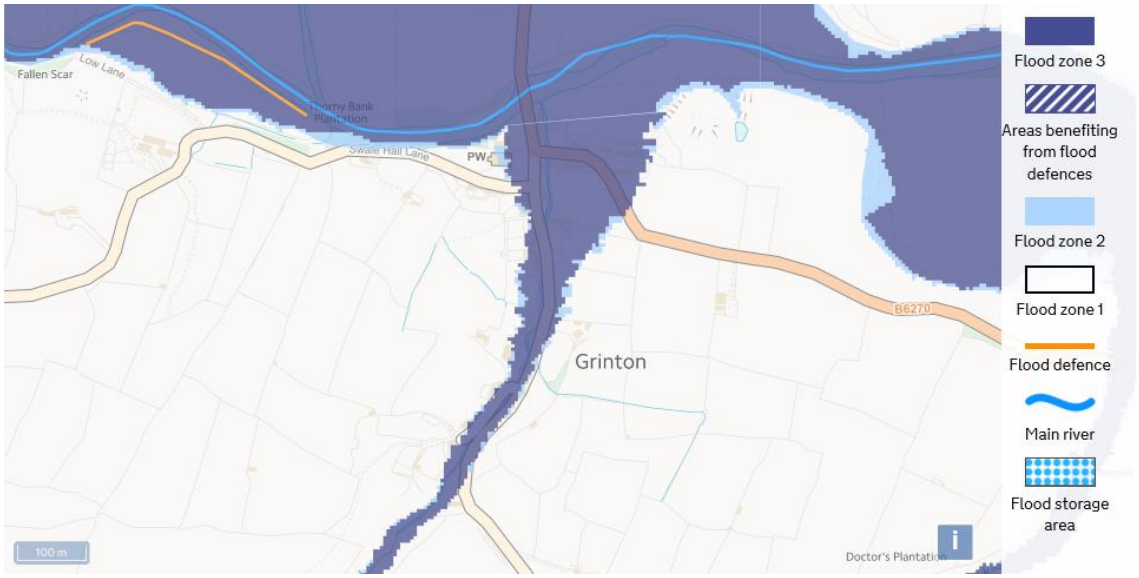
2.3.4 Arkengarthdale

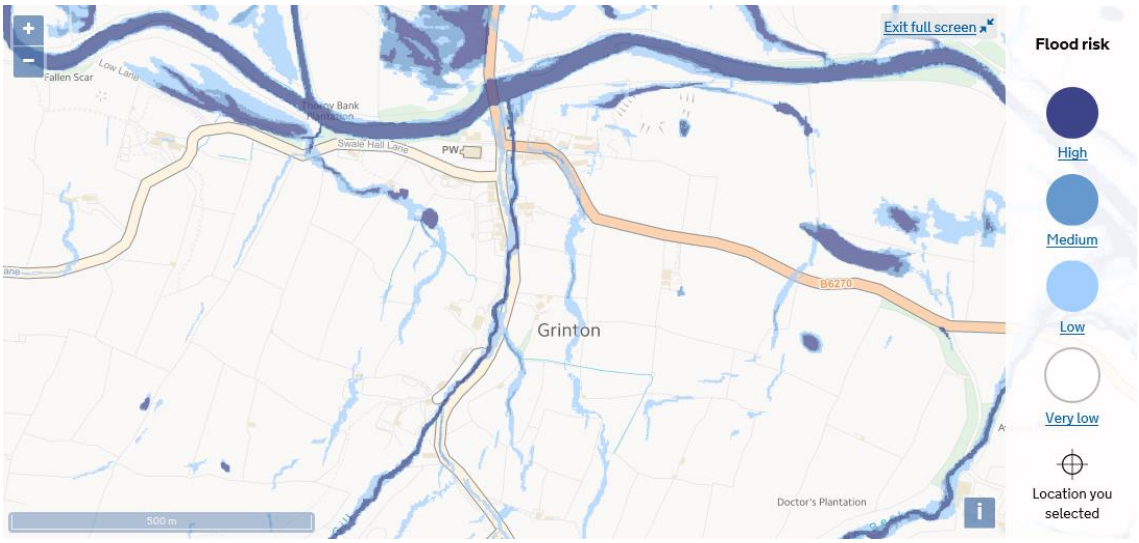
Source of Flooding	Assessment of Risk
Fluvial Flood Risk (River Flooding)	 The flood extents for Arkengarthdale reflect the narrow and steep nature of the valley. The minor watercourses are not respresented on the mapping. It is noted that there is little diference between the Flood Zone 3 (1 in 100 year frequency event) and Flood Zone 2 (1 in 1,000 frequency event). This is predominantely due to the steep sided nature of the valley. Rather than spread out lateraly, flood depths are likely to increase signifantly during a 1 in 1,000 year event. **Whaw** Properties on the right bank of Whaw are shown to be predominantly be in Flood Zone 1 with a low risk of Fluvial flooding, however the flood zone 2 and 3 extent is very close to some of the properties. As explained earlier in the report, the map cannot be used to give a measure of risk at individual property level. **Langthwaite** A number of properties adjoining the river are shown to be located in Flood Zone 2 and 3. The extent narrows through the centre of the settlement as the ground rises quickly up the hill and out of the village. **Arkle Town** The properties in Arkle Town are demonstrated in Flood Zone 1, however as mentioned above, the risk from minor tributaries is not shown on fluvial flood maps.

Pluvial Flood Risk (Surface Water)	 Many of the smaller watercourses not highlighted at risk on the fluvial flood map are within the area indicated to be at high risk of surface water flooding (flooding frequency of greater than a 1 in 30 year event). The flood extents are narrow with little variance between the high and low likelihood events, due to the steep and narrow topography around the gills and becks. **Whaw** In addtion to the risk identified from Arkle Beck, the risk of flooding from the minor watercourse that flows in an easterly direction towards the village and under the access road is shown to be high. Some disruption to the road could be expected from this source. An additional flow overland flow route which does not appear to follow a watercourse has been identified to the east of the village. The risk associated with the overland flow routes is predominately low with some areas of medium and high risk. **Langthwaite** There are two suface water flow paths identified flowing towards Langthwaite. The first is an area of low, medium and high risk flowing in a south easterly direction. This flow path does not appear to be directly linked to any watercourse. During the event however, it would be hard to determine whether this flow route exacerbated the issue as it is also located withn the Flood Zone 2 and 3 extent. The second flow path is linked to an un-named tributary of Arkle Beck. Areas of low, medium and high risk are also evident. Flooding from this source could have affected the properties on the west side of Raw Bank

	The mapping does not show surface water flood risk along the road unclassified road leaving the village up the hill to the east. During a site visit however, residents commented that some properties were affeted by surface water coming down the hill. **Arkle Town** The risk associated with the unnamed watercourse to the west of Raw Bank is shown to be high, however the extents are not shown to affect Arkle Town. There however an area of high risk shown in the midde of the town. Rather than a flow path this suggests that this area is susceptible to accumulation of sheet flow.
Reservoir Flooding	Arkengarthdale is not shown to be at risk of flooding from any reservoirs.
Flood Alert and Warning Areas	Arkengarthdale is included within the Upper River Swale Flood Alert Area.
Current Flood Defences	There are no recorded flood defences within Arkengarthdale. Arkengarthdale is not shown to benefit from any defences.

2.3.5 Grinton

Source of Flooding	**Assessment of Risk**
Fluvial Flood Risk (River Flooding)	 All of Grinton is shown to be located in Flood Zone 2 and 3. There is little diference between the two flood extents for the village, which is reflective of the steep and narrow cacthment. It is noted however, that the properties flooded in Grinton were limited to those that were below the level of the highway and were flooded from a flow path conveying down the highway. None of the properties adjacent to the Gill reported internal flooding from the back of the properties facing the Gill.

Pluvial Flood Risk (Surface Water)	 The surface water flood map more closely demonstrates the flow paths and flooding that was reported during the event. The Gill flows in a deep ravine and is in a state of degradation with significant amount of continuous ongoing erosion. A low risk (between 1 in 100-year and 1 in 1,000-year event) flow path is shown to flow off the Moor and onto the road through Grinton. From the evidence presented, it would appear that the properties were flooded from a combination of this flow path and water from Grinton Gill.
Reservoir Flooding	Grinton is not shown to be at risk of flooding from any reservoirs.
Flood Alert and Warning Areas	Grinton is included within the Upper River Swale Flood Alert Area.
Current Flood Defences	There are no recorded flood defences within Grinton. Grinton is not shown to benefit from any defences.

2.3.6 Middleham

Source of Flooding	Assessment of Risk
Fluvial Flood Risk (River Flooding)	 Middleham is not shown to be at risk of Fluvial Flooding from the River Ure and is located within Flood Zone 1 (event with a frequency greater than 1 in 100 years).
Pluvial Flood Risk (Surface Water)	 The surface water flood risk in Middleham is predominately shown to be low. There are however areas of low and medium risk identified within two distinct flow paths. The most prominent of which flows in a west to east direction towards the Key Community Centre (see Figure 10). The flow path relates to the minor ordinary watercourse observed flowing at the community centre entrance at the time of the visit. The flow path continues past the centre, before flowing through the church yard. Flooding was reported in the churchyard, with water attenuating behind a dry stone wall. Seepage from the wall was reported to externally affect properties on Kingsley Drive. Surface water flows are also shown to be present on Kirkgate, where some properties were internally flooded. An area of low risk is also shown adjacent to the "Plantation". It was confirmed that a property was affected in this area, primarily as a result of flow emanating from the Gallops and flowing down the highway and accumulating in a low spot off the highway.

Reservoir Flooding	Middleham is not shown to be at risk of flooding from any reservoirs.
Flood Alert and Warning Areas	There are currently no flood alerts or warning available for Middleham.
Current Flood Defences	There are no recorded flood defences within Middleham. Middleham is not shown to benefit from any defences.

