Kendal

Flood Investigation Report

Sandylands and Mintsfeet on the 6th December 2015

Flood Event 5-6th December 2015

This flood investigation report has been produced by the Environment Agency as a key Risk Management Authority under Section 19 of the Flood and Water Management Act 2010, in partnership with Cumbria County Council as Lead Local Flood Authority.

Version	Prepared by	Reviewed by	Approved by	Date
v1.0 Working Draft for discussion	David Webborn	Jonathan Coates, EA David Snaith, EA Nathan Insole, EA Elizabeth Kelly, EA Andy Knipe, EA Tom McCormick, SLDC		27th May 2016
v2.0 Incorporating first draft comments	David Webborn	Jonathan Coates, EA Elizabeth Kelly, EA Glyn Vaughan, EA Craig Cowperthwaite, EA	Kathryn Tanner, EA	5th July 2016
v3.0 Final – incorporating draft consultation feedback	Jonathan Coates, EA	Catherine Evans, EA	Kathryn Tanner, EA	November 2016

Executive Summary

The flooding experienced in Kendal on the 5th and 6th of December 2015 was the largest flood event ever recorded in the town, and was the result of the effects of Storm Desmond. This storm caused a period of prolonged, intense rainfall across Northern England. This rainfall fell on catchments that were already saturated and resulted in high river levels and flooding throughout Cumbria and further afield. The flow in the River Kent and its tributaries through Kendal on the 5th of December was the highest ever recorded and the various flooding mechanisms that occurred caused widespread flooding throughout the town.

In response to the Storm Desmond flood event, this *Flood Investigation Report* has been completed by the Environment Agency as a key Risk Management Authority (RMA) working in partnership with Cumbria County Council (CCC) as the Lead Local Flood Authority (LLFA), under the duties set out in Section 19 of the Flood and Water Management Act 2010. This report provides a summary of the flooding that occurred in Kendal on the 5th and 6th of December, and to do so it has used a range of data collected from affected residents, professional partners, site visits, surveys and general observations, along with river and rainfall telemetry data recorded during the event.

Approximately 2,150 properties were directly affected by flooding, with the majority of these located in the Mintsfeet and Sandylands areas of Kendal. Overtopping of defences in the Mintsfeet area occurred when the water level exceeded the height of the defence and flowed over the flood defence embankment structures. In Sandylands, initial flooding from Stock Beck occurred as the capacity of the underground culverted watercourse system was exceeded, followed by overtopping of the Stock Beck Flood Storage Basin (FSB).

This report provides details of the fluvial flooding that occurred from the Rivers Mint, Sprint, and Kent as well as from other smaller watercourses including Stock Beck and Natland Mill Beck. It also identifies areas affected by flooding from groundwater and surface water, and identifies the flow routes and specific causes of the flooding on an area by area basis. Please note that references to left and right bank in this report are for the observer looking downstream with the flow of water.

A total of 23 actions have been recommended in this report, which will require the involvement of a number of organisations as well as from local communities. One of the main actions is for the Environment Agency to undertake a review of the existing modelling data to ensure that the flooding mechanisms that occurred in Kendal are fully understood. This important information will be used to inform Environment Agency investment plans for new flood defences and an improved flood warning service in Kendal.

This report also highlights possible options to reduce flood risk in the future, which include:

1. Investigate options to improve flood storage in the upstream reaches of the Stock Beck catchment.
2. Improve the flood flow capacity of Stock Beck specifically where it flows underground in culverts.
3. Investigate options for upstream flood storage on the rivers Mint, Sprint, and Kent.
4. A combination of increasing channel capacity and constructing flood defences along the entire reach of the Rivers Kent and Mint, from Mint Bridge Road in the north to Helsington Mills in the south.
5. Assess the flood flow capacity of road and railway bridges in Kendal and identify where improvements can be made.
6. Provision of property-level protection.
7. Undertake a detailed assessment for Kendal (including Staveley and Burneside) under the Surface Water Management Plan process, and identify solutions to mitigate surface water flood risk in high risk areas.
8. Review the performance of the existing drainage and sewerage systems during the event to better understand where improvements are required. Particular attention should be given to the

surface water outfalls and Combined Sewer Overflows (CSO's) in the Mintsfeet and New Road areas.

A draft version of the Kendal Flood Investigation Report was published online in July for public consultation. Following the draft publication, public meetings chaired by Cumbria County Council were held in Kendal on 11th and 14th July, where the Environment Agency formally presented the report to the local community. Other Risk Management Authorities were also present at these meetings to answer any questions raised during a question and answer session following presentation of the report. Through the public meetings and local consultation with the community, including with local Flood Action Groups, a range of feedback has been provided on the report. The Environment Agency have reviewed this feedback and, where appropriate, updated the Final version of the report to reflect the required amendments. In some cases, feedback and information provided would not be relevant for direct inclusion in the main body of the report, for example when relating to a very specific issue or historic information provided for local context. In these instances, to ensure this information is still captured in the report, we have included this feedback in Appendix 5 'Public Consultation Feedback'.

Any additional information that can be provided to the Environment Agency and Cumbria County Council help develop our understanding of the flooding is welcomed. A lot of information has already been provided, much of which has been used to inform this report. Any additional information should be provided to;

http://www.cumbria.gov.uk/planning-environment/flooding/floodriskassessment.asp

Contents

Introduction

Under Section 19 of the Flood and Water Management Act (2010) Cumbria County Council, as Lead Local Flood Authority (LLFA), has a statutory duty to produce Flood Investigation Reports for areas affected by flooding. Section 19 of the Flood and Water Management Act 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.

This section of the Act leaves the determination of the extent of flood investigation to the LLFA. It is not practical or realistic for Cumbria County Council to carry out a detailed investigation into every flood incident that occurs in the County, but every incident, together with basic details will be recorded by the LLFA.

Only those with 5 or more properties/businesses involved will have investigations published.

An investigation will be carried out, and a report prepared and published by the LLFA when the flooding impacts meet the following criteria:

- Where there is ambiguity surrounding the source or responsibility of flood incident,
- Internal flooding of one property that has been experienced on more than one occasion,
- Internal flooding of five properties has been experienced during one single flood incident and
- There is a risk to life as a result of flooding.

As a flood Risk Management Authority (RMA), the Environment Agency have partnered with Cumbria County Council (CCC) to produce the 53 flood investigation reports across Cumbria.

Scope of this Report

This Flood Investigation Report **is**:

- An investigation on the what, when, why, and how the flooding took place resulting from the 5th-6th December 2015 flooding event and
- A means of identifying potential recommendations for actions to minimise the risk or impact of future flooding.

This Flood Investigation Report **does not**:

- Interpret observations and measurements resulting from this flooding event. Interpretation will be undertaken as part of the subsequent reports,
- Provide a complete description of what happens next.

The Flood Investigation Reports outline recommendations and actions that various organisations and authorities can do to minimise flood risk in affected areas. Once agreed, the reports can be used by communities and agencies as the basis for developing future plans to help make areas more resilient to flooding in the future.

For further information on the S19 process, including a timetable of Flood Forum events and associated documentation, please visit the County Council website at:

http://www.cumbria.gov.uk/floods2015/floodforums.asp

To provide feedback on the report please email **LFRM@cumbria.gov.uk**.

Flooding History

Kendal is located immediately downstream of the confluence of three major rivers that all drain upland rural catchments, and is therefore highly prone to flooding.

The earliest recorded flooding in Kendal dates back as far as the 17th century. In November 1898 Kendal experienced a significant flood event, the like of which was not experienced again until

December 1954 where flooding nearly reached the same level. The 1954 event flooded around 300 residential and 70 commercial properties, as well as an extensive area of land around Kendal.

Following further significant flood events in 1964 and 1968, the River Kent-Kendal flood alleviation scheme was completed in 1979 and incorporated widening and deepening the river channel to help achieve the required flow capacity through the town. This scheme was subsequently tested in 1985, where a flood of the same magnitude as that of 1954 passed through Kendal with no serious flooding to the protected area. However, flooding did occur in Mintsfeet, and this resulted in the construction of the earth embankments that provide protection in this area.

In February 2004, a fluvial event flooded 80 properties in central Kendal and the Mintsfeet area. In Mintsfeet, both the Lake District Business Park and the Mintsfeet Industrial Estate were badly affected, with 20 and 27 premises flooded respectively. Residential properties on Busher Walk, Garden Road, and Burneside Road were also affected.

Very heavy rainfall on the 6th and 7th January 2005 resulted in the flooding of over 100 properties, with peak river levels on the River Kent in Kendal around 200mm higher than those experienced in February 2004. The main areas affected during this event were Mintsfeet - where 20 residential and 40 commercial properties were flooded - Busher Walk, Aynam Road, and Aikrigg End. The affected properties were in similar locations to those affected in 2004, with central Kendal suffering worse flooding than in the previous year.

A further flood event occurred in November 2009 causing significant flooding in Cockermouth, Keswick, and Workington in north-west Cumbria. Four properties flooded in the Benson Green area from the River Kent, while property basements along Aynam Road and Lound Street were flooded by groundwater and surface water drainage.

The 2015 flood event caused by Storm Desmond was of significantly greater magnitude than past events and the gauged flows in the Rivers Kent, Sprint, and Mint were the highest on record. Table 1 shows the recorded maximum flows in the 3 rivers during these past flooding events and the numbers of properties affected (where available).

Flooding Event	Number of Properties Flooded	Peak Flow in River Kent @ Bowston	Peak Flow in River Sprint @ Sprint Mill	Peak Flow in River Mint @ Mint Bridge	Peak Flow in River Kent @ Victoria Bridge
December 1954	370	-	-	-	280.0[1]
December 1964	100+	-	-	-	222.0[1]
December 1968	-	-	-	-	188.0[1]
December 1985	-	-	68.9	99.8	199.0
February 2004	80	109.0	71.9	112.8	253.6
January 2005	100+	122.5	80.5	115.4	268.5
November 2009	25	118.9	71.7	85.9	248.4
December 2015	2,150	177.0	94.8	170.0	403.0

Table 1: Recent flood events affecting Kendal

Source: Flow gauging station data obtained from Environment Agency records and the National River Flow Archive (www.nrfa.ceh.ac.uk). Property numbers obtained from the Kent and Gowan Interim Hydrology Report (CH2M, May 2016)

[1] Measured at Nether Bridge level gauge based on calibration by current metering near Victoria Bridge

Event Background

This section describes the location of the flood incident and identifies the properties that were flooded.

Flooding Incident

The market town of Kendal is located in south-east Cumbria and is situated predominantly in the floodplain of the River Kent, which flows through the town centre. Upstream of Victoria Bridge gauging station in Kendal, the River Kent drains a mostly rural 183km^2 catchment that includes part of the south-eastern Lake District National Park. The town itself is situated immediately downstream of the confluences of two major tributaries. The River Sprint joins the Kent approximately 2.5km upstream of Kendal town centre and immediately downstream of Burneside village, whilst the River Mint joins the Kent on the outskirts of the town (approximately 1km upstream of the town centre in Mintsfeet). Other watercourses, including Stock Beck, also drain into the River Kent within Kendal itself. The location of Kendal and its river network are shown in Figure 1. The catchment of the River Kent and its tributaries is shown in Figure 7.

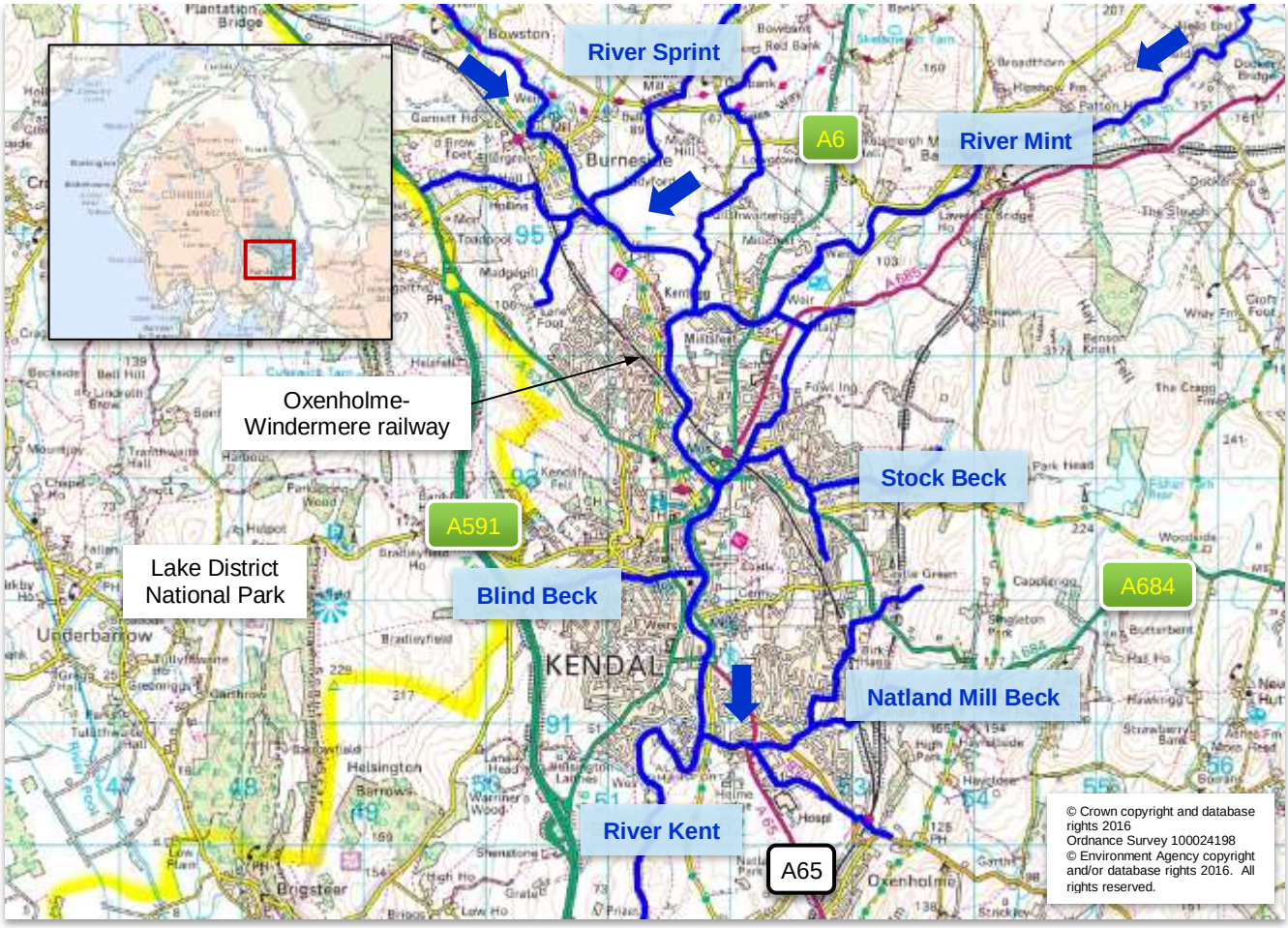


Figure 1: Location of Kendal and its major rivers

Kendal is the third largest settlement in Cumbria and has a population of approximately 30,000. The town is an economic and tourist centre for Cumbria and is the southern gateway to the Lake District National Park.

Due to its position within the floodplain of the Rivers Kent and Mint, parts of Kendal lie within Flood Zone 3 and are therefore at a high risk of fluvial flooding (see Figure 2). The town is also at risk from other sources of flooding, including surface water (see Figure 3).

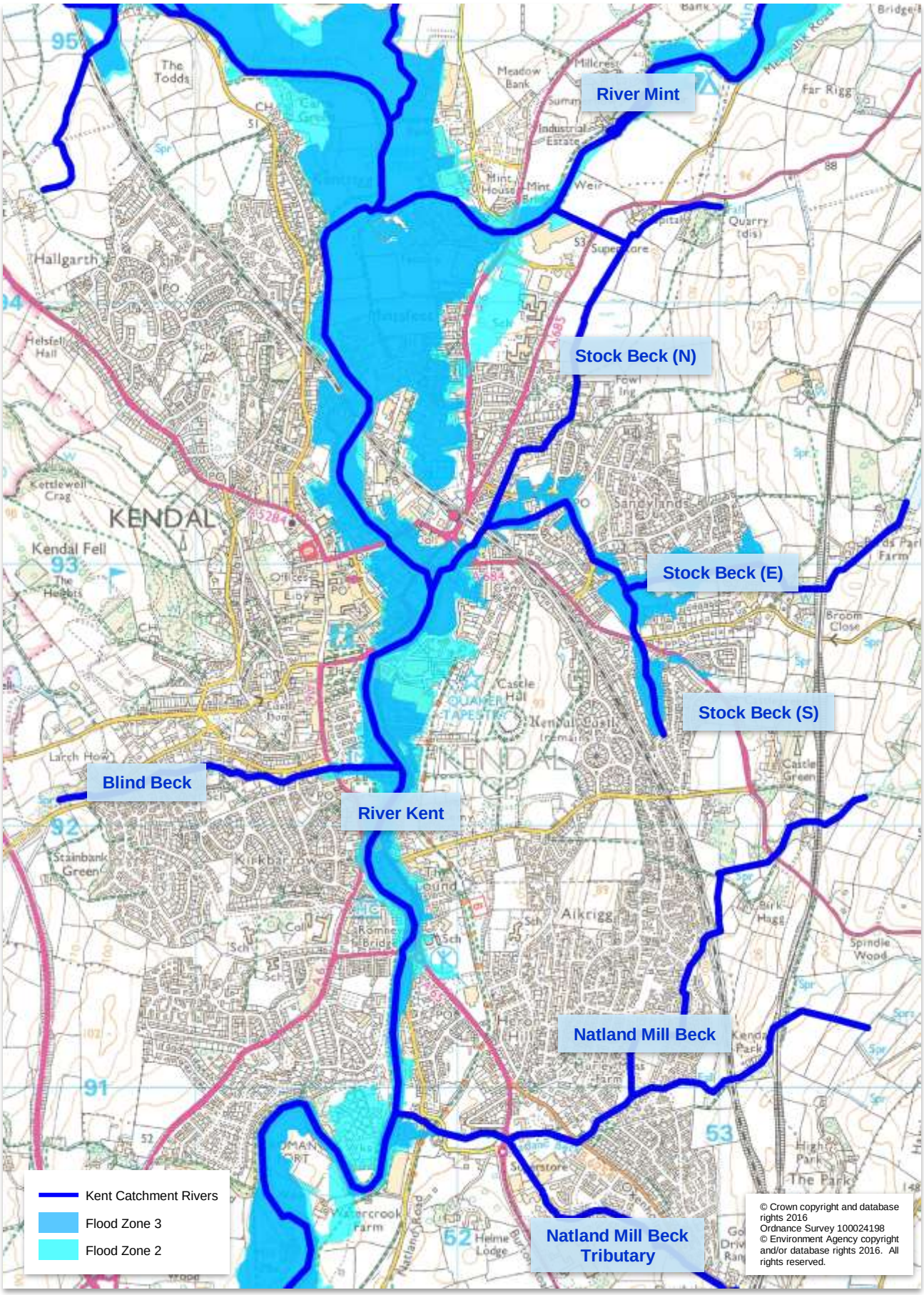


Figure 2: Indicative risk of flooding to Kendal from rivers (fluvial)

Figure 3: Areas within Kendal at risk of surface water flooding

On the 5th and 6th December 2015, approximately 2,150 properties in Kendal suffered significant flooding as a result of Storm Desmond, which caused record breaking rainfall over Cumbria and other parts of north-west England. The storm led to widespread river and surface water flooding across Cumbria, with significant flood events occurring on the Eden, Derwent and Kent catchments.

In Kendal, the main source of flooding was from flood water overtopping the left banks of the Rivers Mint and Kent in the Mintsfeet area, located due north of Kendal town centre where the River Mint joins the River Kent. This caused significant flooding to commercial properties in the Lake District Business Park, with overland flood flows then continuing due south across playing fields before flooding commercial and residential properties located between the Oxenholme-Windermere railway line (situated on an embankment) and the A6 Shap Road, including the Mintsfeet Industrial Estate. This overland flow then continued to spread east towards Appleby Road and combined with overland flow from Stock Beck to cause flooding to properties east of Appleby Road in the vicinity of Sandylands Road. Flood water then continued to flow through the railway overbridge at Longpool, which crosses the A6, where further flooding occurred in the Ann Street and Castle Street area.

River flooding also occurred in the immediate vicinity of the River Kent where it flows through the centre of Kendal, with properties on both banks affected. This flooding extended to the southern part of the town, where Kendal Wastewater Treatment Works (WwTW) suffered damage as a result of sewer surcharging and a blocked outfall.

Flooding from other sources, including groundwater, surface water run-off, and artificial drainage systems was also reported. Figure 4 indicates the extent of the flooding that occurred in Kendal from all sources following Storm Desmond.