2.5 Maintenance responsibilities

A "watercourse" is any river, stream or channel – including ditches, dikes, drains, culverts, cuts, sluices, sewers (excepting public sewers) through which water flows either permanently or periodically. Watercourses are designated as either being "main" rivers or "ordinary" watercourses. Responsibility for maintenance of a watercourse rests with the owner or owners of the land through which that watercourse flows. Often a watercourse will be the boundary between two adjacent landowners and where this is the case the boundary is deemed to be the centre of the channel, the owner of the land or property on each side being responsible for maintenance of their side. Culverts under roads are usually the responsibility of the relevant Highway Authority, either Highways England or North Yorkshire County Council.

The Environment Agency has powers, but not a duty, to carry out maintenance on watercourses which have been designated as "Main" rivers and also the power to build and maintain flood defences on these rivers where deemed necessary and proportionate. Within the district of Richmondshire, the following watercourses have been designated as main rivers:

- Swale
- Ure

Watercourses which are not listed above, including Arkle Beck, are ordinary watercourses, and responsibility for these rests with their riparian owners. North Yorkshire County Council as Lead Local Flood Authority has powers to enforce riparian owners to undertake maintenance, which are exercised proportionally according to the degree of flood risk.

Yorkshire Water is responsible for managing and maintaining the network of public sewers throughout the investigation area. Public sewer networks are either combined systems, where foul and surface water drain through the same pipes to the local waste water treatment works, or are separate systems where foul water is conveyed to the sewage works and surface water is conveyed either to a local watercourse or other receiving body of water, or to a point at which it joins the combined sewer network. The upper dales are mostly served by combined and Foul Sewer systems.

North Yorkshire County Council as the Highway Authority is responsible for maintaining drainage assets on the road network in the study areas.

3 Investigation

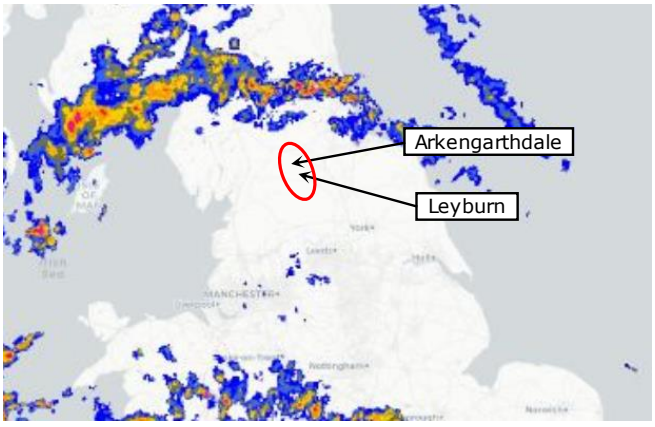
3.1 Rainfall event – location, depth & duration

The National River Flows Archive (NRFA) reports show that July 2019 bore the hallmarks of a typical British summer. It was sunny and occasionally very hot, and accompanied by thunderstorms. In late July there was an extremely short period of hot weather, which was driven by plumes of continental air. This came to end by a series of concentrated thunderstorms and substantial rainfall. This produced disruptive surface water and fluvial flooding which had a severe impact across northern Britain. July rainfall totals were above average for the UK, largely across most of northern Britain. Soil moisture conditions were near zero across northern Britain, which likely attributed to flooding events[3].

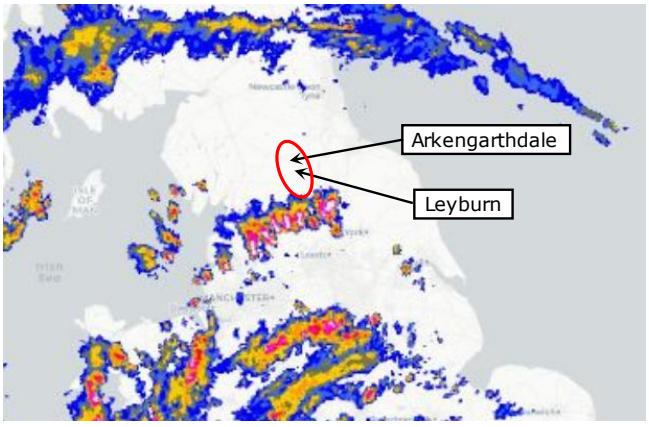
On 30th July, an area of low pressure centred over England with a particular focus on the Pennines was predicted, and this was estimated to bring extensive torrential downpours. The storms tracked across the Yorkshire Dales on a south east to north west trajectory as can be seen in the radar images (below). It appears that a line of storms stretching from Malham to Ripon, which developed early on the afternoon of the 30th, moved north westerly during the afternoon. As they did, a storm cell initially located over Leyburn, Middleham and the middle Ure elongated to cover an area that stretched from Middleham into the Tees valley. Reeth and the Arkle Beck were located in the centre of this storm cell. This weather front produced a number of localised downpours across the northern areas of England[2].

The most significant rainfall on 30th July 2019 happened in the Richmondshire and the Yorkshire Dales area. At Arkle Town peak 1 minute rainfall rates in excess of 150mm/hr equivalent indicate the exceptional nature of a storm cell that persisted for several hours. At this intensity, the average July rainfall fell in two hours, with a return period in excess of 1000 years[4], with rain continuing to fall beyond this period.

These localised heavy downpours resulted in dramatic amounts of rainfall for July across the region. Across North Yorkshire, this was 150-200% more than the July long-term average for the 6-day period of 26-31 July[3].



12:00 GMT (13:00BST)



14:00 GMT (15:00 BST)

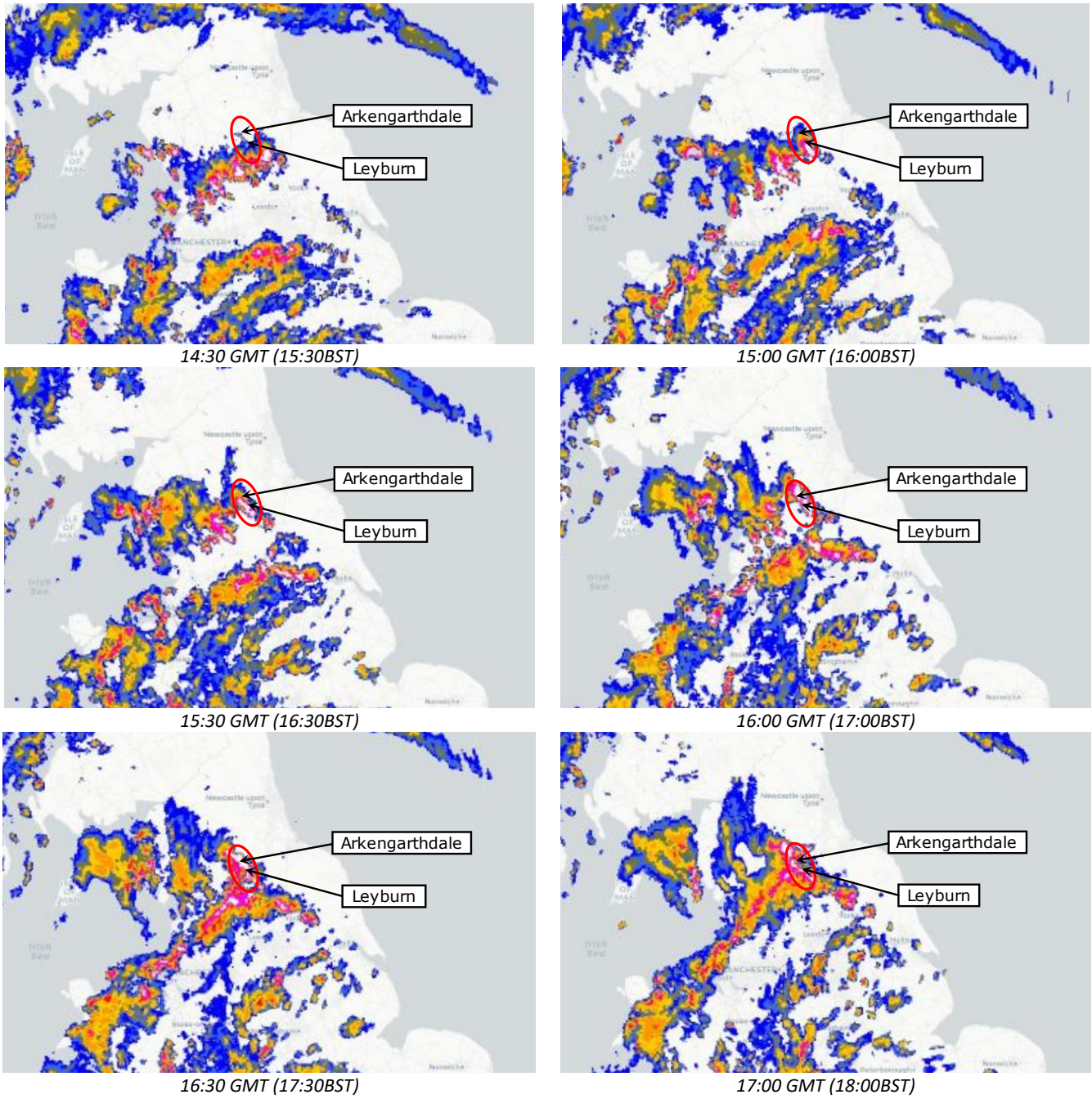


Figure 12 – Rainfall Radar 30th July 2019

3.2 EA rain gauge

The rainfall totals for the Yorkshire Dales area show that little to no rain fell throughout the morning of 30th July 2019 until 13:15. 0.4mm fell at Thornton Steward, which is located south east of Leyburn by 6 miles. Within the next 4 hours, approximately. 33.8mm fell. By 17:30 the intensity of the rainfall tailed off and 2.4mm of rain was recorded over the next 12 hours. A total of 41mm was recorded for the 30th July 2019 for the Leyburn and Bellerby area. This, replicated over the study area of 20 square kilometres, would equate to 676 million litres, which could fill over 250 Olympic swimming pools in a 4-hour period. Meanwhile at Arkle Town the EA rain gauge, which is located 2.7 miles from Reeth, demonstrated 1.4mm of rain falling between 08:15 and 09:45. This was then followed by no rain between 10:00 and 13:45. At 14:00 the storm approached and between 14:00 and 19:15 approx. 99.8mm of rain fell within the local catchment over this short period with the total of 106mm of rain on the 30th July 2019. This, replicated over 20 square kilometres, would equate to 2156 million litres, which could fill over 800 Olympic swimming pools.