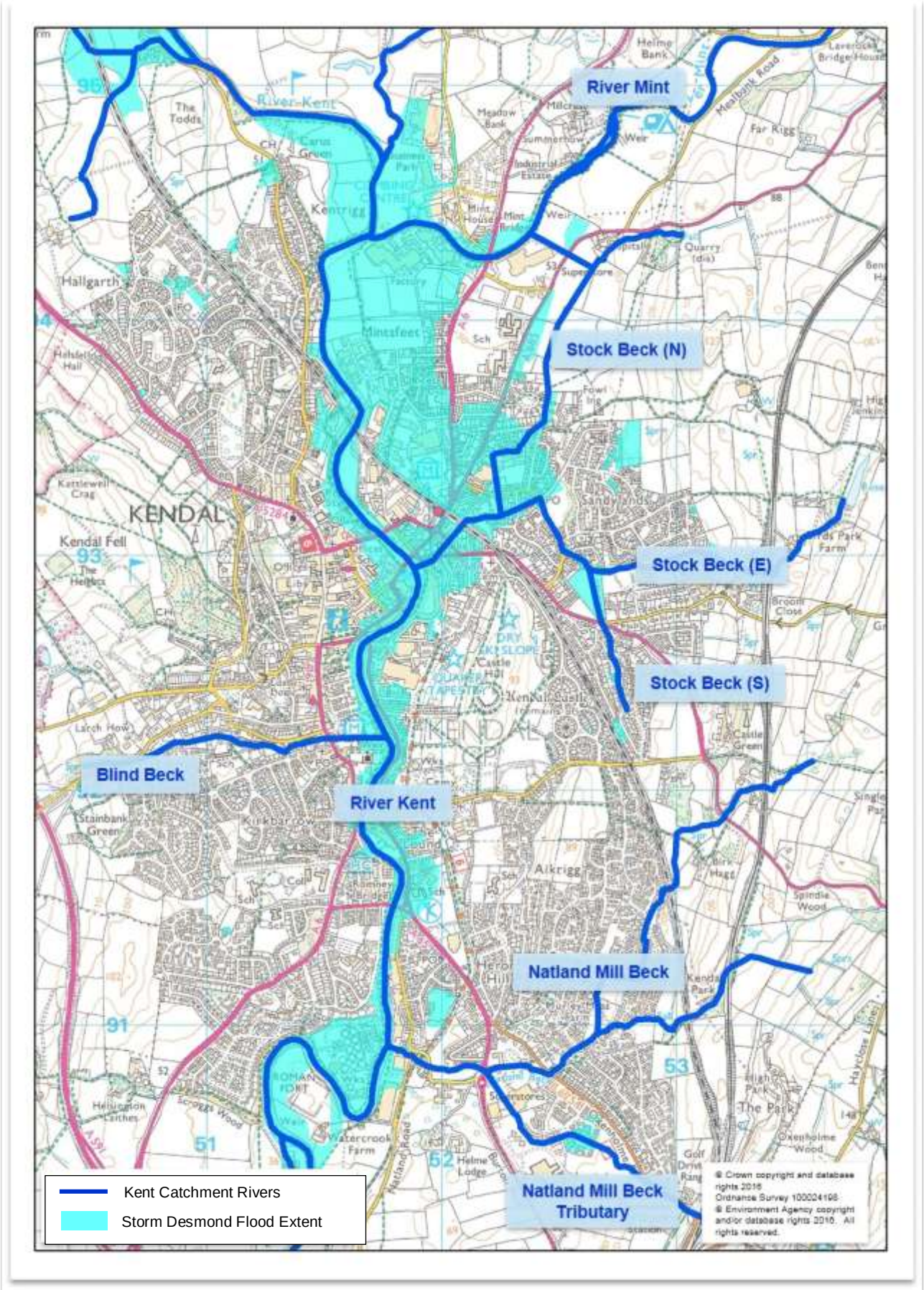


Figure 4: Extent of flooding in Kendal on 5-6th December 2015

For the purpose of this report, the flooded areas have been divided into 11 sub-areas for detailed investigation. These are listed below and shown in Figure 5:

1. **Kentrigg and Carus Green:** River Kent floodplain to the north of the confluence with the River Mint, including the Lakeland factory and Westmorland Business Park.
2. **Mintsfeet:** Area enclosed by the Rivers Mint and Kent to the west of the A6 Shap Road and north of the Oxenholme – Windermere railway line.
3. **Shap Road and Appleby Road:** Area between Shap Road and Appleby Road.
4. **Sandylands:** Sandylands area to the east of Appleby Road, including the Stock Beck Flood Storage Basin (FSB).
5. **Wildman Street, Ann Street, and Castle Street:** Area enclosed by the River Kent and the Oxenholme – Windermere railway, including Gooseholme Park.
6. **Aikrigg Avenue, Dockray Hall, New Road, and Stramongate:** Areas in the immediate vicinity of the right bank of the River Kent, from Aikrigg Avenue in the north to New Road in the centre of Kendal.
7. **River Kent (Right bank):** Areas in the immediate vicinity of the right bank of the River Kent, from Aikrigg Avenue in the north to Kirkbarrow in the south.
8. **River Kent (Left bank):** Areas in the immediate vicinity of the left bank of the River Kent from Gooseholme Park in the north to the A65 Burton Road in the south.
9. **Natland Mill Beck and Natland Mill Beck Tributary:** Properties on Blencathra Gardens and Hardknott Gardens.
10. **Kendal WwTW and Helsington Mills:** Kendal WwTW and properties in Helsington Mills situated on the right bank of the River Kent in the south of Kendal.
11. **Hallgarth:** Isolated areas of flooding in the Hallgarth area between the Windermere – Oxenholme railway and the A5284 Windermere Road.

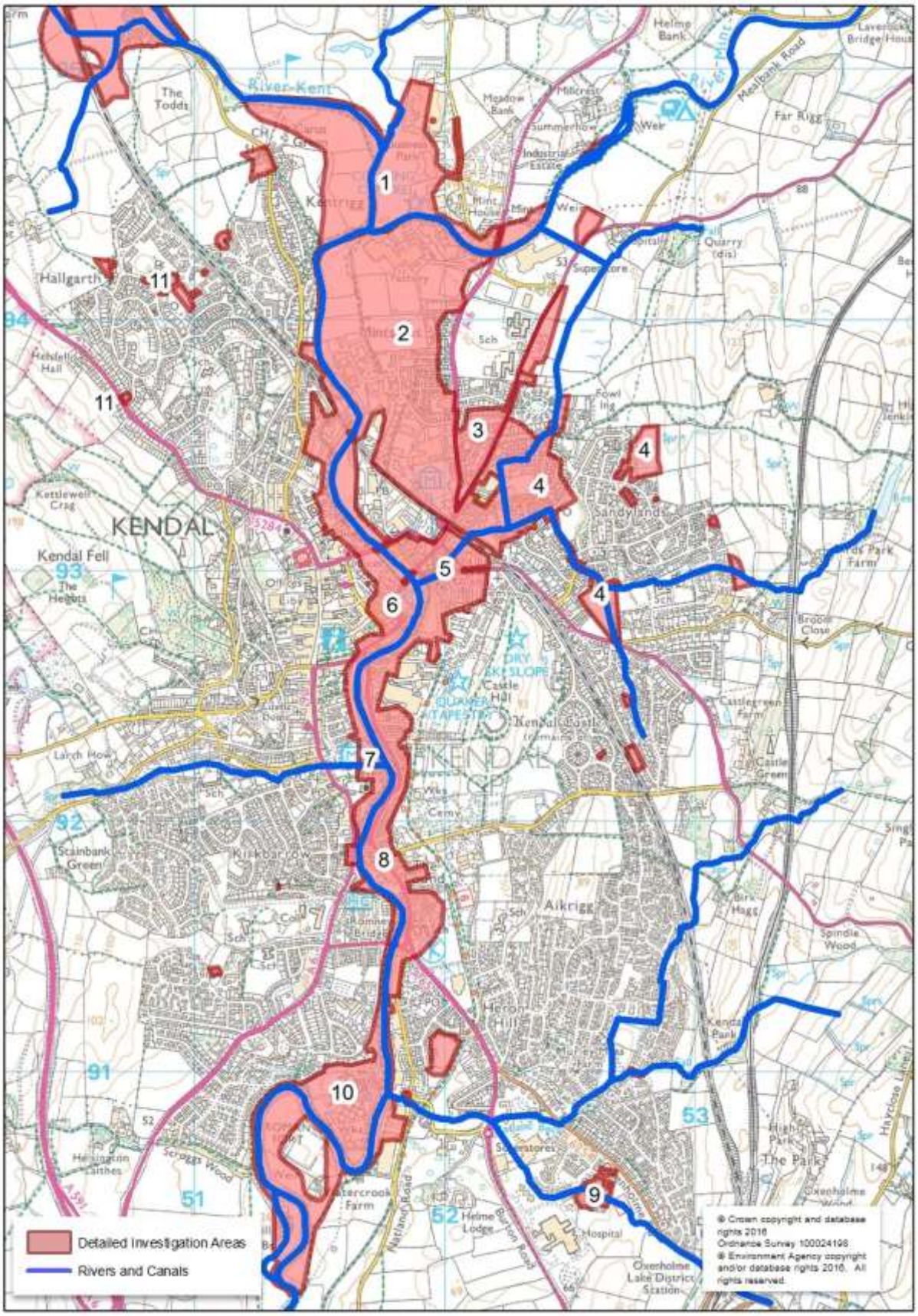


Figure 5: Affected areas subject to detailed investigation

Existing Flood Defences

Following significant flood events in 1954 and 1968, the River Kent-Kendal Flood Relief Scheme was completed in 1979 and incorporated widening and deepening the river channel to help achieve the required flow capacity (often quoted as being designed to convey a flow of 280m³/s). The 1970's scheme mainly relied upon increasing flood flow capacity through Kendal, including smoothing the bed and banks of the river. To help protect the water habitat and maintain aesthetics of the River Kent through Kendal a number of weirs were retained to keep the river from running dry during periods of low flow. Localised raising of land levels during the construction of the Mintsfeet Industrial Estate will have reduced the risk of flooding. Evidence of this land raising is visible in the hump in the footpath that runs through the estate that had a wrack mark (defining the high water level) below its crest after the December 2015 flood.

In the 1980's, flood embankments were built to provide protection to the Mintsfeet Industrial Estate and Lakeland Business Park from the Rivers Kent and Mint. Following flood events in 2004 and 2005, further improvements were made to these flood embankments.

A length of raised embankment is situated between Dockray Hall and the properties at Benson Green, which provides protection to the County Court, Police, Fire & Rescue Service, Mountain Rescue Headquarters, and the County Council Offices. There is a formal flood defence wall that runs along the right bank of the River Kent for approximately 220m adjacent to the A65 New Road.

In 2006, South Lakeland District Council constructed the Stock Beck Flood Storage Basin (FSB). The FSB, in combination with upsized culverts on the Stock Beck Tributaries upstream of the FSB, was designed to reduce the risk of flooding to properties located upstream and downstream of the basin, mainly in the Sandylands estate. In 2013, the responsibility for maintenance of the scheme was transferred to the Environment Agency.

A map of existing flood risk management assets maintained by the Environment Agency is shown in Figure 6.

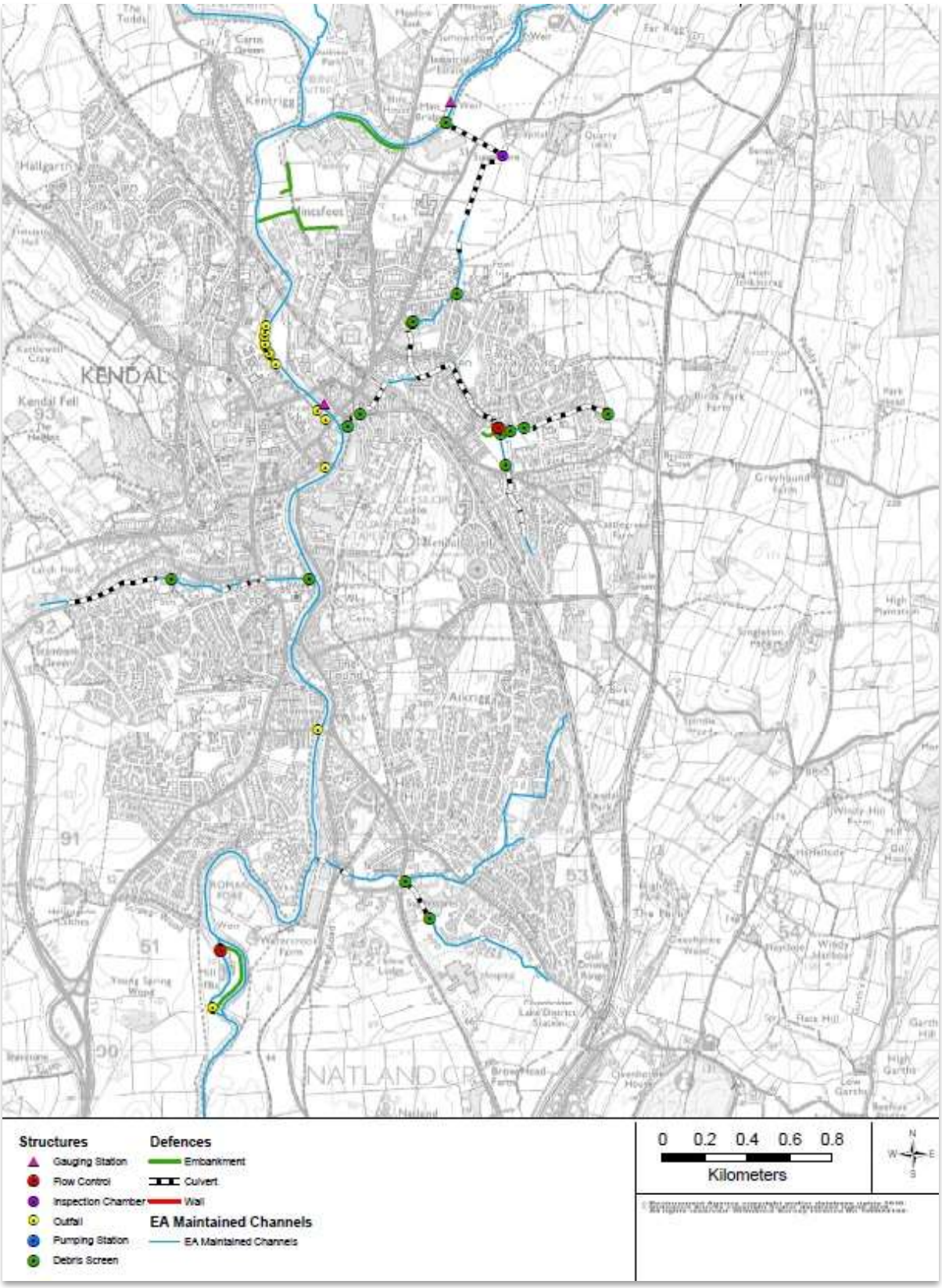


Figure 6: Flood risk management assets maintained by the Environment Agency in Kendal

Investigation

This section describes the rainfall and fluvial events that occurred on the River Kent catchment, the likely causes of flooding and the Environment Agency response in Kendal. It also provides a timeline of the events that occurred over 5th-6th December 2015.

This investigation was carried out by the Environment Agency using data collected from surveys of the area and from the communities affected, with help from Cumbria County Council and South Lakeland District Council. This report combines this data to provide a detailed record of the flooding in Kendal.

Rainfall and Fluvial Events

December 2015 was the wettest calendar month on record, with much of northern England receiving double the average rainfall for that time of year. This also followed a particularly wet November, which resulted in catchments that were already heavily saturated prior to the rainfall event associated with Storm Desmond.

From the 4th to the 7th of December 2015, Storm Desmond resulted in a period of prolonged rainfall across Cumbria, which was particularly intense over 5th-6th December and caused widespread flooding across the county. Over this period, new 24 and 48 hour rainfall records were set for the UK. Both of these were within Cumbria and broke the previous records, also within Cumbria, set in the November 2009 flood event, which saw widespread devastation in the towns of Cockermouth, Keswick, and Workington. The record-breaking total rainfall values are presented in Table 2.

Rainfall Period	Storm Desmond			Previous Record		
	Date	Location	Total rainfall (mm)	Date	Location	Total rainfall (mm)
24 hour rainfall	December 2015	Honister Pass	341.4	November 2009	Seathwaite	316.4
48 hour rainfall	December 2015	Thirlmere	405.0	November 2009	Seathwaite	395.6

Table 2: UK Rainfall Records

Within the Kent catchment, Kentmere Hallow Bank rain gauge recorded a total of 225.8mm of rain between 19:00 on 04/12/2015 and 07:45 on 06/12/2015 and at Fisher Tarn, which is located to the east of Kendal; 139.6mm fell in 48 hours. In the River Mint catchment, the rain gauge at Watchgate recorded 181.8mm of rain in 48 hours. This is the rainfall associated with Storm Desmond and this followed a series of smaller rainfall events in the preceding days, which contributed to the already saturated ground conditions in the catchment. Table 3 summarises the rainfall data recorded in the River Kent, Stock Beck, and River Mint catchments during Storm Desmond and illustrates that the data recorded during Storm Desmond far exceeds the previous record gaugings. The locations of the rain gauges are shown in Figure 7.

Location	Rainfall Period	Storm Desmond		Previous Record	
		Date	Total rainfall (mm)	Date	Total rainfall (mm)
Kentmere Hallow Bank	24 hour rainfall	December 2015	183.4	November 2009	137.6
	48 hour rainfall	December 2015	225.8	November 2009	160.4
Fisher Tarn	24 hour rainfall	December 2015	114.2	October 2008	70.2
	48 hour rainfall	December 2015	139.6	October 2008	74.0
Watchgate	24 hour rainfall	December 2015	147.8	November 2009	89.0
	48 hour rainfall	December 2015	181.8	November 2009	104.8

Table 3: Rainfall data associated with Storm Desmond in the River Kent, Stock Beck and River Mint catchments

Five principal flow gauging stations are located within the catchment of the River Kent[2] (see Figure 7). Three of the stations are located upstream of Kendal, with one on the River Kent (Bowston), one on the River Sprint (Sprint Mill), and one on the River Mint (Mint Bridge). Bowston gauging station replaced Burneside gauging station (now closed) in 1999. Victoria Bridge gauging station is located in the centre of Kendal itself, whilst Sedgwick gauging station is located approximately 6km downstream of Kendal town centre. Together, these stations recorded the fluvial event caused by Storm Desmond, and the recorded data is presented in Table 4, Figure 8 and Figure 9.

In addition to the five principal flow gauging stations, the Environment Agency operates a gauge on Stock Beck. This gauge is located in the Jewson's building yard off the A6 Shap Road. Unfortunately, no data from the Storm Desmond event is available for this station because it suffered damage when overwhelmed by the volume of floodwater.

At Victoria Bridge gauging station, the level of the River Kent peaked at 44.70m AOD at 21:15 on Saturday 5th December. This was the highest river level ever recorded and exceeded the previous record level of 44.20m AOD (January 2005). It is worth noting at this stage that this level would have been higher had a significant amount of flow not bypassed the gauging station via Mintsfeet and Longpool (see Figure 10). In this area, floodwater was impounded upstream of the railway embankment in Mintsfeet before flowing east towards the Sandylands Estate or through the railway bridge along the A6 Shap Road at Longpool.

[2] Flow gauging station data obtained from Environment Agency records and the National River Flow Archive (www.nrfa.ceh.ac.uk)

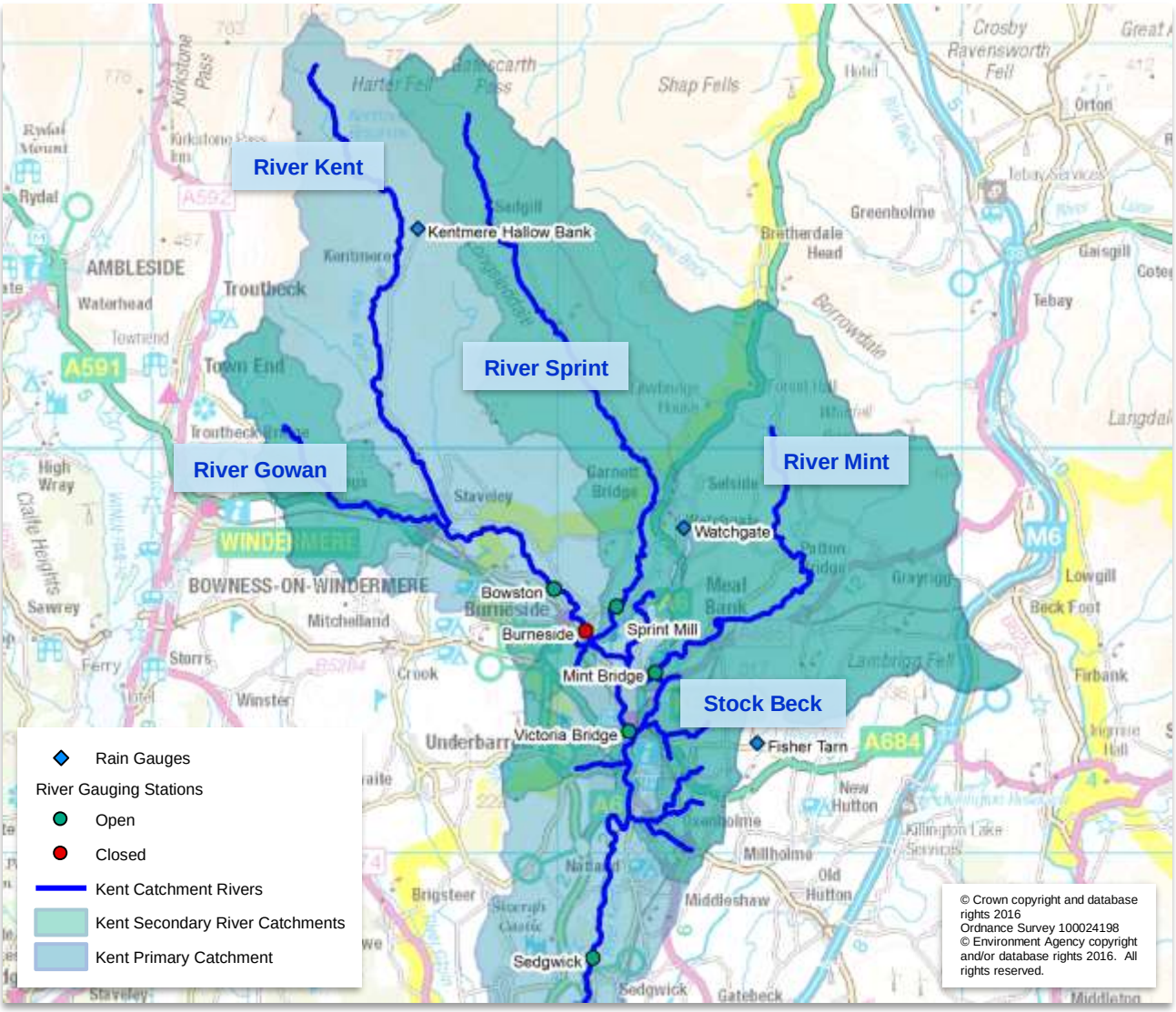


Figure 7: Location of rain gauges and river gauging stations in the River Kent catchment

Gauging Station	River	Area of upstream catchment (km^2)	Peak flow (m^3/s)			
			Dec 2015	Nov 2009	Jan 2005	Feb 2004
Bowston	Kent	71	177.0	118.9	122.5	109.0
Sprint Mill	Sprint	35	94.8	71.7	80.5	71.9
Mint Bridge	Mint	66	170.0	85.9	115.4	112.8
Victoria Bridge	Kent	183	403.0	248.4	286.5	253.6
Sedgwick	Kent	209	526.8	-	347.0	312.0

Table 4: Recorded peak river flows in the River Kent catchment for recent flood events

Source: Flow gauging station data obtained from Environment Agency records and the National River Flow Archive (**www.nrfa.ceh.ac.uk**)

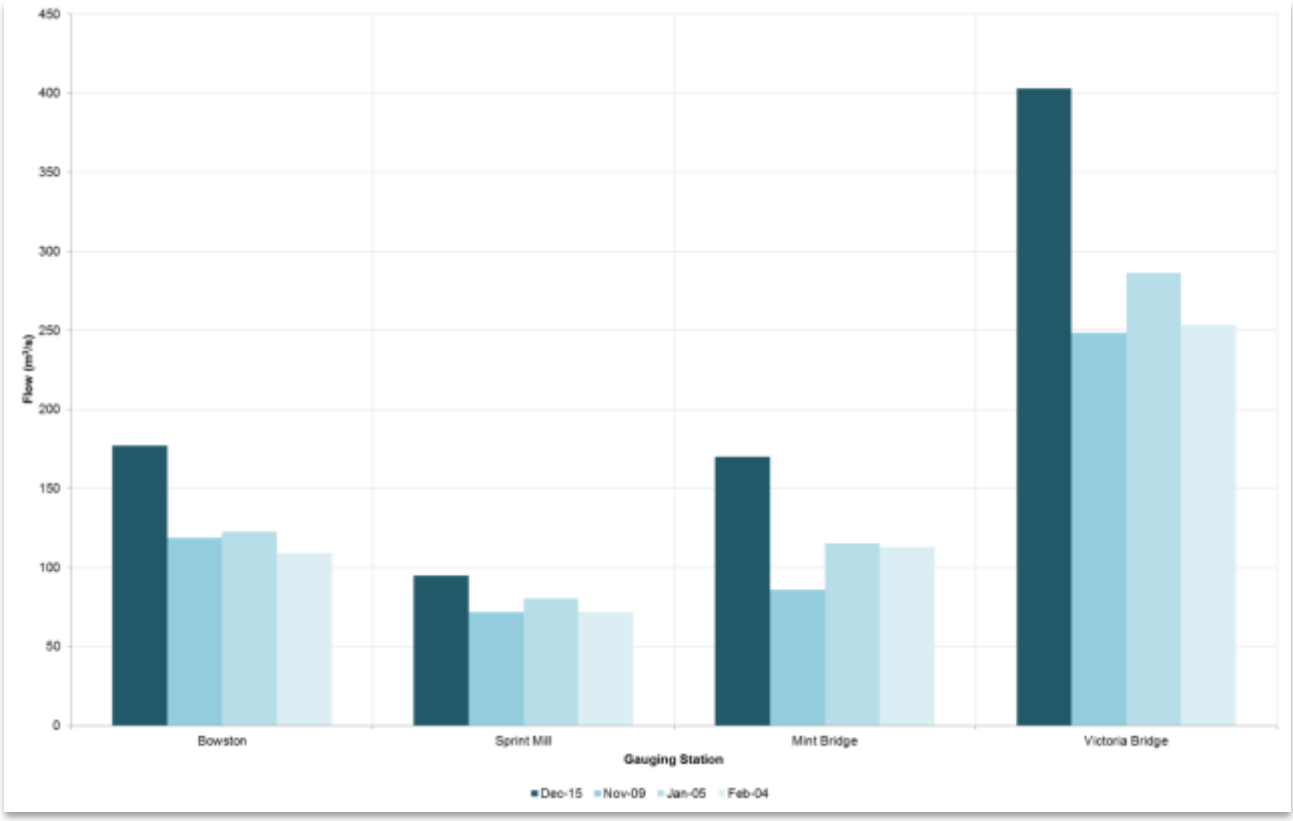


Figure 8: Recorded peak river flows in the River Kent catchment for recent flood events

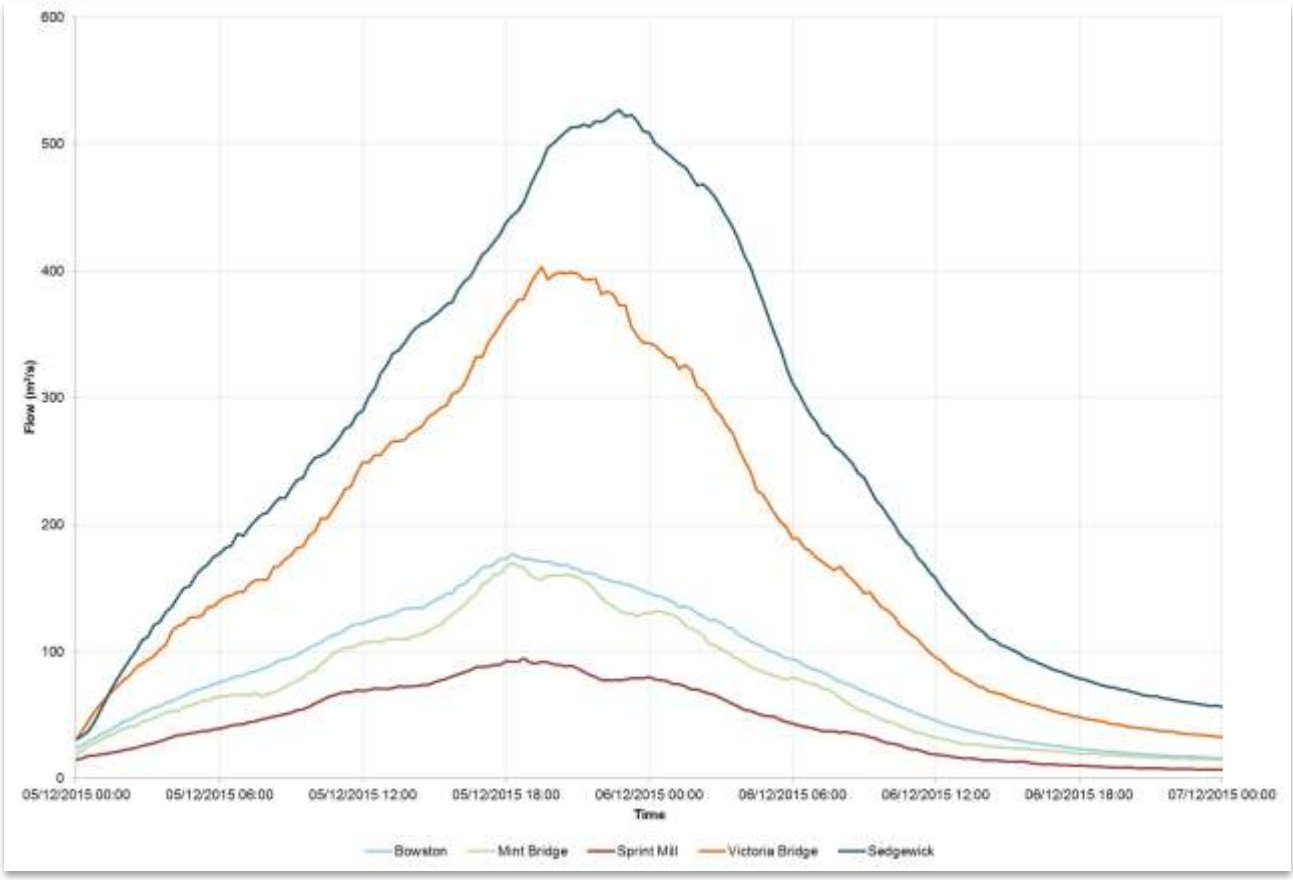


Figure 9: Gauged river flows at various locations in the Kent catchment on the 5th-6th December 2015

The recorded peak flow at Victoria Bridge gauging station was greater than any flow previously recorded at this location on the River Kent, and initial analysis of this data suggests that the December 5th event had a 0.5-0.67% probability of occurring in any given year (Annual Exceedance Probability or

AEP). In reality, the peak flow in the River Kent was higher than the 403m^3/s measured at the gauging station. This is due to the bypassing of the gauging station that occurred as floodwater passed through Mintsfeet and Longpool and became impounded against the Oxenholme-Windermere railway embankment.

The magnitude of the flood event on the River Kent was greater than the size of event that the existing flood defences within Kendal were designed to defend against. The existing defences can contain flows of approximately 280m^3/s, whereas flow in the River Kent on the 5th December 2015 exceeded 400m^3/s. As such, river levels would be expected to be higher than the flood defence level and, therefore, overtopping of the defences would be expected to occur.

Sources of Flooding, Flood Flow Routes and Event Timeline

The overland flood flows that caused the flooding in Kendal on the 5th and 6th December 2015 were complex and derived from multiple sources. From the data and evidence obtained both during and after the flood event, it is clear that river, surface water, drainage systems, and groundwater sources of flooding all contributed to the devastation across the town. Generally speaking, the principal source of flooding in Kendal may be attributed to the River Kent, Mint and Stock Beck river flooding. However, in specific areas, the evidence suggests that surface water flooding, groundwater flooding, and flooding from drainage systems played a critical role. In view of this, the sources of flooding in each of the areas identified in Figure 5 are discussed on an area by area basis in the Likely Causes of Flooding section of this report.

Detailed flow routes are also identified in the Likely Causes of Flooding section of this report. However, an overview of the principal flood flow routes through Kendal is presented in Figure 10. This figure shows the dominant flow paths within the town, but there is evidence that these changed over the course of the event as different sources of flooding came into play and flood waters in some areas began to recede.

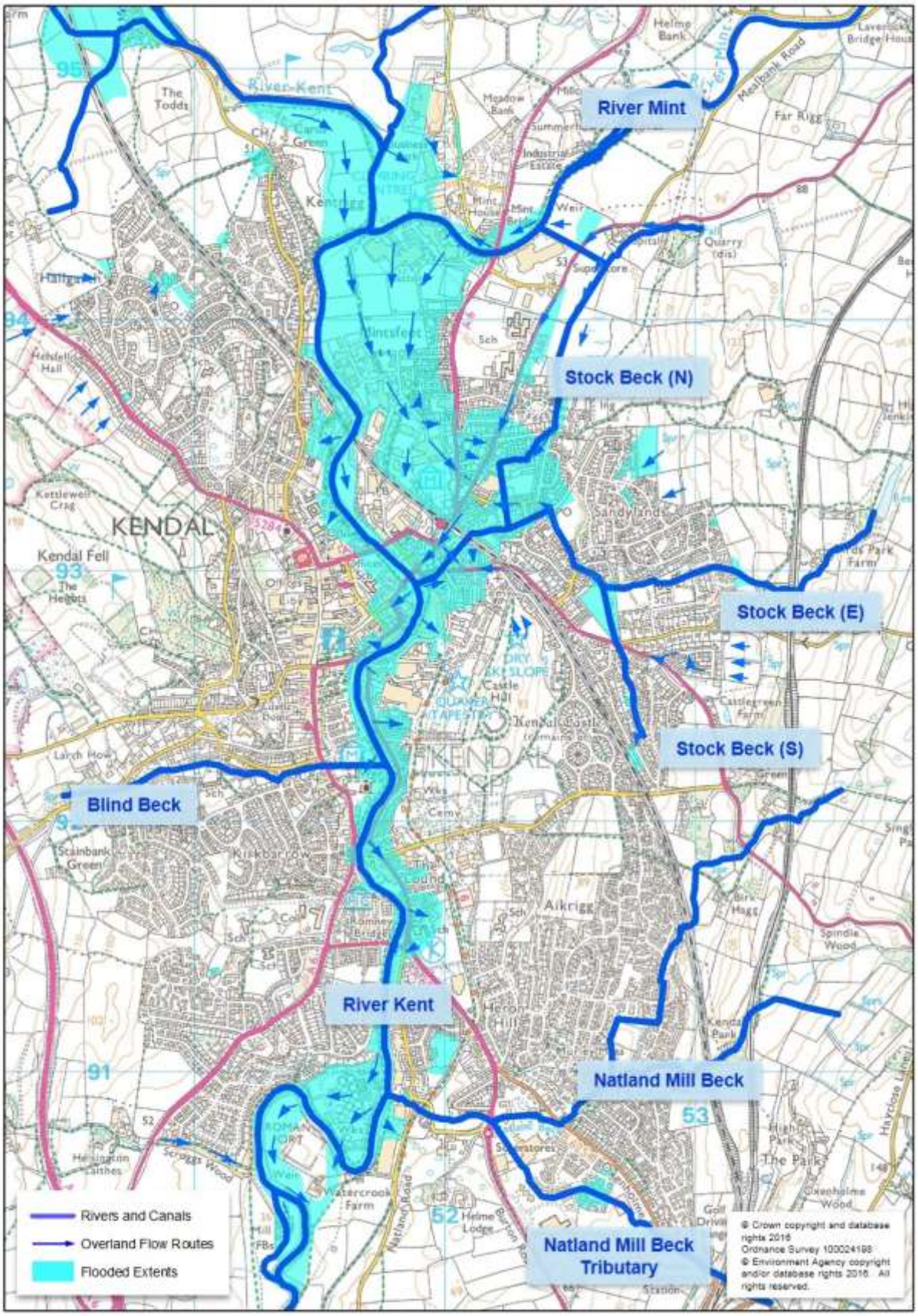


Figure 10: Principal overland flow routes through Kendal

Table 5 provides a summary timeline of the key events as the flooding affected Kendal. Timelines specific to each of the investigation areas are provided in the Likely Causes of Flooding section.

4th December 2015	Event
15:22	**Flood Alert issued (Kent and Bela catchments)**
19:00	First rainfall associated with Storm Desmond recorded at Kentmere Hallow Bank rain gauge.
5th December 2015	**Event**
09:03	**Flood Warning issued (011FWFNC17A: River Kent at Kendal, Benson Green, Burneside Rd, Gilthwaite Rigg, and St Johns Ambulance).**
11:00	Reports of surface water flooding and flooding from artificial drainage systems at various locations around Kendal. Properties on Ullswater Road suffer surface water flooding from run-off from upstream fields. Flooding to property on Finley Close reported.
11:15	Flooding in Castle Street Centre car park due to backing up of surface water drainage system.
11:58	**Flood Warning issued (011FWFNC17B: River Kent at Kendal, Busher Walk, Jubilee Field, Sandes Avenue and Mint Bridge Rd).**
12:00	Spillway at Stock Beck Flood Storage Basin (FSB) starts to overtop.
12:07	**Flood Warning issued (011FWFNC29: Stock Beck at Sandylands).**
13:00	Overland flow observed on Gandy Street.
13:30	Properties affected by flooding at the junction of Eastgate, Jenkin Rise and Sandylands Road. Observed surcharging of the drainage system in the car park at Jenkins Crag Court Sheltered Housing to the rear of properties on Whinfell Drive.
14:45	Overland flow observed on Sandylands Road.
15:00	Flood defence embankment on the left bank of the River Mint overtopped. Flooding reported on Mintsfeet Road. Groundwater flooding of basements to properties on Aynam Road.
15:11	**Flood Warning issued (011FWFNC17C: River Kent at Kendal, Castle Cres, Aynam Rd, Lound Rd, Mintsfeet).**
15:22	**Flood Warnings issued (011FWFNC17D: River Kent at Kendal, Dockray Hall Rd, Natland Aikrigg Ave, Ann St, Back Lane, Beezon Trad Est and 011FWFNC19: River Kent at Helsington Mills).**
15:30 – 17:00	Flood defence embankment on the southern border of the Jubilee Playing Fields overtopped. Water seen filling Kendal Cricket Ground from the Furmanite site.
15:42 – 16:06	**Severe Flood Warnings issued for Kendal.**

16:00	Onset of flooding to properties on and around Sandylands Road. Reported flooding to properties on Appleby Road, initially through the floors. Flooding from manholes associated with Stock Beck culvert on Sandylands Road/Eastgate, 250mm depth of overtopping of spillway at Stock Beck FSB. Flooding from River Mint and Stock Beck in and around Castle Crescent.
17:00	Overtopping of the right bank of the River Kent downstream of Stramongate Bridge. Onset of flooding to properties at Helsington Mills, south of Kendal, with depths reaching 0.9-1.2m.
17:30 – 18:30	Flooding reported in properties between the A6 Shap Road and the A685 Appleby Road.
18:00	Overland flow on A6 Shap Road observed passing beneath railway line at Longpool.
18:15	River Mint peak at Mint Bridge gauging station: 53.0m AOD/170m^3/s.
18:45	River Sprint peak at Sprint Mill gauging station: 59.4m AOD/94m^3/s.
21:15	River Kent peak at Victoria Bridge gauging station: 44.7m AOD/403m^3/s.
6th December 2015	**Event**
00:00	Depth of flooding up to 1.2m in the vicinity of Sandylands Road
08:57	Flow observed by-passing Stock Beck FSB along embankment crest

Table 5: Summary timeline of key events during the Kendal flooding

Likely Causes of Flooding

Area 1: Kentrigg and Carus Green

Kentrigg is located in the north of Kendal on the River Kent and close to its confluence with the River Mint. Flooding in this area was predominantly caused by the fluvial event on the River Kent, with parts of the Westmorland Business Park on the left bank of the River Kent also affected by flooding from Gilthwaiterigg Beck.

For the most part, the areas of land that flooded are green field areas, including part of Carus Green golf course, where substantial damage was reported on the left bank of the River Kent. Flooding also affected facilities at the golf club (on the right bank of the River Kent), where the depth of water reached 0.6m.

The Westmorland Business Park, within which is a factory for the Lakeland homeware brand, suffered flooding. The Lakeland factory itself was flooded and it is believed that this was caused by groundwater flooding. Flooding to a depth of circa 20mm was reported in an extension built to the north of the site. The shallow depth of water meant that staff were able to clean the premises relatively quickly

Fluvial flooding from an ordinary watercourse resulted in five properties on Burneside Road, opposite Kent Lea, being affected. Investigations suggest that this was caused by an obstructed culvert.

The principal flood mechanisms and overland flow routes are shown in Figure 11, with a timeline of the key events given in Table 6.

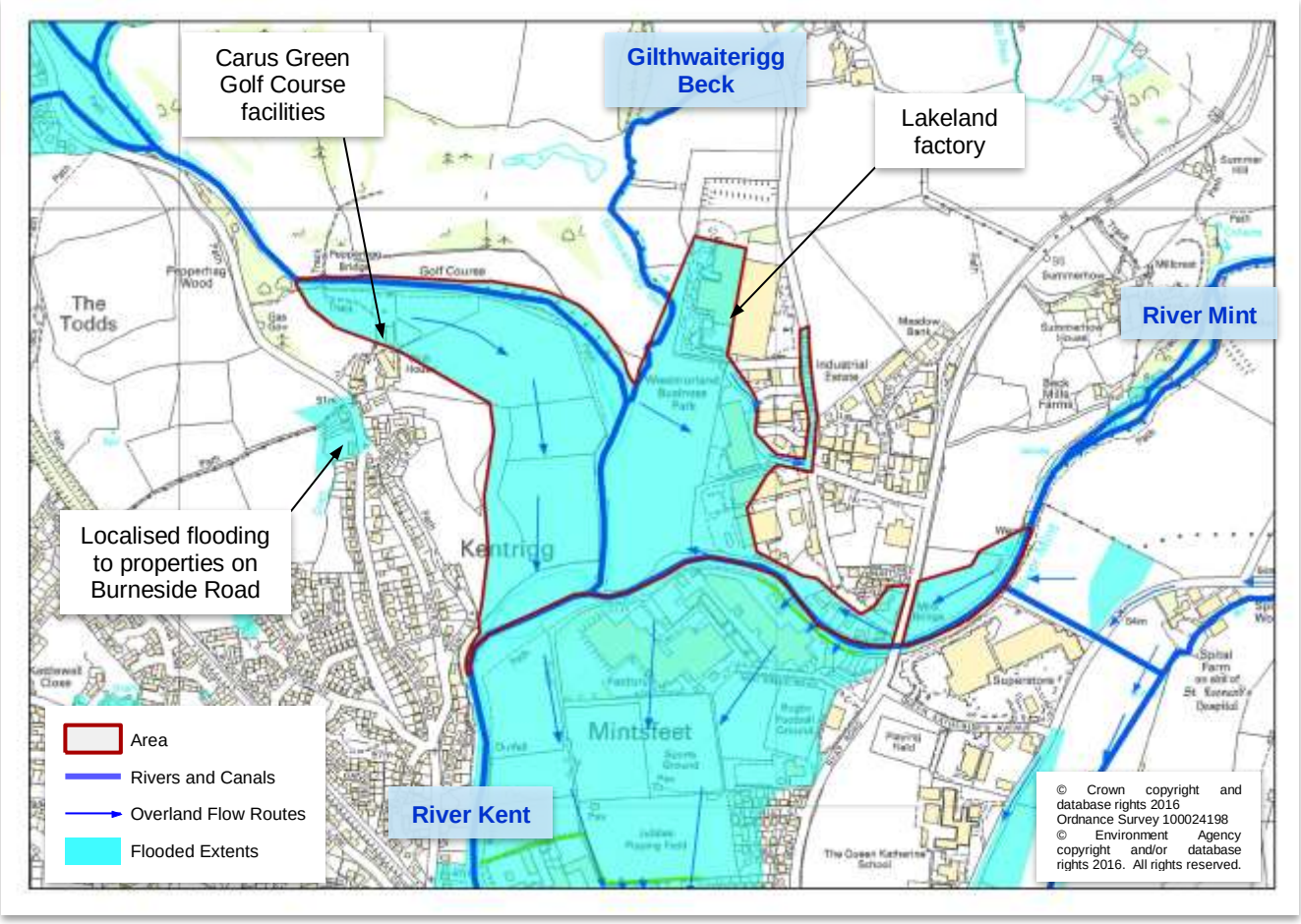


Figure 11: Overland flow routes in the Kentrigg and Carus Green area

5th December 2015	Event

09:03	**Flood Warning issued (011FWFNC17A: River Kent at Kendal, Benson Green, Burneside Rd, Gilthwaite Rigg, and St Johns Ambulance).**
15:42	**Severe Flood Warning issued (011FWFNC17A: River Kent at Kendal, Benson Green, Burneside Rd, Gilthwaite Rigg, and St Johns Ambulance).**
18:15	River Mint peak at Mint Bridge gauging station: 53.0m AOD/170m^3/s.
21:15	River Kent peak at Victoria Bridge gauging station: 44.7m AOD/403m^3/s.