The long-term average for this location is 70.7mm of rain for the month of July[7]. The rain gauge at Thornton Steward indicates that 82% of the monthly average fell in this area over a 4-hour period, and local rainfall at Bellerby and Leyburn where the storm centred may have been higher. At Arkle Town 140% of the monthly average rainfall fell over 5-hour period. The return period for both areas for the day exceeds the 1 in 1000-year storm event[4].

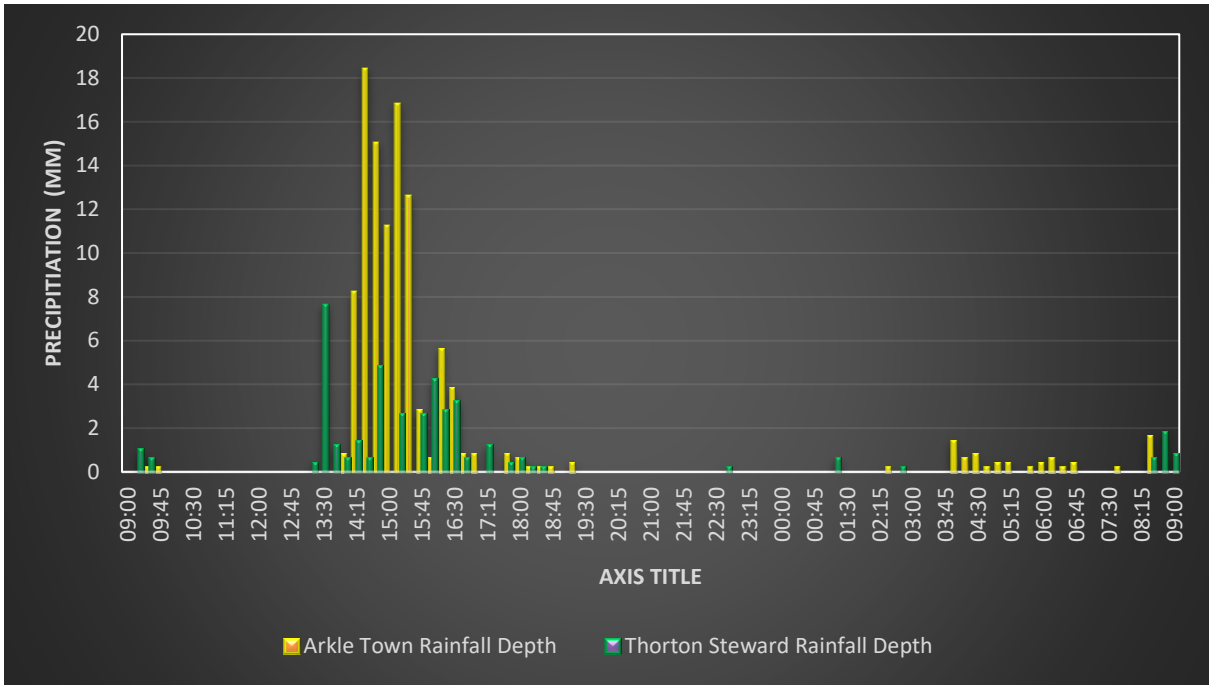


Figure 13 - Upper Dales Rain Gauge Data

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3.4 River gauge levels and flows

The levels quoted in the following section and relative to the gauge datum. The Environment Agency operates river flow gauges on the River Swale and Arkle Beck. The gauge at Arkle Beck in Reeth is shown to have recorded a peak level of 2.134(m) at 16:30hrs on 30th July 2019, which correlates with the peak of the rainfall intensity having been reached before this time. It should be noted that the peak level at Arkle Beck was the highest the gauge could record, therefore the peak could have been (and is assumed to have been) much higher. Further to this, the gauges on River Swale at Grinton Bridge and Catterick Bridge recorded peak levels of 2.463(m) at 18:30hrs and 2.873(m) at 21:00hrs respoectively[7].

Only Arkle Beck at Reeth recorded the highest level on record during this event during this storm. This however was affected possibly by the water reaching the top of the bank and overflowing into the surrounding area. The impact of the localised rainfall drives the significant peak river levels down the length of the Swale as far as Catterick Bridge. The rate of rise at the sites mentioned was notable, at Catterick Bridge the water level rose by 1.8m in 30 minutes. At Grinton Bridge it was 2m in 2 hours, and Reeth by 1.6m in 1.5 hours. Peak flows were recorded at Catterick Bridge. The flows that were recorded correlate with the rainfall gauge at Arkle Town with the storm starting at approx. 14:00hrs.

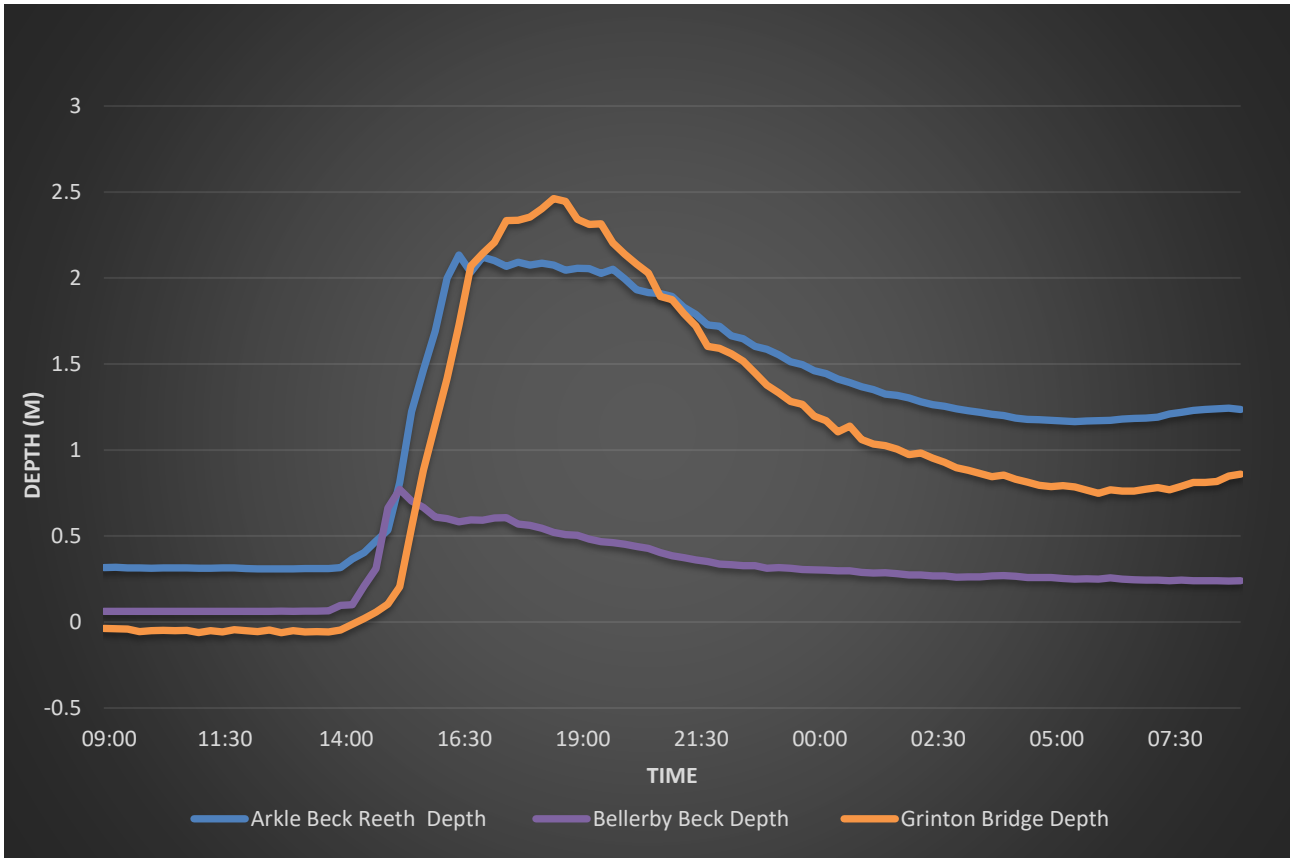

Figure 14 - River Level Gauge Data

3.5 Groundwater levels

Due to the rapid onset of the flood event, groundwater levels are not considered to have played a role and groundwater levels have not been investigated for the purposes of this report.

3.6 Forecasts and flood warnings

The weekly Met Office advisory for the week leading up to the event noted that there was a possibility of thunderstorms caused by an area of low pressure. Severe yellow weather warnings were issued across the most of England and parts of Scotland. Weather forecasters mentioned that there would be possible travel disruption, with storms bringing up to 30mm of rain in one hour causing local flooding and difficult driving conditions[3].

The Environment Agency issued a flood warning at 17:16 on 30/07/2019 due to intense downpours and rapidly rising river levels. The flood warning was for the areas of Arkle Beck at Reeth and Low Fremington. There was also a flood alert issued for the Upper River Swale at 18:36 on 30/07/2019. This was due to intense localised downpours, which was causing surface water flooding. The areas of concern were Reeth, Grinton Bridge and Gilling West. The river levels were predicted to rise through the night due to further heavy showers[3].