Table 6: Timeline of events in the Kentrigg and Carus Green area

Area 2: Mintsfeet

The Mintsfeet area, enclosed by the Rivers Mint and Kent to the west of the A6 Shap Road and north of the Oxenholme – Windermere railway line, comprises a mixture of residential, commercial, and green field land uses. The area was badly affected and the principal source of flooding was from the fluvial event on the Rivers Mint and Kent. Residential and commercial properties on and around Mintsfeet Road suffered significant damage and commercial property in the Lake District Business Park was also affected. The principal flood mechanisms and overland flow routes are shown in Figure 12, with a timeline of the key events given in Table 7.

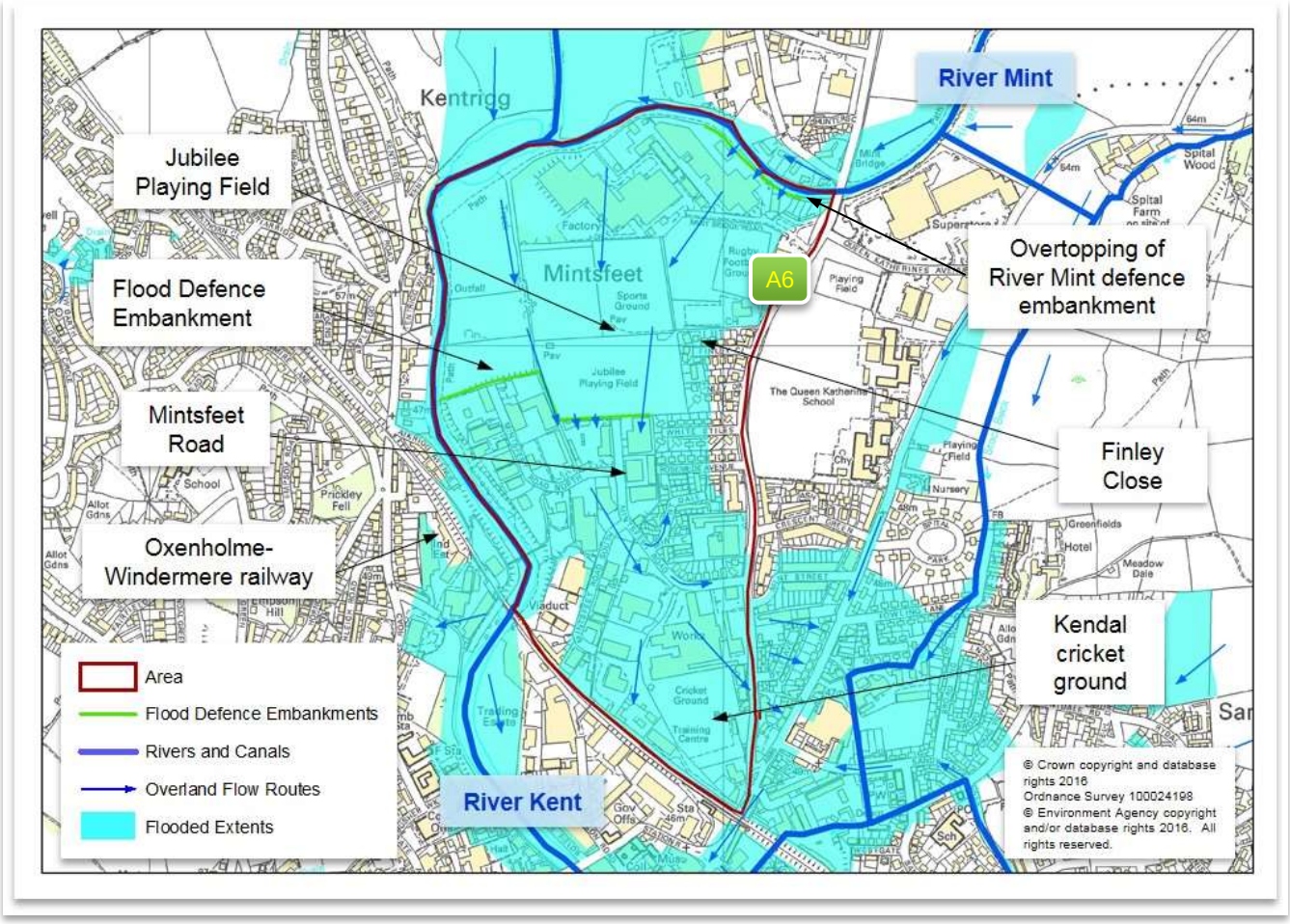


Figure 12: Overland flow routes in the Mintsfeet area

5th December 2015	Event
11:00	Flooding to property on Finley Close reported.
11:58	**Flood Warning issued (011FWFNC17B: River Kent at Kendal, Busher Walk, Jubilee Field, Sandes Avenue and Mint Bridge Rd).**
15:00	Flood defence embankment on the left bank of the River Mint overtopped. Flooding reported on Mintsfeet Road.
15:11	**Flood Warning issued (011FWFNC17C: River Kent at Kendal, Castle Cres, Aynam Rd, Lound Rd, Mintsfeet).**
15:22	**Flood Warnings issued (011FWFNC17D: River Kent at Kendal, Dockray Hall Rd, Natland Aikrigg Ave, Ann St, Back Lane, Beezon Trad Est and 011FWFNC19: River Kent at Helsington Mills).**
15:30 – 17:00	Flood defence embankment on the southern border of the Jubilee Playing Fields overtopped. Water seen filling Kendal Cricket Ground from the Furmanite site.
15:46 – 16:06	**Severe Flood Warnings issued for Kendal.**
17:30	Flooding to properties on the A6 Shap Road, close to Kendal cricket ground.
18:15	River Mint peak at Mint Bridge gauging station: 53.0m AOD/170m^3/s.
21:15	River Kent peak at Victoria Bridge gauging station: 44.7m AOD/403m^3/s.

Table 7: Timeline of events in the Mintsfeet area

The area of Mintsfeet was hit by significant overland flows from the Rivers Mint and Kent. It appears that the most significant of these originated where the two rivers join together to the north-west of the Lake District Business Park. In addition to this, the existing flood defence embankment on the left bank of the River Mint as it passes the business park began to overtop at around 15:00 on 05/12/2015 and was subsequently damaged. The overtopping is understood to have occurred when flow in the River Mint reached around 120m^3/s and the wrack mark was found to be between 600 and 900mm above the embankment crest at this location.

Floodwater from these sources was then able to flow through the business park and across the Jubilee Playing Fields to the south, where it was initially impounded against the existing flood defence embankment highlighted on Figure 12 and shown in Figure 13.

Figure 13: Aerial photograph from 6th December showing the flooding in Mintsfeet and the existing flood defence embankment along the south and western boundaries of the Jubilee Playing Fields

Whilst the embankment in the Jubilee Playing Fields impounded floodwater initially, the sheer magnitude of the flood event meant that it was overwhelmed. This caused flooding to residential properties on Finley Close, Finley Drive, White Stiles, Rosemede Avenue and Mintsfeet Road, with internal flood depths reported to reach 1.2m (see Figure 14). Commercial properties on Mintsfeet Road, including those in the Mintsfeet Industrial Estate were also affected. In addition to the damage caused by internal flooding to property, the combined depth and velocity of the floodwater resulted in widespread structural damage, with a number of boundary walls destroyed in the area.

The level of the River Kent reached the deck of the pedestrian suspension bridge (Dockray Hall Footbridge) linking the Dockray and Mintsfeet areas and severely undermined the foundation of the right pier. Rock armour protection to the river edge was also washed away.

The wrack marks at the railway viaduct between Mintsfeet and Dockray suggest that the water was close to finding its way into the track ballast. Water was seen flowing from the track ballast behind a flank wall under Longpool Bridge, which would suggest that it did reach this level. The flow of water beneath the viaduct removed a large gravel bank that had formed, revealing concrete foundations for the first time in many years.

Flooding in the Mintsfeet area took days to drain away. This is due to there being a limited number of surface water outfalls. The combined sewer network in the Mintsfeet area is pumped and the pumping station was damaged during the flooding. This essentially meant that a small Combined Sewer Overflow (CSO) was the only available outlet for the flood water, which drained over a period of days.

Figure 14: Flooding in the Mintsfeet area

As the floodwater penetrated further south within Mintsfeet, it was eventually impounded against the embankment supporting the Oxenholme – Windermere railway, flooding Kendal cricket ground. The main flow route then turned towards the east and the A6 Shap Road, where flows combined with floodwater from Stock Beck (see Area 3: Shap Road and Appleby Road).

Area 3: Shap Road and Appleby Road

Flooding from the Rivers Mint and Kent affected properties as flood water travelled eastwards across the A6 Shap Road and inundated streets including Mint Street and Dale Avenue. In addition to the damage caused by internal flooding to property, the combined depth and velocity of the floodwater caused structural damage to a number of boundary walls in the area.

This area is located immediately north of the railway embankment and it is likely that this feature had a significant influence on the flooding in the area. As discussed in Area 2: Mintsfeet, floodwater was impounded against the embankment and flooded Kendal Cricket Ground before flowing across Shap Road. As it reached Appleby Road, the floodwater from the River Mint and River Kent combined with floodwater from the north and south tributaries of Stock Beck.

Overland flow from the north tributary of Stock Beck formed a significant flow path down Appleby Road. This flow path originated upstream of the Morrison's superstore at Spital Wood, with out-of-channel flows conveyed down Appleby Road and past the Queen Katherine School before flooding properties on and around Mint Street. The Stock Beck culvert opposite the Morrison's store at Spital Farm surcharged (reached capacity and therefore overflowed) during the event and at this location, much of the in-channel flow was diverted to the River Mint via the Stock Beck overflow. Flow that was forced out-of-bank at this point formed a secondary flow path over open fields that then contributed to flooding on Fowling Lane and Broad Ing.

The principal flood mechanisms and overland flow routes in this area are shown in Figure 15, with the aftermath of the flooding in the area shown in Figure 16. A timeline of the key events is given in Table 8.

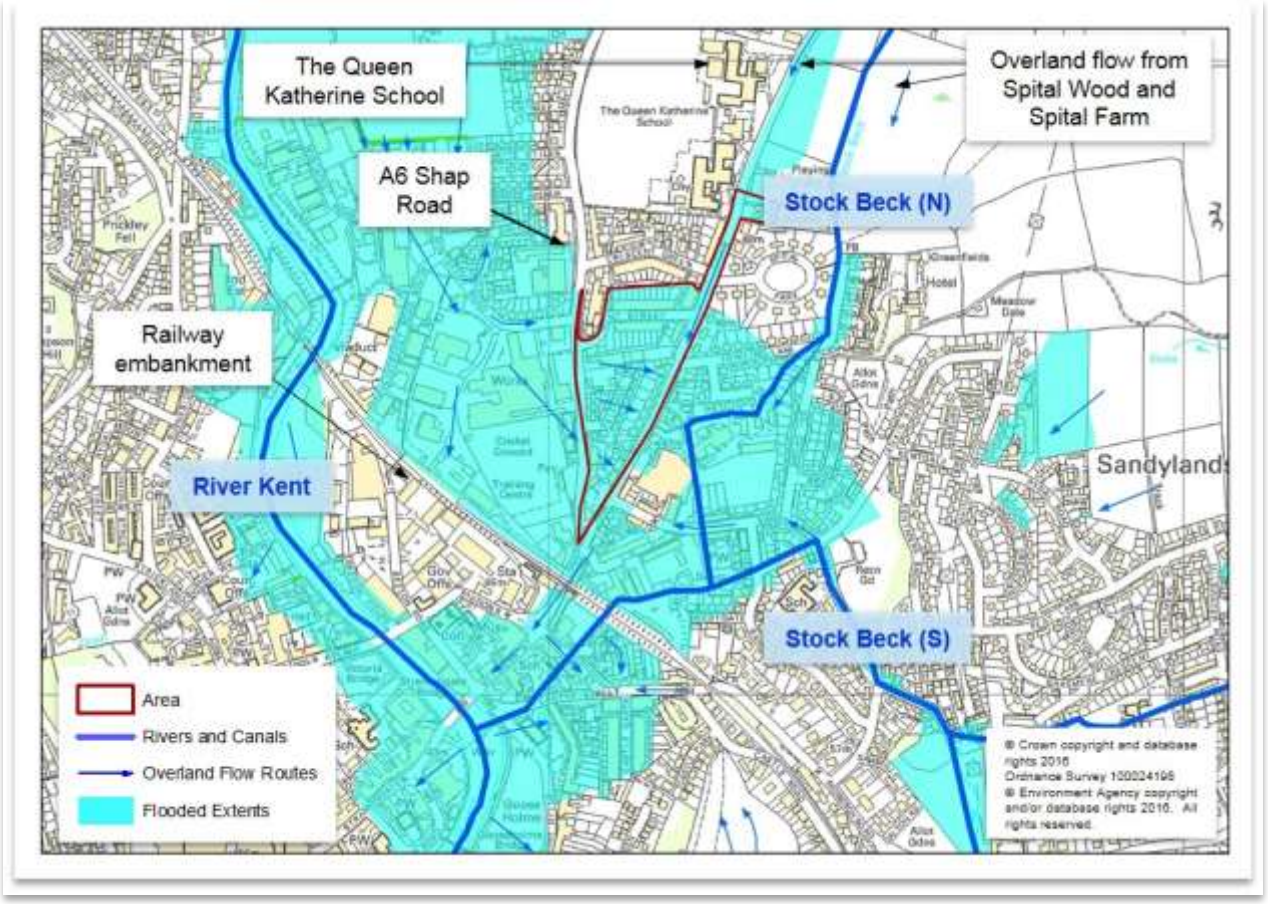


Figure 15: Overland flow routes in the Shap Road and Appleby Road area

Figure 16: Aerial photograph of Shap Road and Appleby Road area on 6th December 2015

5th December 2015	Event
12:07	**Flood Warning issued (011FWFNC29: Stock Beck at Sandylands).**
15:22	**Flood Warning issued (011FWFNC17D: River Kent at Kendal, Dockray Hall Rd, Natland Aikrigg Ave, Ann St, Back Lane, Beezon Trad Est).**
15:55	**Severe Flood Warning issued (011FWFNC17D: River Kent at Kendal, Dockray Hall Rd, Natland Aikrigg Ave, Ann St, Back Lane, Beezon Trad Est).**
16:07	**Severe Flood Warning issued (011FWFNC29: Stock Beck at Sandylands).**
16:00	Reported flooding to properties on Appleby Road, initially through the floors.
17:30	Flow route observed from Kendal Cricket Ground onto the A6 Shap Road.
17:30 – 18:30	Flooding reported in properties between the A6 Shap Road and the A685 Appleby Road.
18:00	Overland flow on A6 Shap Road observed passing beneath railway line.
18:15	River Mint peak at Mint Bridge gauging station: 53.0m AOD/170m^3/s.
21:15	River Kent peak at Victoria Bridge gauging station: 44.7m AOD/403m^3/s.

Table 8: Timeline of events in the Shap Road and Appleby Road area

Area 4: Sandylands

Situated on the east side of Kendal, the Sandylands area has limited coverage within the existing Environment Agency flood warning areas. With the exception of the area in the immediate vicinity of Sandylands Road, it is predominantly outside of Flood Zones 2 and 3, hence the lack of flood warning area coverage. However, on the 5th December 2015, the vast majority of the area between the A6 Shap Road and Jenkin Rise was badly affected by flooding. The area to the east of Sandylands has a number of sinks and springs and is also influenced by the West Coast Mainline, which sits on a raised embankment running north to south. The northern, eastern and southern Stock Beck tributaries all converge at various locations within Sandylands, as illustrated in Figure 17. It should also be noted that prior to being developed, areas of Sandylands were previously swampy land that often became ponds in winter. As a result of development, much of this natural flood storage has been lost.

Reports and evidence suggest that the flooding in this area was caused by multiple mechanisms. The area is situated immediately adjacent to Mintsfeet, and so was affected by flood flows from the Rivers Mint and Kent as per Area 2. In addition to this, the Stock Beck system, which comprises three tributary watercourses, flows through the area and is culverted for much of its length. Flooding was reported from a number of manholes associated with this culvert on Sandylands Road and damage was caused to part of a footpath on Eastgate, where the culvert roof was lifted up by the water pressure. Furthermore, overland flow was observed from the 'north' Stock Beck tributary down Appleby Road, affecting properties on Appleby Road and in the Longlands View and Fowling Lane areas (see Area 3: Shap Road and Appleby Road).

The principal flood mechanisms and overland flow routes in this area are shown in Figure 17, with the aftermath of the flooding in the area shown in Figure 18. A timeline of the key events is given in Table 9.

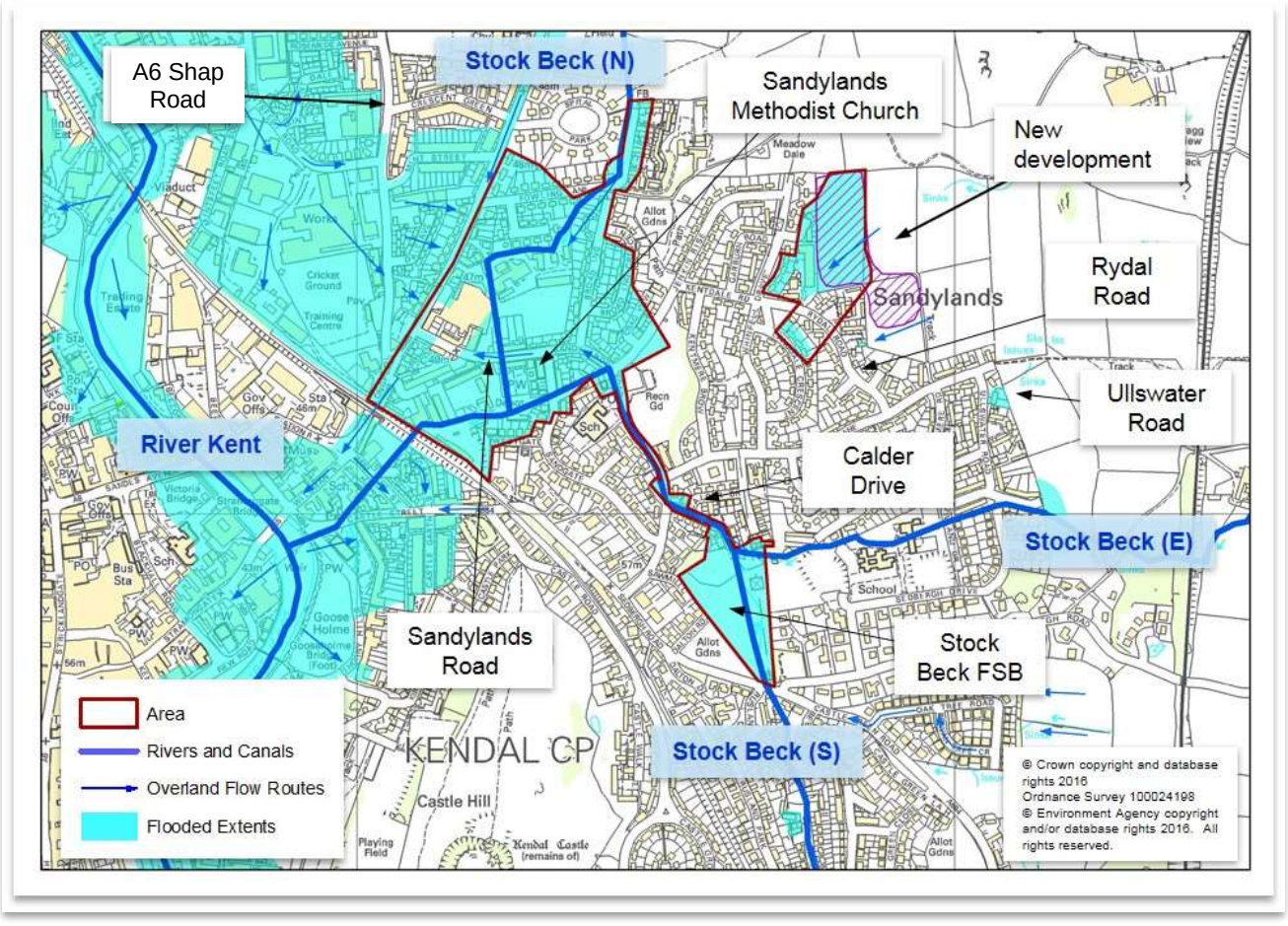


Figure 17: Overland flow routes in the Shap Road, Appleby Road and Sandylands areas

Figure 18: Aerial photograph of the Sandylands area on 6th December 2015

5th December 2015	Event
11:00	Properties on Ullswater Road suffer surface water flooding from run-off from upstream fields.
12:00	Spillway at Stock Beck FSB starts to overtop.
12:07	**Flood Warning issued (011FWFNC29: Stock Beck at Sandylands).**
13:30	Properties affected by flooding at the junction of Eastgate, Jenkin Rise and Sandylands Road. Observed surcharging of the drainage system in the car park at Jenkins Crag Court Sheltered Housing to the rear of properties on Whinfell Drive.
14:45	Overland flow observed on Sandylands Road.
15:22	**Flood Warning issued (011FWFNC17D: River Kent at Kendal, Dockray Hall Rd, Natland Aikrigg Ave, Ann St, Back Lane, Beezon Trad Est).**
15:55	**Severe Flood Warning issued (011FWFNC17D: River Kent at Kendal, Dockray Hall Rd, Natland Aikrigg Ave, Ann St, Back Lane, Beezon Trad Est).**
16:07	**Severe Flood Warning issued (011FWFNC29: Stock Beck at Sandylands).**
16:00	Flooding from manholes associated with Stock Beck culvert on Sandylands Road/Eastgate, 250mm depth of overtopping of spillway at Stock Beck FSB.
16:00 – 17:30	Properties on and around Sandylands Road begin to flood with reports of flooding through the floor initially.

18:15	River Mint peak at Mint Bridge gauging station: 53.0m AOD/170m^3/s.
21:15	River Kent peak at Victoria Bridge gauging station: 44.7m AOD/403m^3/s.
6th December 2015	**Event**
00:00	Depth of flooding up to 1.2m in the vicinity of Sandylands Road
08:57	Flow observed by-passing Stock Beck FSB along embankment crest

Table 9: Timeline of events in Sandylands

Table 9 shows that at the start of the event, flooding originating from surface water, springs, minor watercourses and overland flows from Jenkin Crag contributed to the problems in the Sandylands area. Properties on the east side of Ullswater Road and Rydal Road back onto open fields, with the land rising away from the properties relatively steeply. During the flood event, it is apparent that run-off from these open fields was channelled towards particular properties on these two roads and this resulted in localised internal flooding.

Residents on Rydal Road and in the Jenkins Crag Court Sheltered Housing complex observed the drainage systems in the car park of Jenkins Crag Court surcharging at 13:30 on 5th December. Water was then observed flowing towards the rear of properties on Whinfell Drive, subsequently flooding properties despite several hours of pumping by the Fire Service.

The residents of 31 Rydal Road observed water flowing off the fells into the attenuation pond situated within a new development to the rear of their property. The attenuation pond reportedly overflowed, resulting in a significant depth of water building up behind the garden boundary wall to the rear of their property. Local residents subsequently took action to knock down the boundary wall to the north of their properties, next to a row of garages, to release the water away from their properties. This action allowed the water gathered behind the wall to drain away into the local drainage network, and prevented internal flooding of the properties.

Upstream of the Stock Beck FSB on the southern Stock Beck tributary, properties on Lowther Park and Willow Drove were affected by flooding. Residents on Lowther Park reportedly took action to protect their properties by pumping flood water upstream. There are unconfirmed reports that the actions undertaken on Lowther Park may have subsequently affected properties upstream on Willow Drive.

As the event progressed, properties on Calder Drive were affected by overland flow caused by problems associated with the performance of Stock Beck FSB. This storage basin is located upstream of Calder Drive and on the confluence of the southern and eastern tributaries to the Stock Beck watercourse system (see Figure 6). It is an online flood storage basin and immediately downstream of the confluence, the watercourse discharges through the water-retaining embankment via a flow control structure. This flow control comprises an orifice/penstock (principal control) and a high level weir and spillway (secondary control and auxiliary overflow).

Environment Agency telemetry, which monitors water levels at the FSB, indicates that the basin spillway level was reached around 12:45. The telemetry indicates that levels within the FSB continued to rise through the afternoon, before peaking around 18:00 and slowly receding through the late evening and into 6th December. During the Storm Desmond event, it is apparent from photographs taken on the afternoon of 5th December that the capacity of the storage basin was reached. In Figure 19, the photograph on the left clearly shows that at 16:00, the basin is full and the auxiliary overflow (a protected section of embankment shown in the foreground of the photograph) is in use.

Figure 19: Stock Beck FSB at 16:00 05/12/2015 (left) and at 08:57 06/12/2015 (right)

Furthermore, the photograph on the right in Figure 19 shows water flowing along the crest of the water-retaining embankment after water levels in the main storage basin have started to recede. This water was able to by-pass the storage basin and flow down Calder Drive, causing further internal flooding to a number of properties. The source of the overland flows in this particular case was one of the tributaries of Stock Beck, which drains a steep catchment off the fells due east of Sandylands. At the point of entry into the basin, the watercourse is in open channel and the bed level of the channel is close to the level of the embankment crest. As it meets the embankment, the watercourse then enters into culvert via a trash screen and drop structure as shown in Figure 20.

Figure 20: Stock Beck tributary culvert inlet to Stock Beck FSB

During the event, the trash screen was blocked by debris and the inlet capacity of the culvert exceeded, causing water levels to back up. A significant amount of debris was washed down onto the screen from

a damaged outfall structure immediately upstream. Material was scoured from behind the structure due to discharge from an outfall pipe on the right bank flowing into the discharge from the outfall, with the subsequent turbulence causing the extensive scour illustrated in Figure 21. Unfortunately, the design of the inlet structure is such that the access provided to allow the screen to be cleared also provided the pathway for the water to escape. Flows passed through the gated opening as opposed to entering the culvert and spilled onto the basin embankment crest. The topography of the crest is such that these flows were then channelled along the crest (as opposed to spilling back into the basin) before continuing into Calder Drive.

Figure 21: Scour damage to rear of outfall structure upstream of Stock Beck FSB

Downstream of the flood storage basin, Stock Beck Tributary 1 (which flows out of the FSB) is culverted beneath Calder Drive, Sandylands Road, and Eastgate before it meets the northern tributary (Stock Beck Westgate) upstream of the Oxenholme – Windermere railway line at Jewson's builders merchants. The existing ground profile above this culvert is initially steep as it passes beneath Calder Drive and into Sandylands Road, before flattening out at the Eastgate/Jenkin Rise junction, at which point an ordinary watercourse culvert flowing down Jenkin Rise joins the main Stock Beck culvert. At this location, flooding from manholes was reported, indicating that the capacity of the culvert was exceeded. Local residents reported that properties situated adjacent to this junction were known to have flooded at around 13:30 on 5th December. The existing footpath between Eastgate and Sandylands Road was also damaged due to the high water pressures on the culvert soffit (roof). It is probable that the change in gradient of the existing ground profile along the route of Stock Beck is reflected in the culvert bed level profile, which will translate through to a significant drop in culvert capacity. Furthermore, there was evidence to suggest that as the culvert passes beneath the railway embankment, flows were significantly restricted due to the existing culvert capacity being exceeded, exacerbated further by blockages in the channel. This resulted in the backing up of floodwater, affecting the Jewson's merchant yard and BT offices in the area.

The flooding from both the 'north' and 'south' tributaries of Stock Beck made a significant contribution to the flooding observed on and around Sandylands Road. The sequence of events suggests that it was this source that caused the initial flooding in the area. Video footage provided by Jonny Gios of Sandylands Methodist Church indicates that 15-20 properties on Sandylands Road flooded initially and at that time, the church had been opened as a reception centre for flood victims. However, the church itself had to then be evacuated as flood waters continued to rise and internal flooding occurred in the church to a maximum depth of 350mm. It is likely that this next phase of flooding occurred as the area was hit by out-of-bank flood flows from the rivers Rivers Mint and Kent. As flow from the Rivers Mint

and Kent entered the Sandylands area, water depths in properties on Sandylands Road reportedly reached 1.2m as the event peak occurred at around 21:00. Evidence suggests that the Drovers Drive development (on the old Auction Mart site) may have altered the flood flow routes associated with Stock Beck, with flow now being directed via Broad Ing and increasing the depth of flooding in the Copperfield Lane, Fowl Ing and Broad Ing areas.

At this stage it is important to note the reports from a number of properties, including Sandylands Methodist Church, of the onset of flooding occurring through the floor, as opposed to through doors, windows and walls. This suggests that groundwater flooding also played a role in this area. Based on British Geological Survey mapping, the underlying bedrock is sandstone and the soil on top is alluvium. Environment Agency mapping also shows that the underlying ground is a designated Secondary Aquifer. The underlying ground is therefore capable of holding water and given the already saturated ground conditions prior to Storm Desmond it is likely that groundwater levels were already at or near ground level. Sewers to the rear of properties at the western end of Sandylands Road were seen to be surcharging, lifting manhole covers to several feet.

Area 5: Wildman Street, Ann Street and Castle Street

Flooding occurred in the Wildman Street, Ann Street, and Castle Street area from a variety of sources, with initial reports of flooding from drainage systems and groundwater, as well as fluvial flooding from Stock Beck, the River Mint, and the River Kent. Whilst the area is situated on the left bank of the River Kent, it was the other sources that initially caused flooding in the area before the River Kent burst its banks in the centre of Kendal.

The principal flood mechanisms and overland flow routes in and around the Ann Street and Castle Street area are shown in Figure 22, with a timeline of the key events given in Table 10.

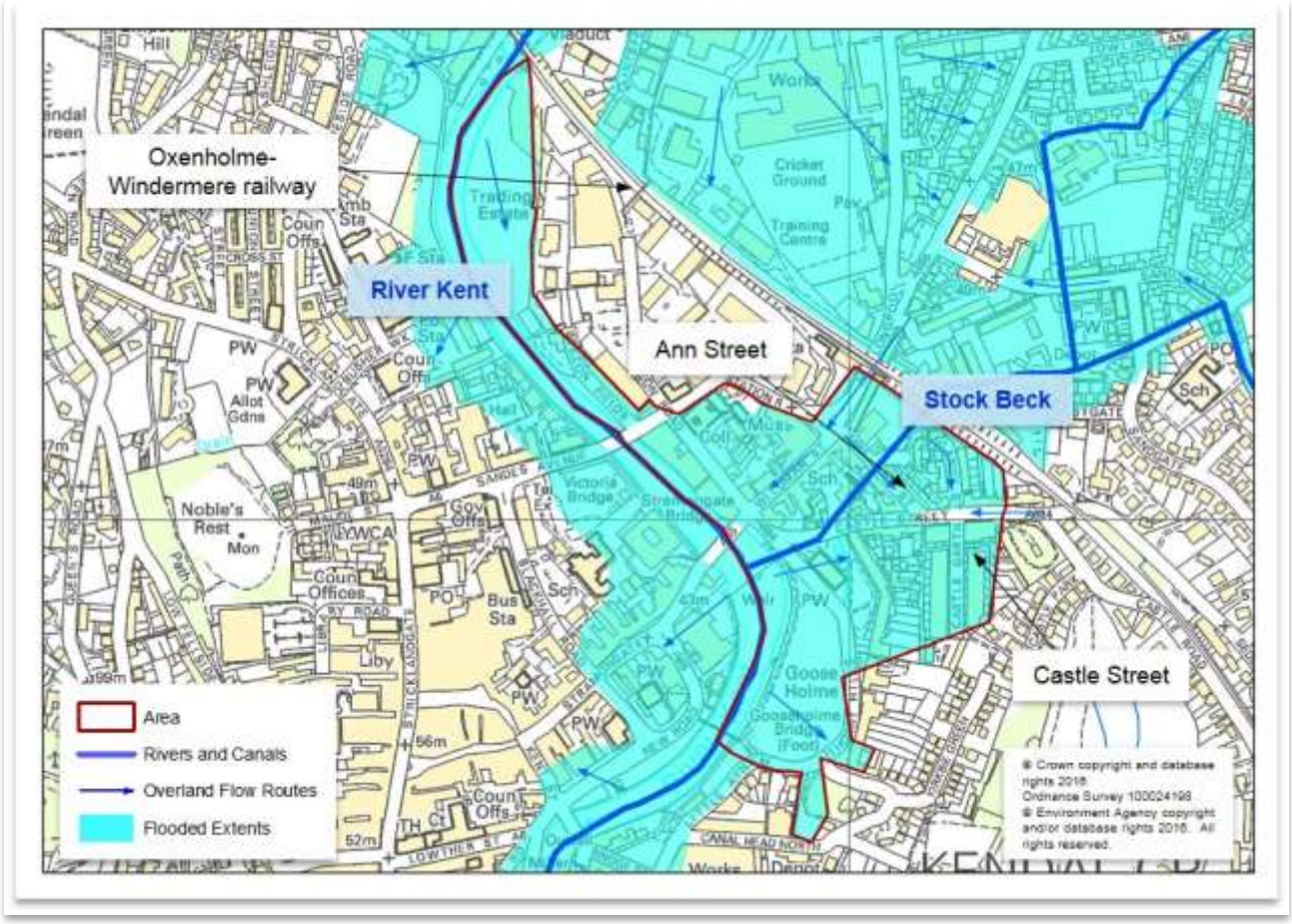


Figure 22: Overland flow routes in the Wildman Street, Ann Street and Castle Street area

5th December 2015	Event
11:15	Flooding in Castle Street Centre car park due to backing up of surface water drainage system.
13:00	Overland flow observed on Gandy Street.
15:11	**Flood Warning issued (011FWFNC17C: River Kent at Kendal, Castle Cres, Aynam Rd, Lound Rd, Mintsfeet).**
15:22	**Flood Warning issued (011FWFNC17D: River Kent at Kendal, Dockray Hall Rd, Natland Aikrigg Ave, Ann St, Back Lane, Beezon Trad Est).**
15:48	**Severe Flood Warning issued (011FWFNC17C: River Kent at Kendal, Castle Cres, Aynam Rd, Lound Rd, Mintsfeet).**

15:55	**Severe Flood Warning issued (011FWFNC17D: River Kent at Kendal, Dockray Hall Rd, Natland Aikrigg Ave, Ann St, Back Lane, Beezon Trad Est).**
16:00	Flooding from River Mint and Stock Beck in and around Castle Crescent.
18:00	Overland flow on A6 Shap Road observed passing beneath railway line at Longpool.
21:15	River Kent peak at Victoria Bridge gauging station: 44.7m AOD/403m^3/s.

Table 10: Timeline of events in the Wildman Street, Ann Street and Castle Street area

Initially, flooding to properties on Ann Street, Castle Street, and Castle Crescent appears to have been caused by groundwater in some instances. A Community Support Officer report[3] provides direct reports from residents of seventeen properties in the area which all suffered initial flooding from groundwater. Initial flooding also occurred where surface water drainage systems serving the area reached their capacity. Flooding was reported early in the event from road gullies in the Castle Street car park.

As the event progressed, the area was hit by fluvial flooding from Stock Beck, which passes beneath the railway line in culvert before crossing Ann Street. The area is also situated at the end of the main flow path from the River Mint and Kent through Mintsfeet and Sandylands, where flood waters were channelled along the A6 Shap Road towards Longpool and through the railway bridge. Flow velocities through the railway bridge at Longpool were high due to the flows being channelled through the narrow opening in the railway embankment.

Properties on and around Ann Street and Castle Street were severely affected by the flooding. The fluvial flooding was caused by a combination of Stock Beck and flood flows through Longpool, with impacts exacerbated further as the River Kent downstream of Stramongate Bridge burst its banks. The result was that the worst affected properties in the area flooded to a depth of 1.2m. Figure 25 shows the aftermath of the event in the area on 6th December.

Residents on Castle Crescent reported that post-flood water drained away from the area via the redundant Stock Beck culvert. The redundant culvert has drainage holes along the base of its raised wall (see Figure 23), allowing water to enter the culvert, and runs along Castle Crescent to the rear of St George's Church, before passing under Gooseholme and discharging to the River Kent via a small pipe. This arrangement provides surface water drainage to the area during and after periods of prolonged rainfall.

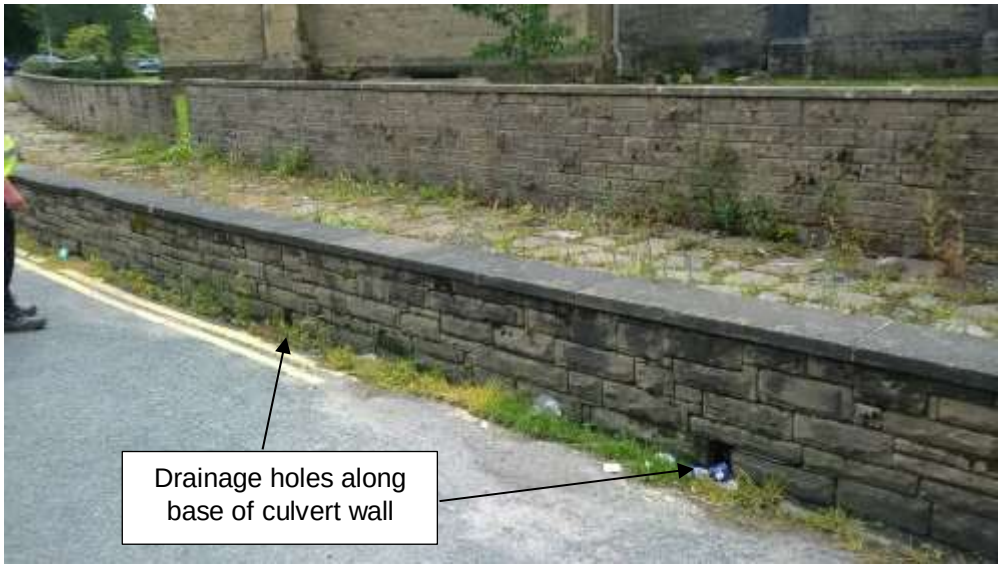


Figure 23: Redundant Stock Beck culvert on Castle Crescent

[3] Community Support Officer Report, Chris Byatt, 09/12/2015

Figure 24: Aerial photograph of the Ann Street and Castle Street area on 6th December 2015

Figure 25: Ann Street in the aftermath of the event on 6th December 2015

Area 6: Aikrigg Avenue, Dockray Hall, New Road and Stramongate

The principal flood mechanism was from the right bank of the River Kent between Aikrigg Avenue in the north and New Road in the south. The magnitude of the flood event (403m³/s peak flow recorded at Victoria Bridge) was greater than the maximum flow that the existing scheme (280m³/s) had been designed, exceeding the capacity of the river channel.

In addition to the fluvial flooding, it was reported that initial flooding to properties on Aikrigg Avenue was caused by sewer flooding.

Commercial properties in the Dockray Hall Industrial Estate were affected by flooding from the River Kent along with residential properties along Dockray Hall Road. Further downstream along Busher Walk, an informal flood defence embankment was overtopped and outflanked by the River Kent affecting Cumbria Police buildings. This flood mechanism also affected a number of properties in the Benson Green and Sandes Avenue area. Reports suggest that groundwater flooding, and overland surface water flows being channelled down Windermere Road, were also a contributory factor in this area.

Residents of Benson Green raised concerns that Victoria Bridge reached capacity, and therefore acted as an obstruction to flow during the flood event, raising flood levels at their properties situated upstream of the bridge. Figure 26 shows the wrack level (marking the peak water level) on the riverside path on the right bank of the River Kent adjacent to Victoria Bridge. This level has been surveyed as 45.30mAOD, which, when compared to the Victoria Bridge soffit level of 45.12mAOD, shows that Victoria Bridge did reach capacity during the flood event by around 0.18m. Figure 26 also shows a collapsed sandbag wall, which has collapsed towards the river, illustrating the force of water flowing towards the river from the rear of properties in Benson Green.

Figure 26: Wrack level on the riverside path at Benson Green, adjacent to Victoria Bridge. Note the sandbag wall which has collapsed towards the river.

In the centre of Kendal, commercial properties on Stramongate and New Road suffered flooding from the River Kent. Overtopping of the right bank of the river downstream of Stramongate Bridge was observed at 17:00 on the 5th December, with the peak river level occurring some four hours later.

Figure 27 indicates the key overland flow routes and a timeline of the key events in the centre of Kendal is given in Table 11.