4 Flooding consequences

Flooding to property was reported across the Upper Dales. Reports of internally flood properties were received from the Fire Service, Yorkshire Water, Richmondshire District Council and North Yorkshire County Council's Resilience & Emergencies and Highways departments. In total 238 reports of internal property flooding were received and many referred to a number of properties being affected. A summary of the flood reports received is presented in the table below[5-8].

RMA	Total calls received	Internal	External	Other
Fire Service	97	97	0	6 x Water rescues 1 x vehicle flooded
Yorkshire Water	16	Not Known	Not Known	
NYCC Highways	70	12	58	
NYCC Resilience & Emergencies	3	Not known	Not known	
Richmondshire District Council	66	238		513 x Number of incidents logged 35 x farm affected

Table 1 – properties reported affected by flooding

It is difficult to say how many individual properties were affected by the flooding during this event. A number of properties reported flooding a number of times and to multiple agencies. Further to this there are a number of restrictions in terms of the data collected and how authorities share it, which inevitably affects the information gathered. Nevertheless, the data from the information available is that internal property flooding was approximately 238 addresses within the Richmondshire district to various risk management authorities.

A high level mapping exercise of the affected properties has been undertaken to determine any spatial patterns and how these compare with the observed meteorological data. An indication of the location of those properties is given on the map in figures 14 and 15 – please note the map does not identify individual properties and the locations marked are indicative only.

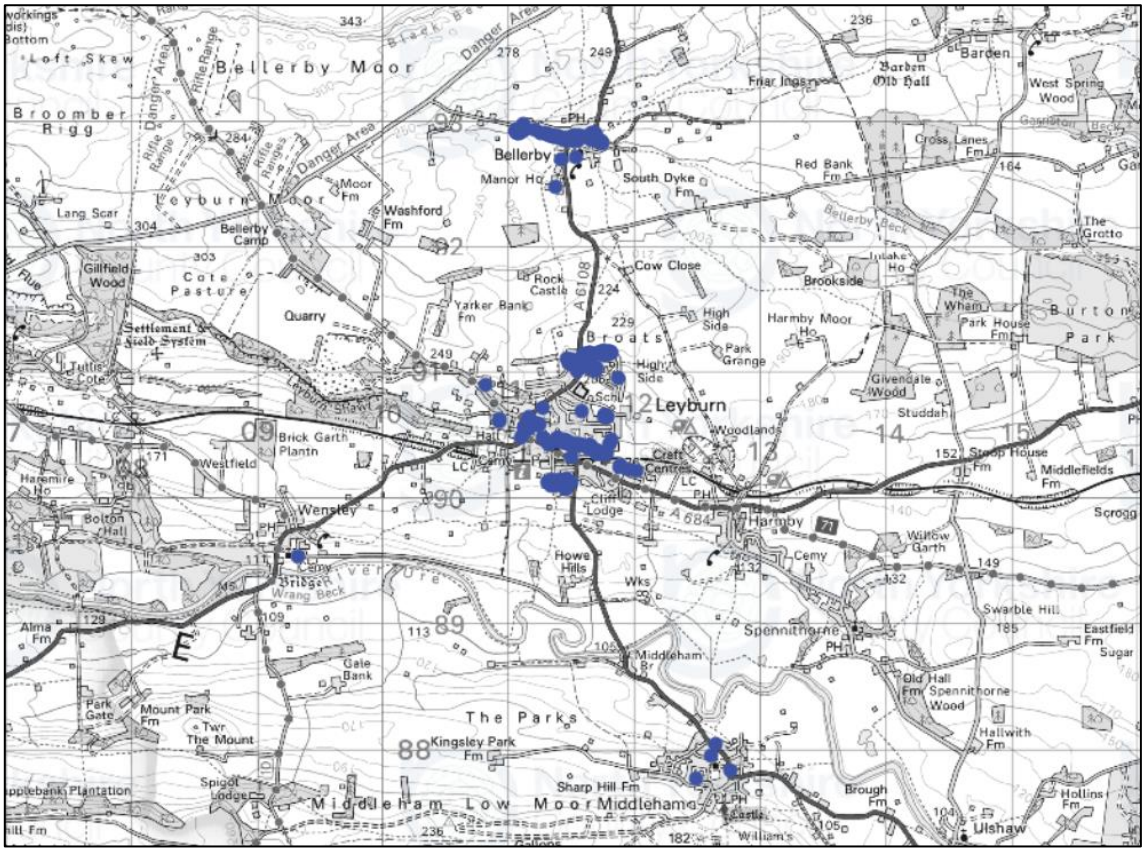

Figure 15 - Lebrun, Bellerby and Middleham Recorded Incidents

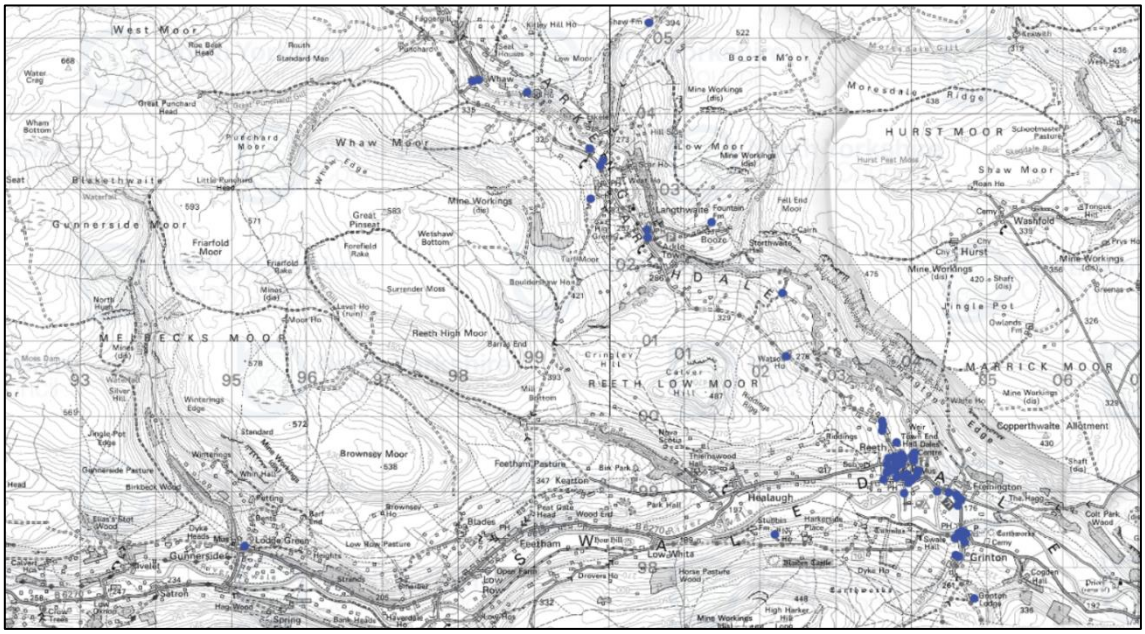

Figure 16 - Reeth and Arkengarthdale Recorded Incidents

The areas affected by flooding across the Upper Dales span a large geographic area. These range from properties in Arkengarthdale, Reeth, Grinton, Bellerby, Leyburn and other surrounding villages. As well as property level flooding there have been reports of structural damage as a result of the rainfall and flooding. The extent of the flooding was not only restricted to residential properties, it also affected commercial businesses, farming assets, roads and bridges. Emergency services responded to a variety of call-outs ranging from vehicles in floodwater to manning pumps. The list of the roads which were affected by the flooding includes:

B6270, Silver Street, Arkengarthdale Road, Whipperdale Bank, Moor road (Bellerby), Heron Tree Lane, A6108 in various locations, including between Leyburn and Bellerby, Mill Lane (Bellerby), Church Street, Runs Bank, Bellerby Road, Mount Drive, Dale Grove, I'Anson Close, Woodside, Maythorne, Richmond Road, Wensleydale Avenue, Brentwood, Bolton Way, Bishopdale Close, High Street, Moor Road (Leyburn), Wensley Road and Grove Square.

The flow routes from the event have been collated from confirmed reports by emergency services, NYFRS, Yorkshire Water and North Yorkshire Highways. A post-flood walkover was conducted by flood risk officers from the North Yorkshire Development Management Team alongside residents of the affected areas. There have also been social media posts containing flood footage, these give a good idea of the nature of the event. A number of areas can be identified throughout this short video, such as Grinton, Whipperdale Bank, Bellerby Road and Leyburn. The force and depth is notable throughout:
https://www.youtube.com/watch?v=ogWUFhNHh98

In addition to the damage caused by flood water, significant geomorphological changes occurred within the catchments in the form of the redistribution of sediment along the watercourses, particularly in Grinton Gill, Cogden Gill, Arkle Beck and its tributaries, and the various confluences of the minor watercourse with the River Swale. Significant erosion occurred in the upper catchments causing further land slips and re-routing of watercourses. As the storm passed and water levels receded, the watercourses' capacity to transport sediment was reduced and a significant amount of sediment accumulated within the channels. One of the worst affected areas was Grinton, where access tracks, outbuildings, retaining walls, and public sewers were all but destroyed. Between 1.5m and 2m depth of sediment was deposited within the channel through Grinton and down to the Swale confluence. Similar issues were experienced along Arkle Beck. On Cogden Gill, the erosion caused the collapse of two road bridges and left boulder strewn fields on the Swale valley floor.

[1] Environment Agency, Section 14 information request return.
[2] NYCC Resilience & Emergencies information request return.
[3] Sourced from the Met Office UK, July 2019 forecast.
[4] Environment Agency, Flood Hydrology Facts: Yorkshire Area Factsheet 27.
[5] NYCC Resilience & Emergencies information request return.
[6] The National River Flows Archive (NRFA) reports that July
[7] Environment Agency, Flood Hydrology Facts: Yorkshire Area Factsheet 29.