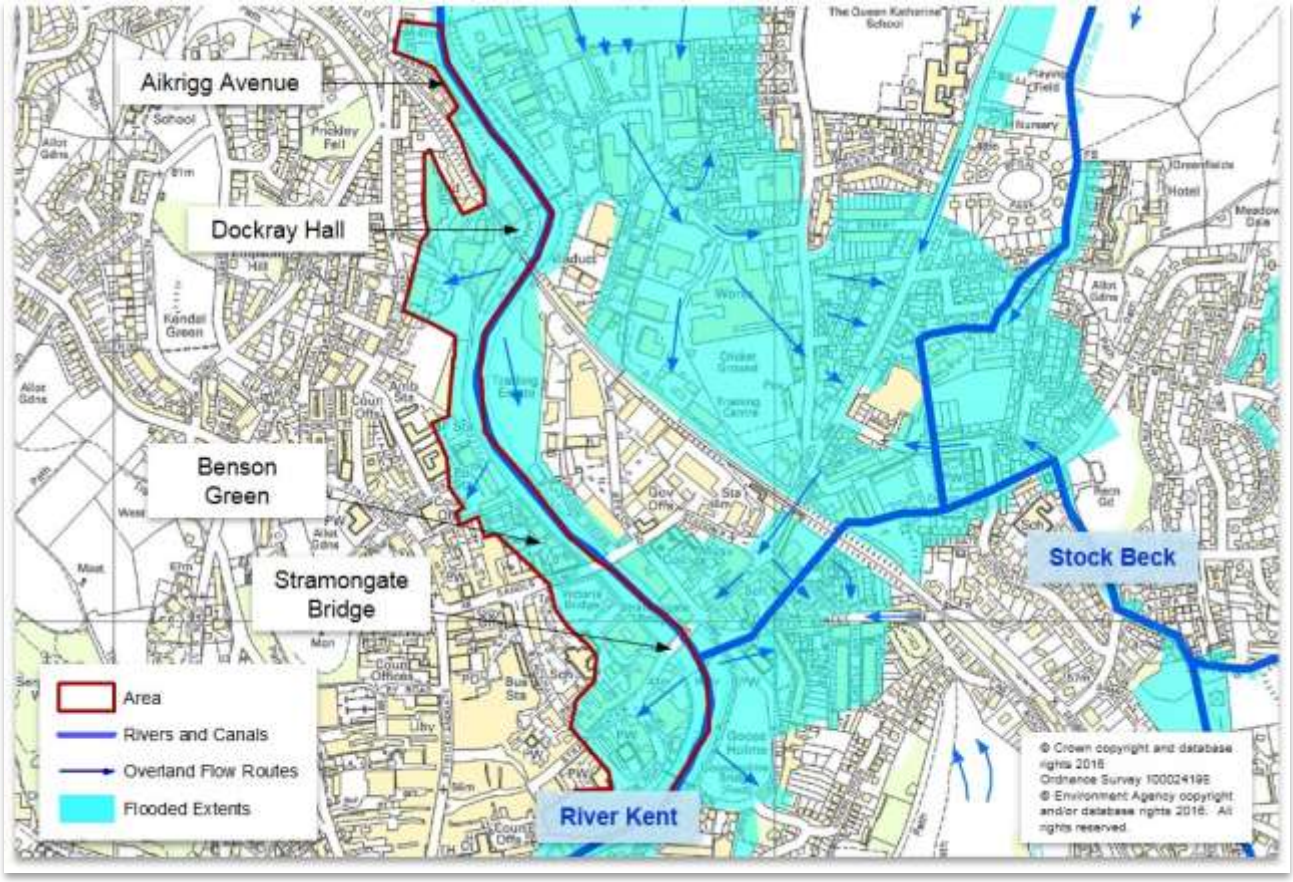


Figure 237: Overland flow routes in the centre of Kendal

5th December 2015	Event
15:11	**Flood Warning issued (011FWFNC17C: River Kent at Kendal, Castle Cres, Aynam Rd, Lound Rd, Mintsfeet).**
15:22	**Flood Warning issued (011FWFNC17D: River Kent at Kendal, Dockray Hall Rd, Natland Aikrigg Ave, Ann St, Back Lane, Beezon Trad Est).**
15:48	**Severe Flood Warning issued (011FWFNC17C: River Kent at Kendal, Castle Cres, Aynam Rd, Lound Rd, Mintsfeet).**
15:55	**Severe Flood Warning issued (011FWFNC17D: River Kent at Kendal, Dockray Hall Rd, Natland Aikrigg Ave, Ann St, Back Lane, Beezon Trad Est).**
17:00	Overtopping of the right bank of the River Kent downstream of Stramongate Bridge.
21:15	River Kent peak at Victoria Bridge gauging station: 44.7m AOD/403m^3/s.

Table 11: Timeline of events for areas in and around the centre of Kendal

Areas 7 & 8: River Kent (Left & Right Banks)

Much of the land in the immediate vicinity of the River Kent as it flows through Kendal suffered flooding with properties on both the left and right banks affected. On the left bank, the flooded areas continue from Castle Street and Gooseholme Park in the north (see Area 4) to the Riverside Business Park on Natland Road in the south. On the right bank, the affected area stretched from the Central Business District (CBD) in the north to the A6 Romney Road in the south.

In this case, the flooding was principally caused by flooding from the River Kent, with flooding from drainage systems and basement flooding from groundwater also reported. Prior to any flooding from the River Kent, the basements of properties on Aynam Road first suffered flooding from groundwater at around 15:00 on 05/12/2015.

'A local resident on Brigsteer Road, in the upper Blind Beck catchment, reported flooding to garages from local springs at The Ghyll, Hylands and other garages further down towards Greenside. There was also localised flooding observed on Brigsteer Road at the junction of the Underwood Estate, where flood depths were reportedly 60cm.'

Figure 28 indicates the key overland flow routes and a timeline of the key events is given in Table 12.

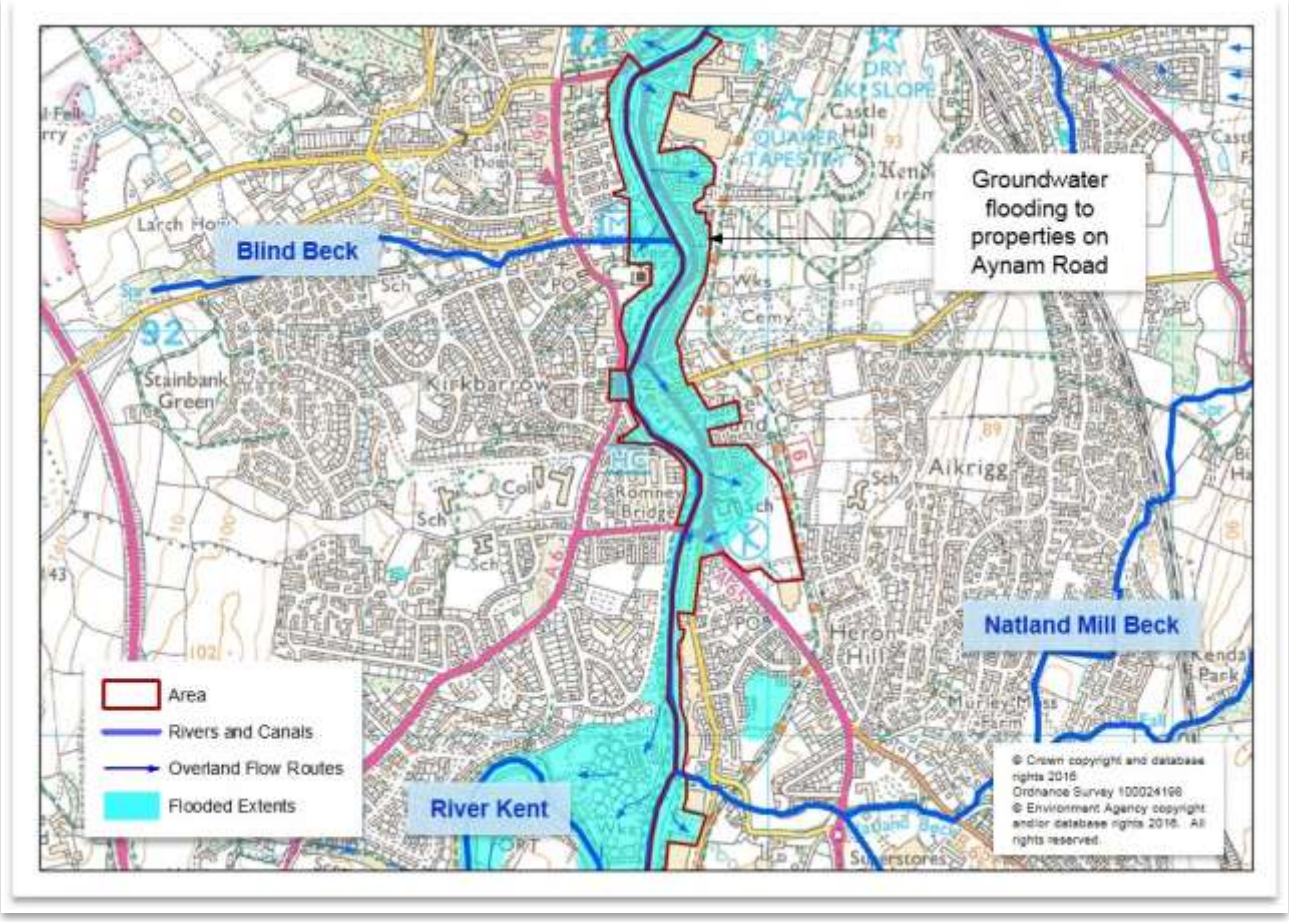


Figure 248: Overland flow routes on the left and right banks of the River Kent through Kendal

5th December 2015	Event
15:00	Groundwater flooding of basements in properties on Aynam Road opposite the Blind Beck outfall.
15:11	**Flood Warning issued (011FWFNC17C: River Kent at Kendal, Castle Cres, Aynam Rd, Lound Rd, Mintsfeet).**
15:22	**Flood Warning issued (011FWFNC17D: River Kent at Kendal, Dockray Hall Rd, Natland Aikrigg Ave, Ann St, Back Lane, Beezon Trad Est).**
15:48	**Severe Flood Warning issued (011FWFNC17C: River Kent at Kendal, Castle Cres, Aynam Rd, Lound Rd, Mintsfeet).**
15:55	**Severe Flood Warning issued (011FWFNC17D: River Kent at Kendal, Dockray Hall Rd, Natland Aikrigg Ave, Ann St, Back Lane, Beezon Trad Est).**
17:00	Overtopping of the right bank of the River Kent downstream of Stramongate Bridge.
21:15	River Kent peak at Victoria Bridge gauging station: 44.7m AOD/403m^3/s.

Table 12: Timeline of events for areas on the left and right banks of the River Kent through Kendal

The east and west sides of Kendal are connected by a series of bridges over the River Kent and these have varying ages and construction types. The bridges include road bridges, pedestrian footbridges, and a railway viaduct, and are thought to have exacerbated the flooding along the banks of the River Kent. Evidence suggests that these bridges reached their capacity during the event and Figure 29 shows the water level in the River Kent approaching the soffit of the eastern arch of Nether Bridge. The railway viaduct is also thought to have had a role in diverting flow in the River Kent into the Mintsfeet area. Further investigatory work is required to fully assess the role of the bridges and to identify where conveyancing improvements can be made.

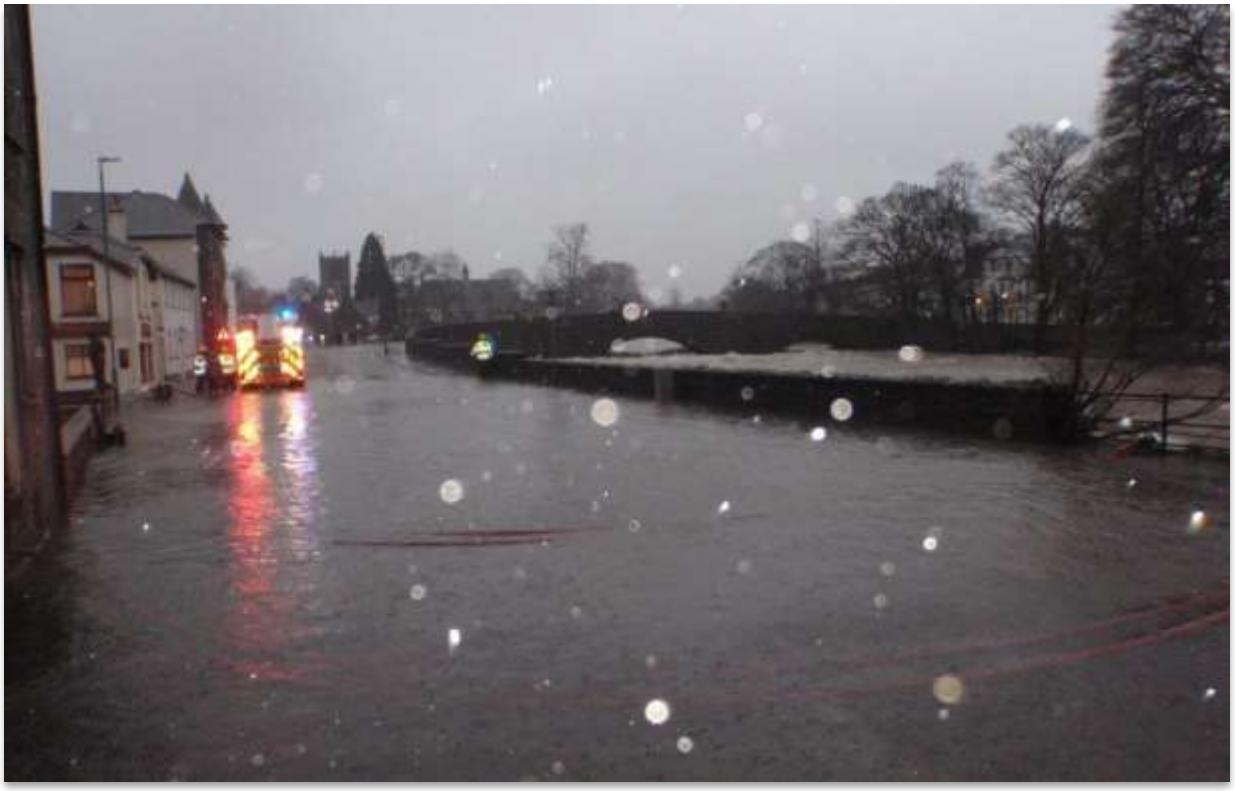


Figure 259: Nether Bridge, taken on the right bank of the River Kent looking north

Area 9: Natland Mill Beck & Natland Mill Beck Tributary

Natland Mill Beck and Natland Mill Beck Tributary drains a small catchment that includes the south-east of Kendal and discharges to the River Kent opposite Kendal WwTW. The watercourse system comprises three tributaries and localised fluvial flooding from the southerly Natland Mill Beck Tributary affected properties on Blencathra Gardens and Hardknott Gardens. This watercourse flows in open channel to the rear of properties on Hardknott Gardens and Blencathra Gardens before passing beneath Hardknott Gardens in culvert.

Reports from local residents who observed the flooding mechanisms were that the Natland Mill Beck Tributary exceeded its channel capacity in the fields upstream and flowed out of bank across the fields towards Blencathra Gardens and Hardknott Gardens. There were also observations of a blockage where the watercourse flows underneath a fence line at the eastern extent of the estate. The blockage at the fence line was caused by debris - including bed material from the watercourse that had been scoured by the velocity of the water - becoming trapped on the fence. This blockage resulted in flow leaving the watercourse channel on the right bank, flowing through properties on Blencathra Gardens and Hardknott Gardens before re-joining the channel. The affected area is shown in Figure 30.

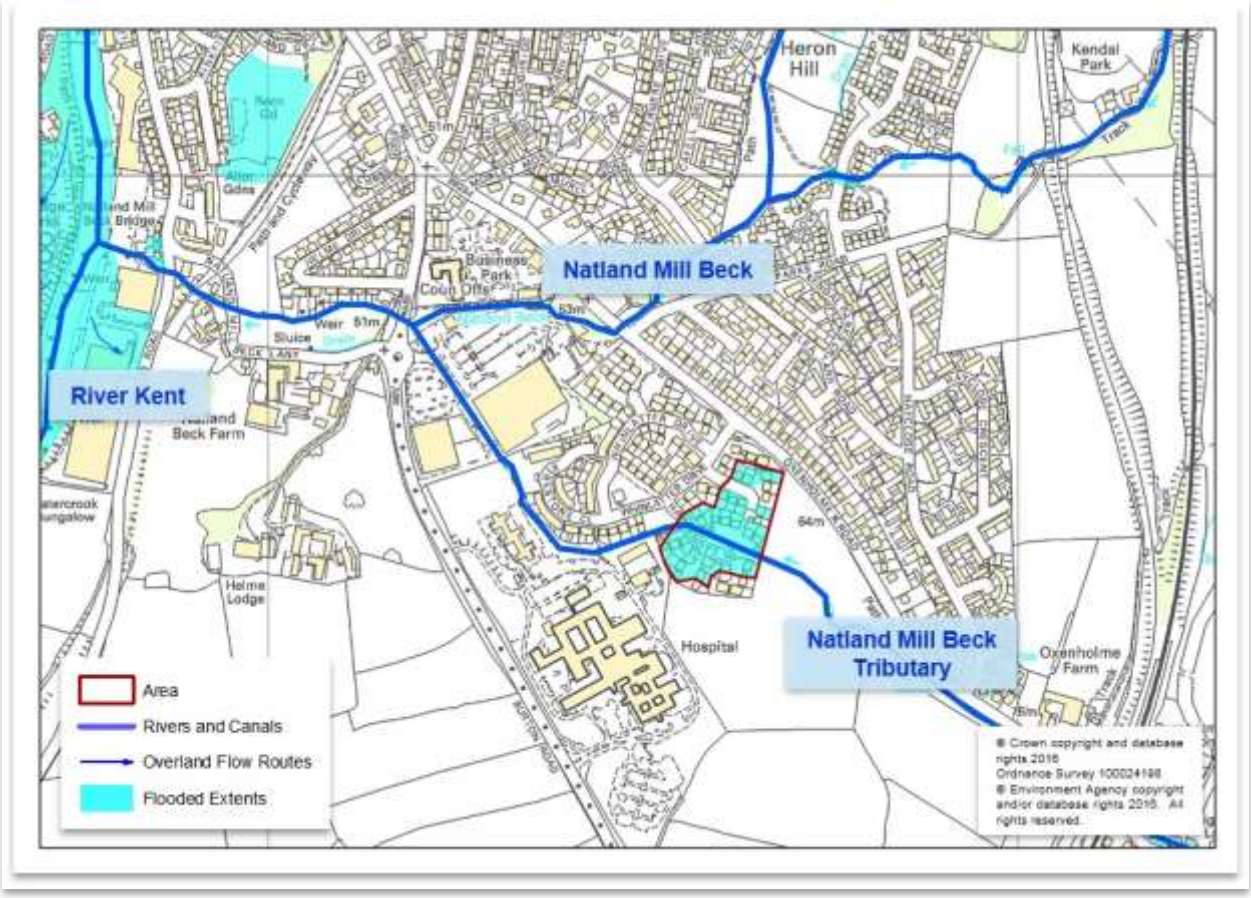


Figure 3026: Affected areas around Natland Mill Beck and Natland Mill Beck Tributary

Area 10: Kendal Wastewater Treatment Works and Helsington Mills

Kendal Wastewater Treatment Works (WwTW) is located at the southern boundary of the town on the inside of a bend in the River Kent. United Utilities reported that the WwTW was submerged under 12ft of water at its deepest and the site was inaccessible until waters subsided. The sudden increase and the intensity of the river flows completely destroyed the outfall resulting in the backing up of flows and flooding of approximately 85% of the area of the site, and damaging almost every treatment stage and mechanical or electrical assets to a greater or lesser degree. In addition, the rising river levels caused parts of the site to flood from rising ground waters. The final effluent discharge pipe was washed away. The workshop and ground floor offices were affected, although there was no significant structural damage. Paths and roadways were damaged and littered with flood debris, hindering access during the early stages of emergency recovery.

At the Watercrook Farm housing development, situated on the left bank of the River Kent opposite the WwTW, an overland flow route from the River Kent developed on the outside bend of the river. Water flowing across the floodplain filled the area to the north of the properties access road, before seeping through the dry stone wall which runs alongside the road. As water encroached towards the Watercrook Farm housing development, residents dismantled sections of this dry stone wall to enable flow to continue downstream across the floodplain and back into the River Kent. Although the main volume of flow bypassed the properties, and dismantling sections of the dry stone wall greatly helped to enable flow across the floodplain and away from the properties, a low level overland flow route followed the access road towards the properties. Residents therefore constructed low level sandbag defences, which prevented internal flooding to properties.

Further downstream on the right bank of the River Kent, there was a flow route caused by surface water run-off and flow from an ordinary watercourse along Scroggs Lane, which provides access to properties in Helsington Mills. Here, water depths were reported as being 0.6-0.9m. This overland flow combined with fluvial flooding from the River Kent to flood properties in the Helsington Mills development to a depth of 0.9-1.2m. 'A resident of Helsington Mills, Phil Chaplow, provided the following details of the flooding that affected the area on the 5th and 6th December. The first property to be affected by flooding in Helsington Mills was Mr Chaplow's property, Mill House, which is the lowest lying property in the development. Flooding reportedly began at Mill House around 15:00 on 5th December. By 16:30, a water depth of 0.9m was observed at the access bridge at the bottom of Scroggs Lane. The peak water level was reached at around 23:30, with Mill House reportedly flooded to a depth of 2.0m. At 08:00 on 6th December, Mr Chaplow reported that water levels remained at around 0.9m, and that it was necessary to wade through water to access properties. It wasn't until about 15:00 later that afternoon when all of the flood water had left the lowest property.'

Figure 31 indicates the key overland flow routes, with the aftermath of the flooding in the area shown in Figure 32 and a timeline of the key events given in Table 13.

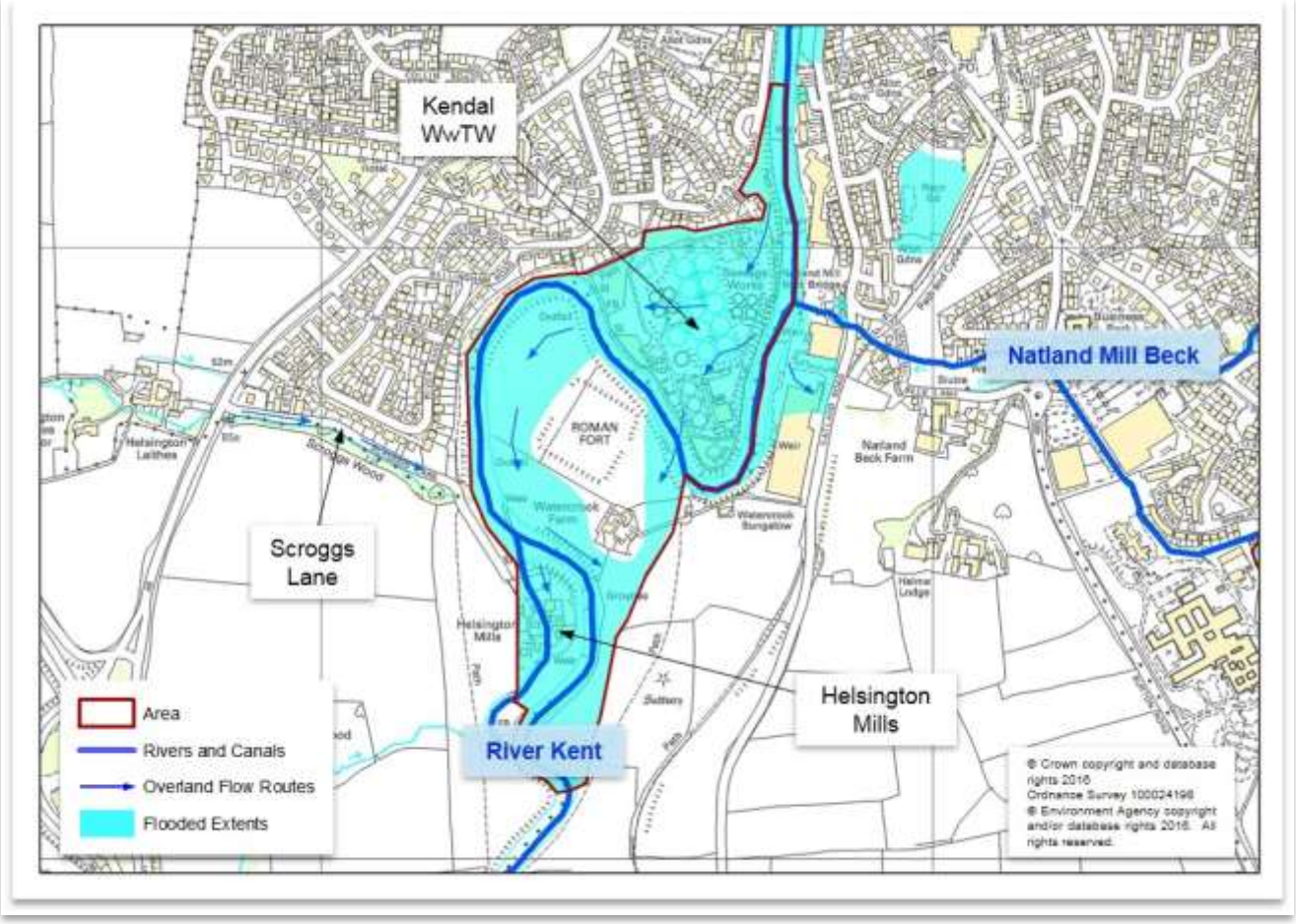


Figure 31: Overland flow routes at Kendal WwTW and Helsington Mills

Figure 32: Aerial photograph of Helsington Mills on 6th December 2015

5th December 2015	Event
15:00	Onset of flooding in Helsington Mill
15:22	**Flood Warning issued (011FWFNC19: River Kent at Helsington Mills).**
16:00	**Severe Flood Warning issued (011FWFNC19: sRiver Kent at Helsington Mills).**
16:30	Water depth at Scroggs lane 0.9m
17:00	Onset of flooding to properties at Helsington Mills, south of Kendal, with depths reaching 0.9-1.2m.
21:15	River Kent peak at Victoria Bridge gauging station: 44.7m AOD/403m^3/s.
23:30	Peak flooding level in Helsington Mills

Table 13: Timeline of events at Kendal WwTW and Helsington Mills

Area 11: Hallgarth

The Hallgarth residential area is located on the north-west side of Kendal. It is drained by an extensive network of public surface water sewers, which also intercept ordinary watercourses flowing down from the upstream green field areas. These sewers all discharge to a 900mm diameter surface water sewer[4] that conveys flows through the Oxenholme-Windermere railway embankment before ultimately discharging to the River Kent.

Whilst the area was unaffected by the river flooding that affected the north and central areas of the town, parts of the area were affected by surface water flooding. In a similar mechanism to that experienced by properties on Ullswater Road and Rydal Road in Area 3, some properties on the junction between Low Garth and Acre Moss Lane suffered from localised surface water flooding. Other overland flow routes were observed in the area, with surface water run-off from areas upstream of the A5284 Windermere Road channelled down the road itself to an observed depth of 100mm at around 19:00.

The principal flood mechanisms and overland flow routes for the Hallgarth area are shown in Figure 33.

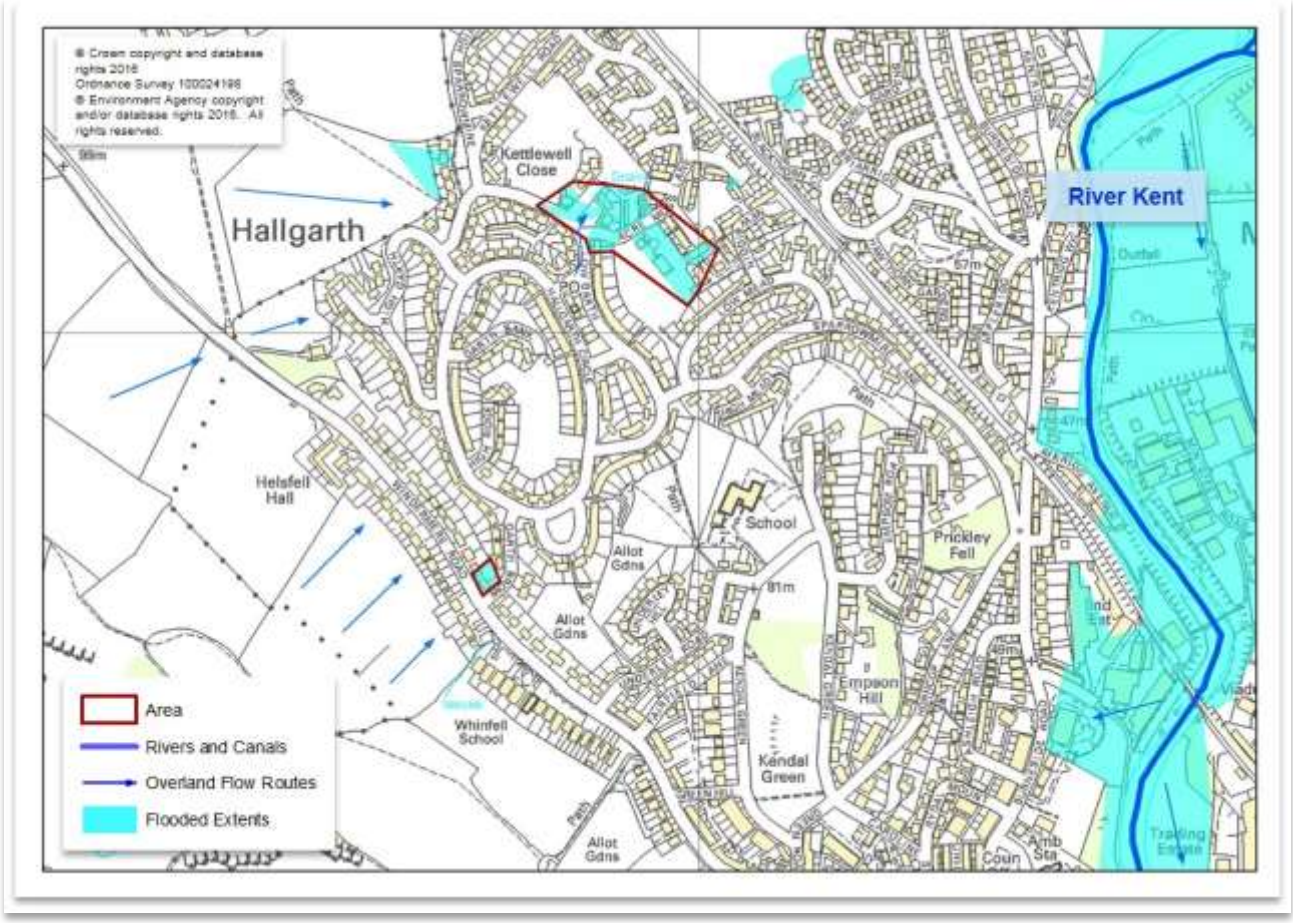


Figure 33: Overland flow routes in the Hallgarth area

[4] Public sewer data obtained from United Utilities Safe Dig mapping (www.safedig.unitedutilities.com)

Environment Agency Flood Incident Response

Pre-event Warning and Preparation

A Flood Alert for the River Kent catchment was issued on the 4th of December at 15:22. Following this, Flood Warnings were issued to the flood warning areas within Kendal between 09:03 and 15:22 on the 5th December. Severe Flood Warnings were issued between 15:42 and 15:55 on the same day. The details of the flood warning areas and the timings of these warnings are shown in Appendix 3.

Many areas affected by flooding during this event were not located within an existing Environment Agency flood warning area, therefore many residents will not have received a direct warning from the Environment Agency. From engagement with residents following the flood event, it is also apparent that many residents did not receive the Flood Warning with adequate time to be able to take action to protect their properties. Residents have also reported that during a previous event in November 2015, Flood Warnings and Severe Flood Warnings were issued by the Environment Agency following which no flooding occurred in Kendal. Residents are fully aware of this inconsistency in the Environment Agency flood warning service. It is also apparent that some properties flooded primarily from sources other than the main rivers in Kendal. The current Environment Agency flood warning service does not provide advance warning of flooding from sources other than the main rivers in Kendal, so it is possible that some residents did not receive a warning prior to, or far enough in advance of, the onset of flooding due to this fact.

The feedback received from engagement with those affected by the flooding in Kendal suggests that the existing flood warning system was not effective for the specific flood mechanisms that occurred in this flood event. The Environment Agency are currently reviewing the performance of the flood warning service in Kendal to identify and implement improvements to the service for future flood events. This will include reviewing the extent of the existing flood warning area coverage to incorporate areas affected by flooding during the December event for the first time. This will be done by using data and information gathered from the event to make improvements to the flood risk mapping model, which is used to define the extent of flood warning areas. Due to the rapidly responding nature of the rivers which flow through Kendal, the Environment Agency use forecast rainfall data and flood forecasting models to predict river levels in advance of possible flooding. This allows Flood Warnings to be issued in advance of possible flooding, allowing enough time for people to take action to protect themselves and their property. Improvements will therefore also be made to flood forecasting models to enable more timely and accurate Flood Warnings to be issued for future flood events.

The debris screens in Kendal were routinely cleared in the weeks leading up to the flood event and cleared immediately prior to the flood event. The Environment Agency also inspected watercourses and operational structures to ensure that there were no blockages which may have caused an increase in flood risk. Kendal currently has very few flood defence assets which require operation; however the sluice at Helsington Mills was closed in advance of the flood event on Friday 4th December at 20:00-21:00.

Throughout the duration of the flood event, Environment Agency staff continued to clear debris screens in and around Kendal. Sandbags were deployed at the Stock Beck Flood Storage Basin to divert flows which were bypassing the eastern tributary debris screen back into the storage basin. The Environment Agency also deployed a pump to the Rinkfield area to pump surface/ground water into the local drainage system to prevent properties from flooding.

Post-event Repairs and Maintenance

Due to the nature of the river environment in Kendal, gravel deposition occurs on both the Rivers Kent and Mint. This can reduce channel capacity, which can have an impact on flood risk. Regular monitoring of gravel accumulation forms part of the Environment Agency's maintenance programme in Kendal – key gravel monitoring locations are surveyed annually at Mintsfeet gravel trap, Dockray Hall, Stramongate Weir, Miller Bridge, and Romney Bridge. If gravel builds up to a level where flood risk is increased, then the Environment Agency undertakes gravel removal to maintain channel capacity and conveyance through the town.

Following the flood event in December 2015, significant volumes of gravel were deposited in the river channel through the town. As a result, in January and February the Environment Agency removed accumulated gravel from key locations throughout Kendal. This comprised of removing approximately 7000 tonnes at Gooseholme, approximately 7000 tonnes from the gravel trap at Mintsfeet (known locally as Sandy Bottoms) and approximately 3000 tonnes in the Romney Road area. Further gravel removal works in other locations through Kendal were completed in the summer. These locations included New Road, Aynam Road (from downstream of Miller Bridge to Abbot Hall), Beezon Fields and an area downstream of Dockray Hall Railway Bridge.

Following the flood event, the Environment Agency has also removed blockages and obstructions (such as large trees) from the Rivers Kent and Mint in Kendal. This included the removal of overhanging trees and vegetation along the banks of the River Kent from the gravel trap at Mintsfeet to Dockray Hall Footbridge to improve channel conveyance and reduce the risk of any further blockages downstream.

The Environment Agency has also been undertaking a programme of emergency repairs to damaged flood defence assets following the December flood event. Work completed includes the repair of an undermined embankment on the River Mint downstream of Mint Bridge and repairs to assets at the Stock Beck Flood Storage Basin. Further asset repairs in Kendal have been completed throughout the summer. The Environment Agency asset repair programme has been further informed by detailed CCTV surveys that have been undertaken for culverted sections of Stock Beck and Natland Mill Beck, as well as dive surveys that have been undertaken along the River Kent.

On-going Maintenance Activities

The Environment Agency maintains flood risk management structures and sections of river channel where maintenance actively reduces the risk of flooding to people and property. Activities we undertake are summarised below:

- We conduct yearly visual inspections of flood defence embankments and walls, and deliver a variety of maintenance tasks which include, as necessary:
  - Grass cutting,
  - Vegetation management,
  - Invasive species control,
  - Vermin control and
  - Expansion joint repairs.
- We deliver targeted maintenance on River Channels where the activity is beneficial to the reduction in flood risk. This could include:
  - Weed Control,
  - Grass Control,
  - Vegetation Management,
  - Invasive Non Native Species Control,
  - Gravel Removal, when justified through investigation and survey.
- On operational structures, we undertake:
  - Quarterly operational inspections and
  - Yearly mechanical maintenance
- On culverts, which could pose a risk of flooding to properties, we monitor the risk of flooding through 6 yearly inspections, and deliver the following on a risk based approach:
  - Cleansing works
  - Repairs and reconditioning works

Recommended Actions

The following table details recommended actions for various organisations and members of the public to consider using the Cumbria Floods Partnership's 5 Themes: Resilience, Upstream Management, Strengthening Defences, Maintenance and Water Level Management Boards (WLMB's). Some of these recommendations may have already been carried out or are ongoing. Some of the actions referred to in Table 14 are identified on Figure 34 following this table.

Cumbria Flood Partnership Theme	Action by	Recommended Action	Timescale
Resilience	Cumbria Local Resilience Forum[5]	Review and update plans to enable homes & business to be better prepared for flooding & reduce the impacts of flooding. For example, review of evacuation procedures / emergency response.	2016
Resilience	Environment Agency, Communities, Parish & District Councils, Kendal Town Council	Work with community action groups in Kendal to complete emergency plans for Winter 2016. Continue to work with all communities to establish a network of Action Groups to share learning and best practice.	2016
Resilience	Save the Children & Lancaster University	Work with children and young people impacted by flooding. A project is being run in Kendal at the moment that will be expanded to cover other communities in Cumbria. Children and young people have an opportunity to share their experience and recover from the trauma of flooding. This project will also support children's participation in community resilience.	2016-2017
Resilience	Environment Agency	Review modelling data to ensure that hydraulic models for the River Kent catchment reflect real conditions as accurately as possible and replicate the 5th-6th December 2015 flood event to ensure the flooding mechanisms identified are reflected in the modelling output. Update the models where required and use this information to make any improvements to the flood forecasting and warning service.	2016-2017
Resilience	Environment Agency	Review and update the Flood Warning Areas for Kendal, ensuring they reflect all known fluvial flooding mechanisms in the Kendal river system as far as possible.	2016-2017
Resilience	Environment Agency and Residents	Ensure all properties at risk are registered to receive flood warnings and that all details are up-to-date.	2016
Resilience	Residents & South Lakeland District Council	Implement flood resilience measures within flooded properties to reduce the impacts of future flooding. South Lakeland District Council is administering the Flood Recovery and Resilience Grants of up to £5000 per property to help people better protect their homes. A further £2,000 top up grant can also be applied	Closing date for grant applications

[5] The Cumbria Local Resilience Forum includes emergency services, local authorities, Cumbria County Council, Environment Agency, Maritime Coastguard Agency and health agencies along with voluntary and private agencies. Under the Civil Contingencies Act (2004) every part of the United Kingdom is required to establish a resilience forum.

Cumbria Flood Partnership Theme	Action by	Recommended Action	Timescale
		for from the Cumbria Flood Recovery Fund.	is end of March 2017
Resilience	South Lakeland District Council, Cumbria County Council and Environment Agency	Review Local Development Plans and Strategic Flood Risk Assessment to reflect current understanding of flooding.	2016
Resilience	South Lakeland District Council, Cumbria County Council and Environment Agency	Review the discharge of planning conditions relating to flood risk for recent developments in Kendal to determine whether flood risk has been increased to surrounding areas as a result of recent development. Monitor the discharge of planning conditions relating to ongoing developments to ensure flood risk will not be increased as a result of new development.	2016-2017
Resilience	Cumbria County Council, United Utilities, Environment Agency and Electricity North West.	Review the resilience of critical transport, utility and power supply infrastructure in relation to flood risk.	2016-2017
Upstream Management	Cumbria Floods Partnership (CFP)	The CFP action plan will consider natural flood management options to reduce flood risk across the catchment. This may also include land use changes and/or flood storage.	Summer 2016
Upstream Management	Cumbria Floods Partnership (CFP), Farmers, Landowners, Community Groups, Trusts.	Explore opportunities for natural flood management solutions to be used upstream of Kendal in order to 'slow the flow' and manage peak river levels.	Medium term (over next 5 years)
Maintenance	Environment Agency, United Utilities and Cumbria County Council	Carry out inspections and repairs to assets which may have been damaged during the flood event.	2016
Maintenance	Environment Agency	Review the gravel and channel maintenance programme within the catchment in response to the flooding event of 2015.	2016-2017
Maintenance	Environment Agency	A new Environment Agency system is being developed to make it easier for communities to understand what maintenance work is being carried out in their area. Improvements will show exactly when, where and what maintenance is being planned each year. Make sure that communities understand how they can access information on planned maintenance at: https://www.gov.uk/government/publications/river-andcoastal-maintenance-programme	2017
Strengthening	Environment	Review the performance of the existing flood defence assets and in particular, the culvert inlet on the eastern Stock Beck	2016-2017

Cumbria Flood Partnership Theme	Action by	Recommended Action	Timescale
Defences	Agency	tributary as it enters Stock Beck FSB. Consider what worked well and where improvements to defence assets are required.	
Strengthening Defences	Cumbria County Council, South Lakeland District Council and United Utilities	Review the performance of the existing drainage and sewerage systems during the event to better understand where improvements are required. The review should give particular attention to the surface water outfalls and CSOs in the Mintsfeet and New Road areas.	2016-2017
Strengthening Defences	Cumbria County Council in partnership with the Environment Agency and United Utilities	Conduct a detailed assessment for Kendal (including Staveley and Burneside) identify solutions to mitigate surface water flood risk in high risk areas that will integrate with fluvial flood risk mitigation options as part of a joined up approach.	2016-2017
Strengthening Defences	Environment Agency in partnership with Cumbria County Council and South Lakeland District Council	Develop options to improve the existing Standard of Protection in Kendal as part of a wider appraisal of flood risk management improvements in the Kent catchment (including Staveley, Ings, and Burneside). Defence options to be appraised are likely to include upstream storage, improvements to flood channel conveyance, raised flood defences and natural flood management.	2016-2017
Strengthening Defences	Environment Agency & Cumbria County Council in partnership with United Utilities	As part of developing options to manage flood risk in Kendal, undertake an appraisal of the existing Birds Park Reservoir to determine whether it could provide sufficient upstream storage capacity to reduce the flood flows entering the Stock Beck culvert and Stock Beck FSB.	By March 2017
Strengthening Defences	Cumbria County Council & Environment Agency	Assess the impact of the road bridges and footbridges in Kendal on flood flows and investigate options to increase their flood capacity, taking into account the potential effects on flood risk downstream.	2016-2017
Strengthening Defences	Environment Agency in partnership with Cumbria County Council and Network Rail	Work with Network Rail to understand the interaction of both the West Coast Mainline and the Windermere branch line with the rivers and watercourses in and around Kendal, their effect on flooding and their vulnerability during a flood.	2016-2017
Strengthening Defences	Environment Agency	Review the need and practicalities of deploying temporary defences in certain locations in Kendal as an interim or longer term measure to help reduce flood risk.	2016-2017