4.1 Likely causes of flooding

The observed rainfall on the 30th July 2019 was the one of the most intense rainfall event recorded in the United Kingdom and is as such considered an exceptional event. The observed flow routes have been assessed against the current understanding of flood risk, and meteorological data and analysis. Overall, there is a strong correlation between the observed flow routes and the current low risk 1 in 1,000 surface and fluvial flood risk mapping. This provides further confidence in the hydrological analysis undertaken by the Met Office and Environment Agency.

North Yorkshire is drained by an extensive network of ordinary watercourses that are not classified as main rivers. They generally follow natural and historic drainage routes and range from being well-known and named becks, to underground networks of culverts and pipes which may have evolved over centuries, and for which there may be little or no record.

Landowners, be they individuals or organisations, are responsible for the upkeep of all watercourses and for maintaining the flow in them, as riparian owner (see Section 4.2.5). As many watercourses have however been culverted or piped in the past, landowners may not be aware of their existence until a problem occurs. Lack of maintenance leading to blockages and collapse can pose a significant flood risk resulting in surcharge, overland flow and surface collapse.

The condition of the open ordinary watercourses have been assessed during walkover surveys and were found to generally be in good condition with no significant obstructions noted. Given the topography, the watercourses tend to be fast flowing with self-cleansing and erosive velocities. The presence of vegetated channel beds, particularly in the mill race through Bellerby is an indication of bed stability with little or no change to the bed levels in recent time. It was noted on many occasions however that historically, there has been a significant build-up of sediment in the mill race in Bellerby. It was alleged, that in the past (circa 50 years ago) work parties would be organised from the Cross Keys Inn to periodically dig out any accumulated silt.

Subsequent to the event, CCTV drainage surveys have been undertaken in Bellerby and Leyburn (Reeth to commence February 2020) to assess the condition of the infrastructure. It was not possible to survey the culverts in Bellerby due to the flow in the watercourses being too high following rainfall throughout the months following the event.

The culvert that carries watercourse A in Leyburn was found to be in good operational order with no defects found that would limit its capacity. The configuration of the drainage in this area is however complex, and it appears that many attempts have been undertaken to alleviate the historic flooding issues by providing addition pipes and overflows. Given the extent and historical references to flooding experienced in the vicinity of watercourse A, it is recommended that further studies are undertaken to ascertain the capacity of the network.

Where the watercourses flow through historic culverts, in particular the culverted watercourse B as referenced in Figure 2 due to the old stone construction and the current water levels in the watercourses, the surveys had to be abandoned, and the condition remains unknown. Dye testing and observed flows have however indicated that the culverts are flowing freely.

There have been no defects reported during this investigation on the public sewer network, however it has been noted from site visits with residents that overflowing sewerage was observed at the Brentwood Foul Pumping Station, Leyburn. Yorkshire Water confirmed on site that the foul pumping station has sufficient capacity to deal with the foul loading for the areas served, however surface water can enter the foul drainage network through cross connections of private surface water, infiltration of surface and ground into the sewers or manholes and surface water inundation when manhole covers are submerged under surface water. It is unlikely that surface water flows could be completely eradicated from the foul sewer network in such a flood event due to the inevitable interaction.

Notwithstanding this, upon visually inspecting the drainage systems and through anecdotal evidence from the residents, it has been discovered that a significant amount of debris trapped in the culvert under The Olde Wynd (or School Lane as shown on OS Mastermap). Most likely due to a clay pipe running through the culvert. The blockage against the pipe will have undoubtedly exacerbated the flooding in the vicinity and downstream of The Olde Wynd, in Bellerby.

In Arkengarthdale, Arkle Beck reached its highest ever recorded level. The primary cause of flooding along Arkengarthdale was fluvial flooding.

Dramatic images were broadcast of significant flooding in High and Low Fremington. This observed data indicates that the flooding was a combination of both fluvial flooding from Arkle Beck and surface water flooding from the hills above. A review of the rolling ball analysis (which demonstrates how water would track along the given topography) for the area clearly shows the track of flows from the valley sides. The topography prevents flows from reaching Arkle Beck and directs the flow towards High Fremington as shown in Figure 17). It is also apparent that flows from Arkle Beck combined with the overland flow routes to contribute to the flooding in Fremington.

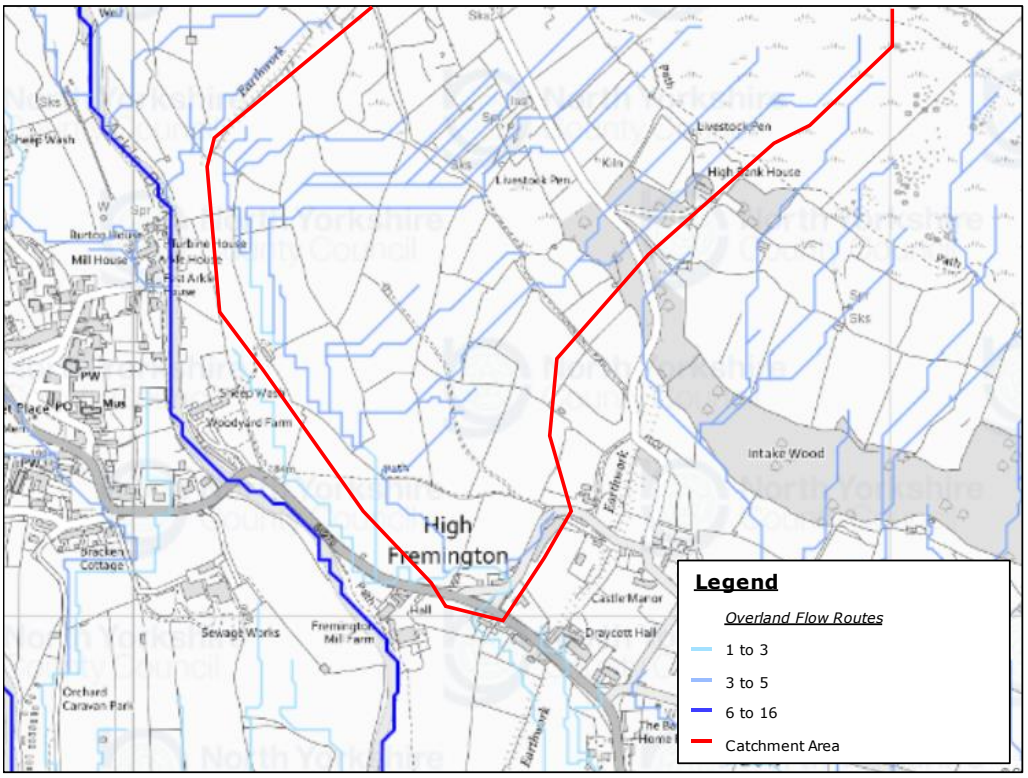

Figure 17 - High and Low Fremington Overland Flow Route Analysis

In Grinton, a significant amount of debris was deposited within the channel, resulting in a reduced capacity. It is apparent from the YouTube video reference in section 4, that this led to some overtopping of the channel, particularly in the village green area. This resulted in additional water flowing down the road to the centre of the village.

In addition to the observed flow routes, there are many recorded incidents, particularly on Dale Grove in Leyburn and hillside farms and properties in Swaledale, of flooding from sheet runoff directly from the moorland and agricultural land. Sometimes referred to as overland sheet flow or pluvial flooding, overland flow flooding is characterised by water flowing over the ground surface where there is no drainage system to accept it. It is caused when the intensity of rainfall exceeds the infiltration capacity of the surface onto which it falls or when the soil is saturated and cannot accept more water. The infiltration capacity of soils can be influenced by a number of factors including and antecedent soil conditions such as saturated soils from previous wet weather or conversely from periods of long dry weather. During the summer months, soil can become dry and then hardens, reducing the potential for water to infiltrate into the ground. Antecedent soil conditions can also be influenced by land use.

The shallow and exposed areas of bedrock, will undoubtedly have limited the infiltration capacity of the soil and will have resulted in increased runoff, however this is a naturally occurring feature of the in the Dales, characterised by the number of springs and watercourses.

Where there are drainage systems present, particularly historic highway drainage systems, these are designed to cope with the rain which falls on the highway only, with typically design affording a capacity which will convey rainfall events up to the 1 in 30-year scale. Similarly, the public sewer network is designed to contain up to the 1 in 30-year level of rainfall event. Rainfall in excess of this will inevitably overwhelm the system, and with rainfall at a rate over a 1 in 1000-year event the capacity of any drainage network would be greatly exceeded.

New drainage systems on proposed development site and any flood alleviation scheme (local or national) are generally designed to a standard of 1 in 100 with freeboard allowances for climate change. During the event of 30th July 2019, any new drainage system of flood alleviation scheme would have been significantly overwhelmed and it would therefore not be possible to prevent flooding from such scale of an event.

Two minor defects were identified within the public highways drainage network in Leyburn[4] however the defects had not completely blocked the drainage systems (only to such an extent that the camera crawler could not pass the defect). It cannot be ascertained whether these defects were present before the event or were caused during the event. Notwithstanding this, the intensity of the rainfall would have far exceeded the capacity of the highway gullies, meaning that the flood water was flowing across the surface rather than through the network. The defects are therefore not considered to have been a material cause of the flooding. Similarly, although reports of blocked highway gullies were received by North Yorkshire County Council Highways, it is not clear whether the gullies were blocked before the event, or became blocked during it.

4.2 Flood incident response - risk management functions undertaken

The response to any flooding incident is initially conducted by the Emergency Services under the Civil Contingencies Act 2004. Other than the Environment Agency the other Risk Management Authorities, have reactive duties and powers bestowed under the Flood and Water Management Act 2010. The immediate response to the incident by emergency services, the Environment Agency and NYCC Emergencies and Resilience team will be de-briefed and reviewed separately to this Section 19 report. The requirement of the section 19 report is to is to reflect on the responsibilities of each Risk Management Authority and assesses whether each authority has undertaken the statutory duties leading up to the event, during and after in accordance with the Flood and Water Management Act 2010 (see Appendix 6.1). In accordance with Section 19 of the FMWA, the LLFA has identified the following as Risk Management Authorities with actions and responsibilities in relation to the Flooding on 30th July 2019:

- The Environment Agency
- North Yorkshire County Council as Lead Local Flood Authority and Local Highway Authority
- Richmondshire District Council

[4] Yorkshire Water & NYCC Highways Section 14 information request return.

- Yorkshire Water

4.2.1 Environment Agency –

Under the FWMA the Environment Agency (EA) has a strategic overview role for all sources of flooding as well as an operational role in managing flood risk from Main Rivers, reservoirs and the sea. As part of this role the EA has developed a National Flood and Coastal Erosion Risk Management Strategy for England – 'Understanding the Risks, Empowering Communities, Building Resilience.'

This national strategy outlines the EA's strategic functions as:

- Ensuring that flood risk management plans (FRMPs) are in place and are monitored to assess progress. The plans will set out high-level current and future risk management measures across the catchment. Swaledale and Wensleydale fall into the Humber district flood risk management plan (FRMP) area. The plan can be viewed on line here: https://www.gov.uk/government/publications/humber-river-basin-district-flood-risk-management-plan
- Publishing and regularly updating its programme for implementing new risk management schemes and maintaining existing assets.

The latest statement updated September 2019 can be viewed here:
https://www.gov.uk/government/collections/funding-for-flood-and-coastal-erosion

- Supporting Risk Management Authorities' understanding of local flood risk by commissioning studies and sharing information and data.
- Supporting the development of local plans and ensuring their consistency with strategic plans.
- Managing and supporting Regional Flood and Coastal Committees and allocating funding.

The source of flooding has been determined to be from local sources as defined in Section 4.1 and not from Main Rivers, Reservoirs or the Sea. Other than the EA's duty as a category 1 responder regarding flood risk (Civil Contingencies Act 2004 – It is required to warn and inform of flood risk), the EA was therefore not duty bound to exercise its operational responsibilities during the flood event. However, the EA did undertake the following Key actions:

- The Flood Warning was issued at 17:16 on 30/07/2019 for Arkle Beck.
- Flood alerts were issued for 122WAF936 Upper River Swale.
- As the flooding did not emanate from Main Rivers such as the Swale and Ure, and given the rapid onset of flooding, the Environment Agency did not send a response on the ground on the 30th July 2019, although EA staff were liaising with the emergency services throughout.
- EA staff attended various community meetings including drop in session in Leyburn and Reeth providing advice on post-incident clean up and disposal of contaminated waste.
- Removal of debris on the Swale/Grinton Beck confluence with c. 50 loads of material removed from the River Swale and stored locally for re-use. Working closely with NYCC and RDC.

The EA will continue with its programme of inspections. There are currently no proposals to undertake any works around the Upper Dales area.

In light of the above, it is considered that the EA has and will continue to undertake its duties in accordance with the FWMA 2010.

4.2.2 North Yorkshire County Council

The Development Management Team which undertakes the LLFA function for the council is not a category responder and instead provides the strategic view on flood risk management activities within the county. The flood risk management functions set out in the FWMA 2010 include (but are not limited to);

- Provision of a Local Flood Risk Management Strategy (LFRMS).

The Local Flood Risk Management Strategy was published in 2015. The strategy sets out how the authority will manage local sources of flood risk within its administrative boundary. This plan focuses on the development of action to meet the six North Yorkshire Flood Risk Management priority objectives:

1. Promoting a greater role for communities in managing flood risk
2. Improved knowledge and understanding of flood risk and management responsibilities for all stakeholders, communities and the media
3. Sustainable and appropriate development
4. Improved knowledge of watercourse networks and drainage infrastructure
5. Flood risk management measures that deliver social, economic and environmental benefits
6. Best use of all potential funding opportunities to deliver flood risk management measures

In addition to the duties and the responsibilities in the FWMA 2010, the conclusions and recommendations of this report will be based upon the local Flood Risk Management Strategy objectives.

- Designation and maintenance of a register of structures or features that have a significant effect on flood risk.

It is recognised in NYCCs strategy that identifying these features and drainage networks is a huge task that presents significant practical challenges and significant potential costs. Nevertheless, in areas where the flood risk is significant, the location and mapping of critical assets has a great potential for assisting in the management of flood risk by highlighting those risks and facilitating preventative actions. NYCC as LLFA intend to take a systematic, risk based approach to this task, identifying those areas of greatest risk and working with riparian owners and local communities to manage that risk. This will be supported by the gathering of information on the recent flooding event in July and the continual development of the Asset Register (see section 5.3). As discussed in Section 4.1, the surveying and mapping of these features in the aftermath of the July 2019 has already begun.

- Consenting and enforcement works on Ordinary Watercourses.

Using powers under the Flood and Water Management Act, the LLFA worked with RDC to facilitate the removal of circa 1,000m^3 of gravel from Grinton Gill following the significant deposition of material on behalf of the riparian owners. The LLFA also provided advice to Arkengarthdale Parish Council on similar works independent required on Arkle Beck.

Staff members from the Development Management Team attended various drop-in session and circulated contact details for the team in order to provide advice on maintenance work and remedial works on ordinary watercourses.

The events caused significant damage to river and watercourse banks and have led to substantial remediation works across the impacted area. The LLFA has continued to provide advice to landowners and their agents on the consenting process and the undertaking of works in ordinary watercourses in the months following the event.

- Responding to statutory consultations on drainage proposals in planning applications.
- Undertaking Section 19 investigations.

NYCC also has responsibilities as a Highways Authority and as an Emergency Responder (under the Land Drainage Act 1991 and the Civil Contingencies Act 2004 respectively) which may relate to flooding.

Highway Authorities are responsible for providing and managing highway drainage which may include provision of roadside drains and ditches, and must ensure that road projects do not increase flood risk.

The Highways Authority has a duty under the Highways Act 1980 to maintain highways that are maintainable at public expense. This includes a duty to maintain existing highways drainage. Highway drainage systems are designed to take highway surface water. Highway drainage systems are not designed as "storm drains", and do not have the capacity for the level of rainfall from an extreme flash flood. The Highway Authority has powers to improve drainage systems but no duty to do so.

It is confirmed that NYCC in its capacity as highway authority has undertaken the following specific activities:

- Assisted in the emergency response to the event.
- Co-ordination of road closures and diversions
- Undertook emergency repairs to damaged road and bridges.
- Undertook additional maintenance activities such as jetting and repair of gully pots post flood event.

In light of the above, the report concludes that NYCC in its capacity as LLFA and LHA has and will continue to undertake its duties in accordance with the FWMA 2010.

4.2.3 Richmondshire District Council

District and Borough Councils are named as Risk Management Authorities within the Flood and Water Management Act 2010, and are required to comply with the LLFA Local Strategy. Through the planning processes, they control development in their area, ensuring that flood risks are effectively managed.

In addition, in relation to the Civil Contingency Act (2004), the District Council:

- Is a Category 1 Responder
- On a priority basis, will provide sandbags to residents and businesses where property is at risk of flooding.
- Support the Emergency Services on request by providing Incident Liaison Officers.
- Provide emergency accommodation – i.e. set up rest centres as required and other welfare provision.
- Assist with arranging transport or evacuating areas.
- Participate in vulnerable people searches.
- Lead with co-ordination of recovery.

In addition to the roles and responsibilities set out above, Richmondshire District Council also undertook the following Key actions

- provision of sandbags and skips (both for residential household furniture etc. and silt clearance)
- dealt with emergency housing requests and referrals to adult social services
- undertook house to house visits to ensure residents had access to services
- provision of supplies to the Reeth and Bellerby hub
- providing financial support for the park and ride transport to Reeth Show
- organising the provision of hot meals for residents without access to facilities in their own homes.
- Led teams of volunteers
- Hosted conferences for partner agencies and liaising with other district councils for support/knowledge sharing.

- Provided council tax discount to those people and businesses affected by the flooding for up to 12 months to enable recovery.
- Provided presence, giving guidance and direction at the Reeth and Bellerby Hubs.
- Set up databases of necessary actions and followed through the delivery of these.
- Organised the removal of contaminated silt.
- Organised and liaised with Team Rubicon (volunteer organisation) who were critical in supporting residents to clear and return to damaged properties.
- Handled the submission of the Bellwin claim and supporting documentation to recover funded costs.

The NYCC Resilience & Emergencies Unit provides support to the District Council.

4.2.4 Yorkshire Water

Water companies in England and Wales are named as a Risk Management Authority under the Flood and Water Management Act 2010 and must have regard to the Local Strategy of the LLFA. They are required to manage risks associated with assets or processes that may cause or be affected by flooding, and must share relevant data with other flood risk authorities.

They also have flood risk management functions under the Water Resources Act (1991). Relevant actions of water companies include: the inspection, maintenance, repair and any works to their drainage assets which may include watercourses, pipes, ditches or other infrastructure such as pumping stations.

The Civil Contingencies Act 2004 (CCA) also designates water and wastewater undertakers as statutory category 2 responders to national disasters and emergencies, placing on them duties to share assured information with other responders in an appropriate manner.

In addition to the roles and responsibilities set out above, Yorkshire Water also undertook the following Key actions:

- Asset inspections to identify any defects after the incident on both the public sewer network and above ground assets.
- Reconnected private clean water supply pipes where these had been damaged and/or washed away during the event
- Reconnected/mitigated the public sewer network where it had been damaged during the event (approximately 60-80 meters was washed away).
- Carried out reinstatement to a collapsed length of sewer in Reeth which had created a small sink hole in the heavy rain
- Mitigated impact to waste water treatment sites where these were damaged by the intense rainfall.

4.2.5 Responsibilities of Riparian Land Owners and Individual Property Owners

It is critically important that the extent and nature of each organisation's role in flood risk management is understood and appreciated by the communities and individual residents affected by flooding. It is equally important that we set out the roles that others, including riparian owners, are required to play.

Landowners whose land is adjacent to a watercourse are known as 'riparian owners'.

A landowner can be an individual e.g. home owner or farmer, private business or an organisation e.g. the District Council as park owner, on school grounds the county council as property owner.

A watercourse is defined as every river, stream, ditch, drain, cut, dyke, sluice, sewer (other than a public sewer) and feature through which water flows, but which does not form part of a Main River.

Riparian owners have legal duties, rights and responsibilities under common law and the Land Drainage Act 1991 for watercourses passing through or adjoining their land. These responsibilities are to:

- Pass on the flow of water without obstruction, pollution or diversion affecting the rights of others.
- Accept flood flows through their land, even if these are caused by inadequate capacity downstream.
- Maintain the banks and bed of the watercourse and keep structures maintained.
- Keep the bed and banks free from any artificial obstructions that may affect the flow of water including clearing litter, heavy siltation or excessive vegetation.

Guidance on the rights and responsibilities of riparian ownership are outlined in the Environment Agency publication 'Living on the edge', available at:

http://www.environment-agency.gov.uk/homeandleisure/floods/31626.aspx

5 Summary of impacts & findings

The flooding on the 30th July 2019 was one of the most intense and destructive events in recent memory. Given the vast, isolated area that was affected the true impacts of the flooding will not be known for some time, if at all.

Storm water will find and flow along the easier flow routes, often the road network and will pond in low points in the topography. Historically this kind of flooding has been associated more with urban areas where there are greater areas of impermeable surface. Investigations into recent flooding events in the county have however indicated that surface water runoff is an increasing issue in rural areas.

Richmondshire District Council has noted that responding to the flooding event was initially coordinated by North Yorkshire Police, as is standard. The fire and rescue service also received a significant number of calls primarily from the Leyburn, Bellerby, Reeth, Langthwaite, Fremington and Grinton areas. Due to the greater population density and the number of calls received, initial thoughts were that the Leyburn and Bellerby areas had been more affected than the Swaledale area. As the incident developed it became clear that there was widespread devastation to people, their properties and livestock over a very rural area, some of whom had called the emergency services and others that had dealt with the impact themselves.

Significant damage was caused to residential and commercial properties. Whilst the true value of damages is difficult to calculate, an industry standard estimate would value flood damages for residential properties within a range of £30k per property upwards. With up to 238 reported internal flooding, the cost to insurance companies alone could be in the region £7.14milion. This does not include the cost to businesses and farmers.

Yorkshire Water undertook emergency repairs to the foul sewer systems where they had been exposed and washed away by the erosive nature of the flooding.

The erosive nature of the event was particularly visible with significant structural risk to property reported in the Swaledale Area, with significant loss of access tracks, undermining of property foundations and watercourses changing their courses entirely.

Following the incident immediate critical emergency repairs were undertaken on the B6270 between Grinton and Richmond to repair a land slide which had washed away part of the road and to replace the bridge over Cogden Gill with a temporary structure. Further emergency repairs were undertaken on Cogden Gill on Grinton Moor where the listed bridge was completely washed away, isolating Swaledale from Leyburn as the nearest town. These repairs were all undertaken by NYCC in its capacity as Highway Authority, to ensure the safety of the road network. A short synopsis of the impacts is presented in the following video.
https://www.youtube.com/watch?v=H9STAkQkE5g

In Grinton circa 1,800 tonnes of gravel was extracted from Grinton Gill and its confluence with the River Swale in order to alleviate the immediate raised danger of repeated flooding in the village. The cost to remove the material from the Gill alone, excluding the confluence was circa £60,000. This work was undertaken in partnership with the Environment Agency RDC and NYCC with assistance from Swale and Ure Drainage Board.

Infrastructure was damaged and vital services were affected, notably the Fire Station in Leyburn. At least 238 individual properties reported flooding though the actual numbers of properties which did flood internally have not been verified. There are particular locations where these were concentrated on which this report concentrates.

Courtesy of local NFU representatives, the following impacts on the rural communities and agricultural sector were recorded.

- Miles of damage to stone walls and fences, meaning little stock-proof areas across holdings and major disruption to businesses for extended periods
    - This also has meant a massive recovery operation which will last over the next few years to re-build and re-instate.
- Acres of land submerged in debris and stone, leading again to major remediation work to bring pasture back in to productivity over the next few years.
- Becks re-coursed through fields, farm yards and buildings, again taking lots of remediation efforts to re-instate these on their original courses and clean-up masses of debris left behind after the event
- Becks were further silted up increasing the risk of further flooding to land and businesses, and further responsibilities and costs for the landowner/farmers to undertake riparian works.
- Buildings engulfed in water with equipment ruined, or swept away.
- Many farmhouses were heavily affected from flood waters and remediation works are still on-going.
- Livestock were swept away and killed (around 100 animals known)
- Crucial access tracks were destroyed isolating farms from communities
    - This is alongside many PROWs, bridges and footbridges which were destroyed, many of which double up as key agricultural accesses
- Forage already harvested and that ready for harvesting was completely ruined for most affected farmers meaning a double impact of the loss of winter feed and having to dispose of the forage as waste.
- Environmental work on the land were affected
- Water gates swept away

The figures are estimates recorded from farmers at the time of the flooding event, so are again unlikely to show the true extent of the damage, especially with some farmers giving estimates and some of those choosing not to.

A poignant quotation from the NFU is that *"This is an overview but many more farming families felt impacts beyond this, and now are trying to pick up the pieces. Insurance has covered costs where possible, with charities helping support alongside the announcement of the Farming Recovery Fund to help affected farmers following intense NFU lobbying. However, many farmers will incur costs beyond the financial support available, one quoting costs incurred at £38,000 already. Many farmers are still dealing with the disruption to business they have suffered alongside the mental strain many have endured watching their livelihoods washed away, alongside treasured family pets and livestock killed. We can't forget that these farms are people's family homes and have been for hundreds of years so are steeped in history. We continue to support our members where we can, and the council's immediate reaction alongside other key organisations in the area has been crucial to mitigating impacts, but as you would expect, the recovery for farming businesses in areas affected will last for many years to come."*

Some of the impacts on the farming community have also been captured by an interview on Farmers Weekly and North Yorkshire County Council Youtube channels :https://www.youtube.com/watch?v=Kd93rlRtgsU and https://www.youtube.com/watch?v=DvJz5WaHAnw

Whilst there is no definitive measure, it is clear from the work carried out by all agencies and representatives of the communities that the there is much more to consider than just the physical and economic impacts of the flooding and that we must recognise that many of the people affected by the flooding have also required humanitarian aid and health and wellbeing support including mental health support, provided by the various charities and NYCCs Major Incident Response Team.

5.1 Conclusions

The flooding on 30th July was caused by a torrential downpour which saw a month and a half's worth of rain fall in a very short time. Whilst a weather warning had been issued for intense thunderstorms, the storm was not forecast or predicted to be as intense for such a duration of time. The fact that the event was not predicted, that no warnings were issued, other than for Arkle Beck and the rapid onset of the flooding all meant that there was no time for a co-ordinated response. Forecasting and warning technology is developing all the time and there may be new technologies or methods which could be of assistance.

The rainfall experienced falling on what have already been recognised as rapid response catchments greatly exceeded the capacity of the watercourse and drainage network to convey it. The observed flood extents correlate with the predicted flood modelling for the 1 in 1,000-year event. If climate change predictions are accurate undoubtedly more of these intense, short duration, summer storms will be experienced.

Other than the blockage reported in Bellerby, no other blockages were reported. The assessment of risk, coupled with the frequency of historic flooding does raise areas of particular concern, such as Mount Drive/Bellerby Road, Leyburn and Bellerby as a whole. Drainage systems will have been built to a water industry standard capacity which means it should be able to cope with up to a 1 in 30-year rainfall event. The rainfall event which occurred was in excess of a 1 in 1,000-year event.

Upgrading Leyburn and Bellerby drainage systems so that they have sufficient capacity to cope with these types of events would require changes in national policy and legislation, and huge levels of investment, along with major on-going disruption while the work was undertaken. Further to this it is worth noting that oversizing drainage networks increases blockage issues due to lower velocities in the network. It is not realistic at this time to expect drainage infrastructure to be upgraded to a capacity sufficient to cope with this level of event.

Identifying these networks is a huge task that presents significant practical challenges and significant potential costs. Nonetheless, in areas where the flood risk is significant, the location and mapping of critical assets has a great potential for assisting in the management of flood risk by highlighting those risks and facilitating preventative actions. NYCC as LLFA intend to take a systematic, risk based approach to this task, identifying those areas of greatest risk and working with riparian owners and local communities to manage that risk. This will be supported by the gathering of information on local flood risk incidents and the development of the Asset Register (see section 5.3).

In Bellerby better protection from blockages could be afforded to the various culverts in the form of new trash screens, or the improvement of existing screens. The culvert inlets are located on land within various ownership, which can complicate responsibilities for maintenance. The LLFA would have to work with communities to ensure maintenance responsibilities and regimes are established at the outset, with responsibility for regular inspections also agreed with those responsible.

Whilst there is a long history for flooding within the study area, the records are sparse and the LLFA has had to depend on anecdotal evidence from residents and various media sources in order to inform the understanding of risk. Since the formation of the LLFA in 2012, its strategy aims to improve the recording of incident data to improve the understanding of risk across the county. The information collated during and after the event provides a strong evidence base in order to inform the publication of this report and now serves as a definitive record of the event. Section 19 reports can also serve as platform for future work and investment in the affected areas.

Whilst there is a significant improvement in the way the information is collated, it is evident from the responses received to the Section 14 requests that more work needs to be done. The LFRMS aims to develop clear protocols and processes for the assessment and investigation of flooding incidents, embedding them in the authority and refining data capture protocols and processes for capture and strategic analysis of flood incident data.

It is critical during a flood event that clear and accurate information is provided to the decision makers. The County Council in partnership with the District Council have already started work on a prototype system that will help decision makers react and respond to flooding.

Furthermore, the County Council is also assisting Defra with its boosting surface water action forecasting system.

5.2 Recommendations

The following recommendations are made following the findings of this report:

1. The LLFA to work with NYCC Resilience & Emergencies and the Environment Agency to support the work of Defra and ICASP (Yorkshire Integrated Catchment Solutions Programme) to investigate any relevant developing technologies in short term forecasting, and surface water risk warning, particularly in relation to other identified “rapid response” catchments with the aim of improving forecasting of intense, localised storms.

2. LLFA with the assistance of NYCC Highways and the Local Parish Councils should continue to undertake further investigations into the condition of assets associated with ordinary watercourses. Blockage consequence modelling and condition surveys should be carried out on screens and culverts associated with ordinary watercourses, with the intention of informing a program of improvement and maintenance.

3. LLFA and other partner organisations to work together to identify opportunities to hold back water in attenuation areas during extreme rainfall. Locations where this could be viable include Bellerby and Leyburn. The potential costs and benefits of this approach should be explored so as to inform any future proportionate requests for regional or national funding.

4. The LLFA will continue to support Natural Flood Risk Management, and work with communities and land owners to implement natural measures of reducing flood risk from surface water runoff.

5. LLFA to make an assessment of the potential for property level resilience in areas where multiple properties are at risk from repeated events. In particular key services such as the Fire Station should be made resilient to flooding.

6 Appendices

6.1 Rights & responsibilities (authorities and landowners)

Environment Agency

Under the FWMA the Environment Agency (EA) has a strategic overview role for all sources of flooding as well as an operational role in managing flood risk from Main Rivers, reservoirs and the sea. As part of this role the EA has developed a National Flood and Coastal Erosion Risk Management Strategy for England – 'Understanding the Risks, Empowering Communities, Building Resilience.'

This national strategy outlines the EA's strategic functions as:

- Ensuring that flood risk management plans (FRMPs) are in place and are monitored to assess progress. The plans will set out high-level current and future risk management measures across the catchment.
- Publishing and regularly updating its programme for implementing new risk management schemes and maintaining existing assets.
- Supporting Risk Management Authorities' understanding of local flood risk by commissioning studies and sharing information and data.
- Supporting the development of local plans and ensuring their consistency with strategic plans.
- Managing and supporting Regional Flood and Coastal Committees and allocating funding.

The EA's operational functions are/include:

- Risk-based management of flooding from main rivers including permissive powers to do works including building flood defences.
- Regulation of works in main rivers through the consenting process.
- Regulation of reservoirs with a capacity exceeding 10,000m3.
- Working with the Met Office to provided severe weather warnings – available to Risk Management Authorities.
- Provide warning of flooding on main rivers.
- The maintenance and operational management of main river assets including flood defences.
- Statutory consul-tee to the development planning process.
- The power to serve notice on any person or body requiring them to carry out necessary works to maintain the flow in main rivers.

'Main Rivers' are defined through an agreed map which is updated annually. These tend to be the larger rivers in the country, though some smaller watercourses in sensitive locations are also defined as 'Main Rivers'.

The EA are also category 1 responders regarding flood risk (Civil Contingencies Act 2004). They are required to warn and inform of flood risk.

Water Company

Water companies in England and Wales are named as a Risk Management Authority under the Flood and Water Management Act 2010 and must have regard to the Local Strategy of the LLFA. They are required to manage risks associated with assets or processes that may cause or be affected by flooding, and must share relevant data with other flood risk authorities.

They also have flood risk management functions under the Water Resources Act (1991). Relevant actions of water companies include: the inspection, maintenance, repair and any works to their drainage assets which may include watercourses, pipes, ditches or other infrastructure such as pumping stations.

The Civil Contingencies Act 2004 (CCA) also designates water and wastewater undertakers as statutory category 2 responders to national disasters and emergencies, placing on them duties to share assured information with other responders in an appropriate manner.

North Yorkshire County Council (NYCC)

NYCC, as Lead Local Flood Authority, has flood risk management functions which include (but are not limited to);

- Provision of a Local Flood Risk Management Strategy (LFRMS).
- Designation and maintenance of a register of structures or features that have a significant effect on flood risk.
- Consenting and enforcement works on Ordinary Watercourses.
- Responding to statutory consultations on drainage proposals in planning applications.
- Undertaking Section 19 investigations.

NYCC also has responsibilities as a Highways Authority and as an Emergency Responder (under the Land Drainage Act 1991 and the Civil Contingencies Act 2004 respectively) which may relate to flooding.

Highway Authorities are responsible for providing and managing highway drainage which may include provision of roadside drains and ditches, and must ensure that road projects do not increase flood risk.

The Highways Authority has a duty under the Highways Act 1980 to maintain highways that are maintainable at public expense. This includes a duty to maintain existing highways drainage. Highway drainage systems are designed to take highway surface water. Highway drainage systems are not designed as "storm drains", and do not have the capacity for the level of rainfall from an extreme flash flood. The Highway Authority has powers to improve drainage systems but no duty to do so.

Roadside gullies are subject to routine maintenance in accordance with the NYCC Highway Asset Management Plan. The frequency of cleaning is dependent on an evidence based categorisation of risk, determined by factors relating to the consequence of failure and a range of other operational factors. NYCC are investigating drainage improvements in critical locations with a history of flooding.

District or Borough Council

District and Borough Councils are named as Risk Management Authorities within the Flood and Water Management Act 2010, and are required to comply with the LLFA Local Strategy. Through the planning processes, they control development in their area, ensuring that flood risks are effectively managed.

In addition, in relation to the Civil Contingency Act (2004), the District and Borough Council:

- Are a Category 1 Responder. On a priority basis, they will provide sandbags to residents and businesses where property is at risk of flooding.
- Support the Emergency Services on request by providing Incident Liaison Officers.
- Provide emergency accommodation – i.e. set up rest centres as required and other welfare provision.
- Assist with arranging transport or evacuating areas.
- Participate in vulnerable people searches.
- Assist with co-ordination of recovery.

The NYCC Resilience & Emergencies Unit provides support to the District Council.

Internal Drainage Board

Internal Drainage Boards (IDBs) are local operating authorities established in areas of special drainage need (typically low lying areas) in England and Wales.

IDBs have permissive powers to undertake works to secure clean water drainage and water level management in designated drainage districts. In managing water levels IDBs have an important role in reducing flood risk in areas beyond their administrative boundary.

All Risk Management Authorities

All RMAs under the Flood and Water Management Act (2010) have a responsibility to cooperate and coordinate with regards to their flood risk management functions, including raising awareness of flood risk and the sharing of information.

Riparian Owners

Landowners whose land is adjacent to a watercourse are known as ‘riparian owners’.

A landowner can be an individual e.g. home owner or farmer, private business or an organisation e.g. the district council as park owner, on school grounds the county council as property owner.

A watercourse is defined as every river, stream, ditch, drain, cut, dyke, sluice, sewer (other than a public sewer) and feature through which water flows, but which does not form part of a Main River.

Riparian owners have legal duties, rights and responsibilities under common law and the Land Drainage Act 1991 for watercourses passing through or adjoining their land. These responsibilities are to:

- Pass on the flow of water without obstruction, pollution or diversion affecting the rights of others.

- Accept flood flows through their land, even if these are caused by inadequate capacity downstream.
- Maintain the banks and bed of the watercourse and keep structures maintained.
- Keep the bed and banks free from any artificial obstructions that may affect the flow of water including clearing litter, heavy siltation or excessive vegetation.

Guidance on the rights and responsibilities of riparian ownership are outlined in the Environment Agency publication 'Living on the edge', available at:

http://www.environment-agency.gov.uk/homeandleisure/floods/31626.aspx

6.2 Useful contacts & links

Flood Forecasting Centre

The Flood Forecasting Centre (FFC) is a partnership between the Environment Agency and the Met Office, combining our meteorology and hydrology expertise into a specialised hydrometeorology service. The centre forecasts for all natural forms of flooding - river, surface water, tidal/coastal and groundwater.

ffc-environment-agency.metoffice.gov.uk/

Online Flood Risk Mapping

This service uses computer models to assess an area's long term flood risk from rivers, the sea, surface water and some groundwater.

https://flood-warning-information.service.gov.uk/long-term-flood-risk/map

National Flood Forum

A charity to help, support and represent people at risk of flooding.

https://nationalfloodforum.org.uk/

North Yorkshire Local Resilience Forum

NYLRF is a partnership of local agencies working together to prepare for, respond to and recover from potential major incidents and emergencies via the duties stated in the Civil Contingencies Act 2004 (CCA).

http://www.emergencynorthyorks.gov.uk/

NYCC Resilience & Emergencies Unit

The resilience and emergencies unit is responsible for planning for a wide variety of potential incidents and emergencies that could affect the population of North Yorkshire.

northyorks.gov.uk/resilience-and-emergencies-unit

NYCC Flood & Water Management

As lead local flood authority, we investigate and assess flood risks, including flooding from surface water, groundwater and existing watercourses. We work with partners involved in flood and water management to protect communities from the impact of flooding.

https://www.northyorks.gov.uk/flood-and-water-management

NYCC Major Incident Response Team (MIRT)

For the management of evacuation centres and the ongoing emotional recovery of resident post incident.

MIRT@northyorks.gov.uk