Table 14: Recommended actions for consideration

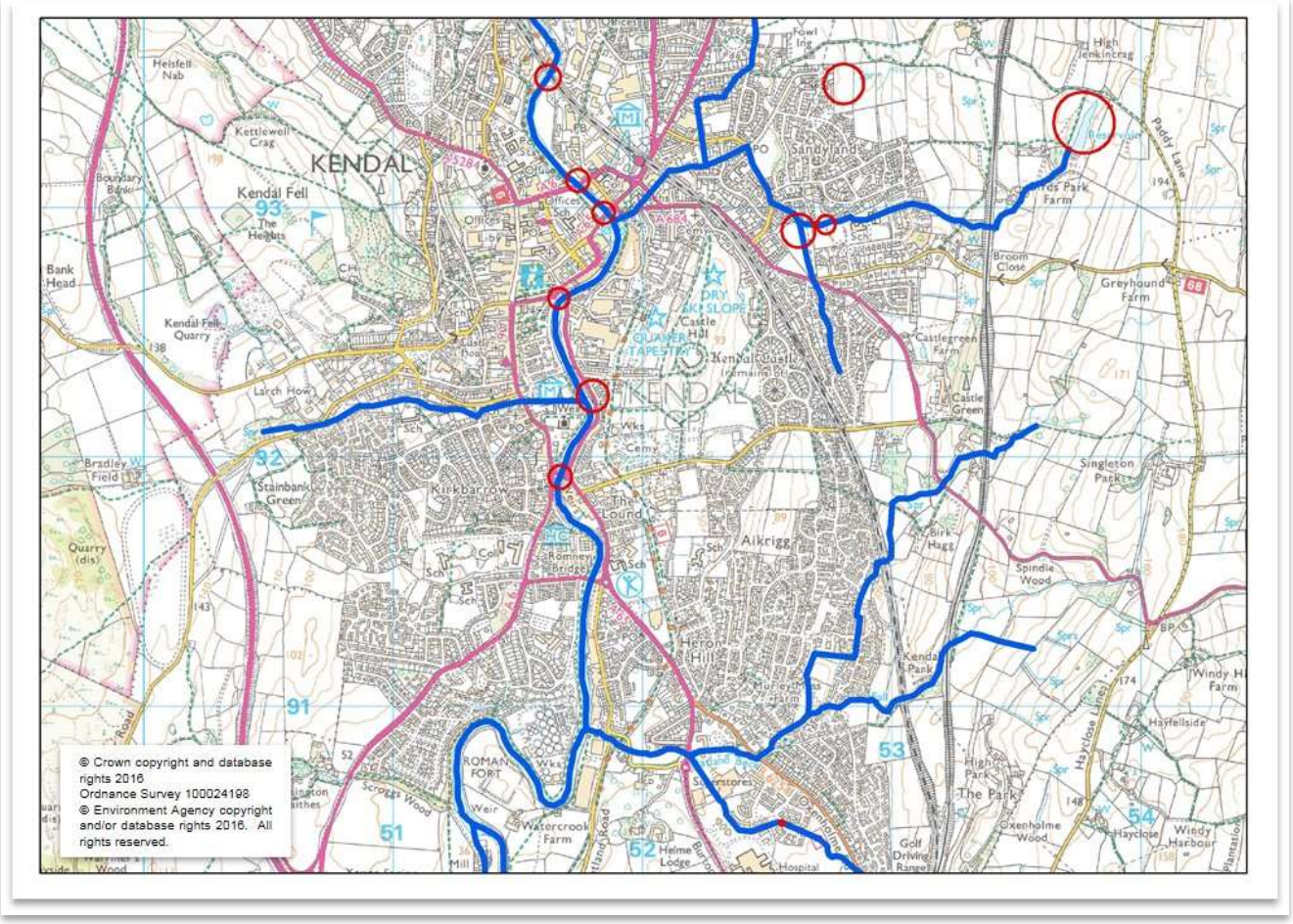
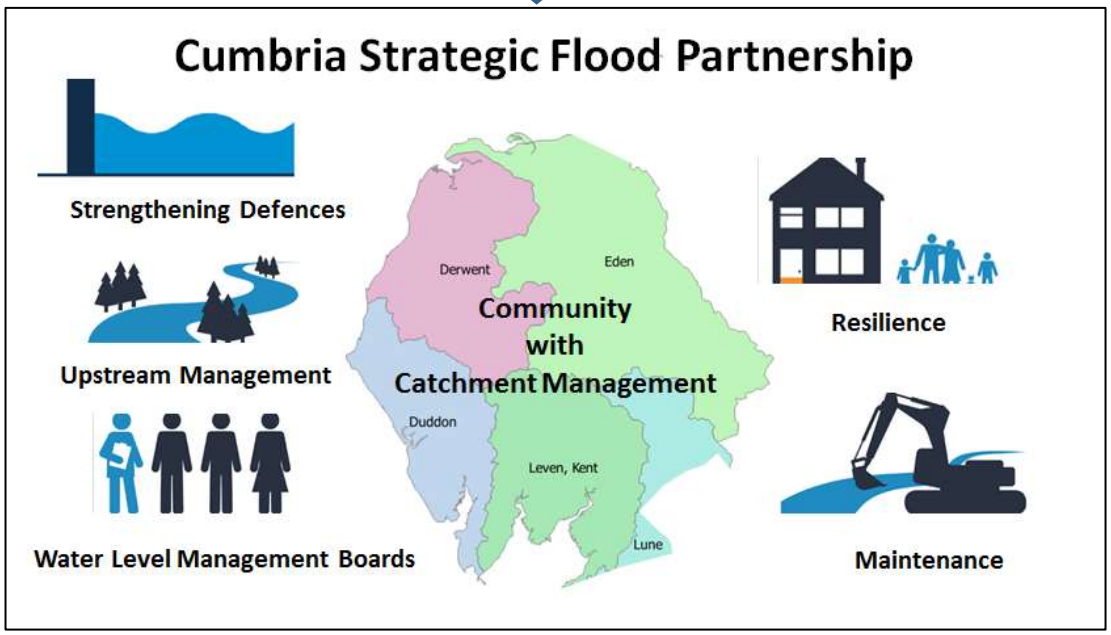


Figure 34: Locations of specific actions identified in Table 14

Next Steps – Community & Catchment Action Plan

The Cumbria Floods Partnership has brought together a wide range of community representatives and stakeholders from a variety of sectors to plan and take action to reduce flood risk. The Cumbria Floods Partnership, led by the Environment Agency, is producing a 25 year flood action plan for the Cumbrian catchments worst affected by the December 2015 flooding, including Carlisle. The plan will consider options to reduce flood risk across the whole length of a river catchment including upstream land management, strengthening flood defences, reviewing maintenance of banks and channels, considering water level management boards and increasing property resilience. The Cumbria Floods Partnership structure below details how these 5 themes are being delivered in the Flood Action plans which will be completed in July.

The diagrams below helps demonstrate how the two partnerships have now come together:



Cumbria Strategic Flood Partnership

RFCC

Cumbria Strategic Partnership Board

Catchment Management Group

Eden

Catchment Management Group

Derwent

Catchment Management Group

Kent and Leven

Steering Groups

(Various per Catchment)

MSFWG

Community

'Farmers, environmental charities, landowners, private companies, councils and government agencies have joined together with a common goal.
To look at the evidence and potential funding sources to find flood solutions for defences, resilience, maintenance, upstream management and water level management boards, so they can work together to help communities at risk of flooding.'

In an dynamic move the Cumbria Strategic Flood Partnership have created three groups whose aim is to look at all options for how flood risk can be reduced in Cumbria.

This group the first of its kind in the country brings together the expertise of all those whose water and land management experience to look at what can be done to protect communities both residential and farming.

They will then discuss their findings to the communities at risk and plan a way forward.

This landmark move will ensure that fully integrated solutions for land and water management are utilised to protect people and the environment in which they live and rely on.

Appendices

Appendix 1: Acronyms and Glossary

Acronym	Definition
EA	Environment Agency
CCC	Cumbria County Council
SLDC	South Lakeland District Council
LLFA	Lead Local Flood Authority
FLAG	Flood Action Group
LFRMT	Local Flood Risk Management Team
FWMA	Flood and Water Management Act 2010
LDA	Land Drainage Act 1991
WRA	Water Resources Act 1991
UU	United Utilities

Term	Definition
Aquifer	A source of groundwater comprising water-bearing rock, sand or gravel capable of yielding significant quantities of water.
Attenuation	In the context of this report - the storing of water to reduce peak discharge of water.
Catchment Flood Management Plan	A high-level planning strategy through which the EA works with their key decision makers within a river catchment to identify and agree policies to secure the long-term sustainable management of flood risk.
Culvert	A channel or pipe that carries water below the level of the ground.
De Facto Flood Defence	A feature or structure that may provide an informal flood defence benefit but is not otherwise designed or maintained by the Environment Agency
Flood Defence	Infrastructure used to protect an area against floods as floodwalls and embankments; they are designed to a specific standard of protection (design standard).
Floodplain	Area adjacent to river, coast or estuary that is naturally susceptible to flooding.
Flood Resilience	Measures that minimise water ingress and promotes fast drying and easy cleaning, to prevent any permanent damage.
Flood Risk	The level of flood risk is the product of the frequency or likelihood of the flood events and their consequences (such as loss, damage, harm, distress and disruption)
Flood Risk Regulations	Transposition of the EU Floods Directive into UK law. The EU Floods Directive is a piece of European Community (EC) legislation to specifically address flood risk by prescribing a common framework for its measurement and management.

Term	Definition
Flood and Water Management Act	Part of the UK Government's response to Sir Michael Pitt's Report on the Summer 2007 floods, the aim of which is to clarify the legislative framework for managing surface water flood risk in England.
Flood Storage	A temporary area that stores excess runoff or river flow often ponds or reservoirs.
Flood Zone	Flood Zones are defined in the NPPF Technical Guidance based on the probability of river and sea flooding, ignoring the presence of existing defences.
Flood Zone 1	Low probability of fluvial flooding. Probability of fluvial flooding is < 0.1%
Flood Zone 2	Medium probability of fluvial flooding. Probability of fluvial flooding is 0.1 – 1%. Probability of tidal flooding is 0.1 – 0.5 %
Flood Zone 3a	High probability of fluvial flooding. Probability of fluvial flooding is 1% (1 in 100 years) or greater. Probability of tidal flooding is 0.5%(1 in 200 years)
Flood Zone 3b	Functional floodplain. High probability of fluvial flooding. Probability of fluvial flooding is >5%
Fluvial	Relating to the actions, processes and behaviour of a water course (river or stream)
Fluvial flooding	Flooding by a river or a watercourse.
Freeboard	Height of flood defence crest level (or building level) above designed water level
Functional Floodplain	Land where water has to flow or be stored in times of flood.
Groundwater	Water that is in the ground, this is usually referring to water in the saturated zone below the water table.
Inundation	Flooding.
Lead Local Flood Authority	As defined by the FWMA, in relation to an area in England, this means the unitary authority or where there is no unitary authority, the county council for the area, in this case Cumbria County Council.
Main River	Watercourse defined on a ‘Main River Map’ designated by DEFRA. The EA has permissive powers to carry out flood defence works, maintenance and operational activities for Main Rivers only.
Mitigation measure	An element of development design which may be used to manage flood risk or avoid an increase in flood risk elsewhere.
Overland Flow	Flooding caused when intense rainfall exceeds the capacity of the drainage systems or when, during prolonged periods of wet weather, the soil is so saturated such that it cannot accept any more water.
Residual Flood Risk	The remaining flood risk after risk reduction measures have been taken into account.
Return Period	The average time period between rainfall or flood events with the same intensity and effect.
River Catchment	The areas drained by a river.

Term	Definition
Sewer flooding	Flooding caused by a blockage or overflowing in a sewer or urban drainage system.
Sustainability	To preserve /maintain a state or process for future generations
Sustainable drainage system	Methods of management practices and control structures that are designed to drain surface water in a more sustainable manner than some conventional techniques.
Sustainable development	Development that meets the needs of the present without compromising the ability of future generations meeting their own needs.
Sustainable Flood Risk Management	Sustainable Flood Risk Management promotes a catchment wide approach to flooding that uses natural processes and systems (such as floodplains and wetlands) to slow down and store water.
Topographic survey	A survey of ground levels.
Tributary	A body of water, flowing into a larger body of water, such as a smaller stream joining a larger stream.
Watercourse	All rivers, streams, drainage ditches (i.e. ditches with outfalls and capacity to convey flow), drains, cuts, culverts and dykes that carry water.
Wrack Marks	An accumulation of debris usually marking the high water line.
1 in 100 year event	Event that on average will occur once every 100 years. Also expressed as an event, which has a 1% probability of occurring in any one year.
1 in 100 year design standard	Flood defence that is designed for an event, which has an annual probability of 1%. In events more severe than this the defence would be expected to fail or to allow flooding.

Appendix 1: Summary of Relevant Legislation and Flood Risk Management Authorities

The table below summarises the relevant Risk Management Authority and details the various local source of flooding that they will take a lead on.

Flood Source	Environment Agency	Lead Local Flood Authority	District Council	Water Company	Highway Authority
Rivers					
Main river					
Ordinary watercourse					
Surface Runoff					
Surface water					
Surface water on the highway					
Other					
Sewer flooding					
Sea					
Groundwater					
Reservoirs					

The following information provides a summary of each Risk Management Authority's roles and responsibilities in relation to flood reporting and investigation.

Government: DEFRA develop national policies to form the basis of the Environment Agency's and the LLFA's work relating to flood risk.

Environment Agency: Strategic overview of all sources of flooding and coastal erosion as defined in the Flood and Water Management Act (2010). As part of its role concerning flood investigations, this requires providing evidence and advice to support other RMAs. The Environment Agency also collates and reviews assessments, maps and plans for local flood risk management (normally undertaken by LLFA).

Lead Local Flood Authorities: Cumbria County Council is the LLFA for Cumbria. Part of their role requires them to investigate significant local flooding incidents and publish the results of such investigations. LLFAs have a duty to determine which RMA has relevant powers to investigate flood incidents to help understand how they happened, and whether those authorities have, or intend to, exercise their powers. LLFAs work in partnership with communities and flood RMAs to maximise knowledge of flood risk to all involved. This function is carried out at CCC by the Local Flood Risk Management Team.

District and Borough Councils: These organisations perform a significant amount of work relating to flood risk management, including providing advice to communities and gathering information on flooding. These organisations are classed as RMA's.

Water and Sewerage Companies: Manage the risk of flooding to water supply and sewerage facilities and the risk to others from the failure of their infrastructure. They make sure their systems have the appropriate level of resilience to flooding and where frequent and severe flooding occurs they are required to address this through their capital investment plans. It should also be noted that following the Transfer of Private Sewers Regulations 2011, water and sewerage companies are now responsible for a larger number of sewerage than prior to the regulation. These organisations are classed as RMAs.

Highway Authorities: Highway authorities have the lead responsibility for providing and managing highway drainage and certain roadside ditches that they have created under the Highways Act 1980. The owners of land adjoining a highway also have a common-law duty to maintain ditches to prevent them causing a nuisance to road users. These organisations are classed as RMAs.

Flood risk in Cumbria is managed through the Making Space for Water (MSfW) process, which involves the co-operation and regular meeting of the Environment Agency, United Utilities, District/Borough Councils and CCC's Highway and LFRM Teams to develop processes and schemes to minimise flood risk. The MSfW Groups will meet approximately 4 times per year to co-ordinate operations and work together to mitigate flood risk in the vulnerable areas identified in this report by completing the recommended actions. As LLFA, CCC has a responsibility to oversee the delivery of these actions.

Where minor works or 'quick win' schemes can be identified, these will be prioritised and, subject to available funding and resources, will be carried out as soon as possible. Any major works requiring capital investment will be considered through the Environment Agency's Medium Term Plan process or a partner's own capital investment process.

Flood Action Groups are usually formed by local residents who wish to work together to help reduce flood risk in their area. The FAGs are often supported by either CCC or the Environment Agency and provide a useful mechanism for residents to forward information to the MSfW Group.

Appendix 2: Links to Other Information on Flooding

Sign up for Flood Warnings
https://www.gov.uk/sign-up-for-flood-warnings

Environment Agency – Prepare your property for flooding; a guide for householders and small businesses to prepare for floods
https://www.gov.uk/government/publications/prepare-your-property-for-flooding

Environment Agency – What to do before, during and after a flood: Practical advice on what to do to protect you and your property
https://www.gov.uk/government/publications/flooding-what-to-do-before-during-and-after-a-flood

Environment Agency – Living on the Edge: A guide to the rights and responsibilities of riverside occupiers
https://www.gov.uk/government/publications/riverside-ownership-rights-and-responsibilities

Flood and Water Management Act 2010:
http://www.legislation.gov.uk/ukpga/2010/29/contents

Water Resources Act 1991:
http://www.legislation.gov.uk/all?title=water%20resources%20act

Land Drainage Act:
http://www.legislation.gov.uk/all?title=land%20drainage%20act

Appendix 3: Flood Warnings and Alerts

Kendal is covered by a Flood Alert, and certain areas are served by six Flood Warnings as shown in the table below, which summarises the times of the Flood Warnings issued during this flood event:

Flood Warning	Flood Warning Issued	Severe Flood Warning Issued	Customers	Contacts	% Success*
011FWFNC17A	05/12/15 09:03	05/12/15 15:42	76	215	81
011FWFNC17B	05/12/15 11:58	05/12/15 15:46	152	349	64
011FWFNC17C	05/12/15 15:11	05/12/15 15:48	553	1059	68
011FWFNC17D	05/12/15 15:22	05/12/15 15:55	609	1054	71
011FWFNC19	05/12/15 15:22	05/12/15 16:00	35	117	70
011FWFNC29	05/12/15 12:07	05/12/15 16:06	87	87	84

The following pages show additional details on the Flood Alerts and Warnings issued during this event.

Flood Alerts

011WAFLE: Kent and Bela Catchments

Alert issued on Thursday 03/12/2015 at 14:46
Alert removed on Friday 04/12/2015 at 07:00
Alert issued on Friday 04/12/2015 at 15:22
Alert removed on Thursday 10/12/2015 at 16:18

Customers in Flood Alert area registered on FWD: 227
Contacts (landline, mobile, email etc.) in Flood Alert area registered on FWD: 609
Successful contacts: 531
Unsuccessful contacts: 78

Alert Message:

A Flood Alert has been issued by the Environment Agency for the Rivers Kent and Bela. Flooding is possible for Rivers Kent and Bela. Low lying land and roads will be affected first. Be prepared to protect yourself, family, pets and property.

Heavy and persistent rainfall, along with strong South-Westerly winds, is forecast to continue this evening through until Sunday 06/12/2015. With the ground already saturated the river levels are expected to rise further and we may see some significant impacts. The forecast is likely to result in Flood Warnings being issued on Saturday. We advise that you keep an eye on the situation by listening to weather forecasts, checking our web pages or calling Floodline. We are continuing to monitor the situation and have workers on site operating defences and clearing blockages where required.

*Contact Successful if at least one attempt to contact a fully-registered recipient registered to the property returned a status of "Acknowledged", "Successfully Received", "Successfully Sent" or "Unacknowledged"

Flood Warning Target Areas

011FWFNC17A: River Kent at Kendal, Benson Green, Burneside Rd, Gilthwaiterigg, and St Johns Ambulance

Flood Warning issued on Saturday 05/12/2015 at 09:03
Severe Flood Warning issued on Saturday 05/12/2015 at 15:42
Severe Flood Warning removed on Sunday 06/12/2015 at 12:01

Date/Time Warning Level Reached: 05/12/2015 10:15
Time customers had to take action: 01:11:38
Customers in Flood Alert area registered on FWD: 76
Contacts (landline, mobile, email etc.) in Flood Alert area registered on FWD: 215
Successful contacts: 174
Unsuccessful contacts: 41

Severe Warning Message:

Severe Flooding. Danger to life.

A Severe Flood Warning has been issued by the Environment Agency for the River Kent at Kendal, Benson Green, Burneside Rd, Gilthwaite Rigg, and St Johns Ambulance.

This Severe Flood Warning is for Commercial and residential properties adjacent to the River Kent at Kendal, Aikrigg Avenue, Benson Green, Burneside Rd, Gilthwaite Rigg, St Johns Ambulance, Bowling and Social Club.

We are forecasting significant rainfall during today and tomorrow. Environment Agency staff are currently inspecting and operating our flood defences and clearing debris screens. River levels are expected to rise very quickly so we are issuing severe flood warnings to enable people to take the following preparatory actions by:-

- Checking vulnerable family, friends and neighbours.
- Installing flood protection measures to your property if you have them.
- Only travel if necessary and do not drive through flood water.
- Considering activating or get ready to activate your community emergency plan. Reception Centres are open for public use.
- Keep a check on Environment Agency website www.gov.uk/flood.

We will continue to monitor river levels. To report any flooding, please contact the Incident Hotline on 0800 80 70 60. The river level recording station used for this flood warning is Victoria Bridge.

011FWFNC17B: River Kent at Kendal, Busher Walk, Jubilee Field, Sandes Avenue and Mint Bridge Road

Flood Warning issued on Saturday 05/12/2015 at 11:58
Sever Flood Warning issued on Saturday 05/12/2015 at 15:46
Severe Flood Warning removed on Sunday 06/12/2015 at 12:13

Date/Time Warning Level Reached: 05/12/2015 15:30
Time customers had to take action: 03:31:02
Customers in Flood Alert area registered on FWD: 152
Contacts (landline, mobile, email etc.) in Flood Alert area registered on FWD: 349
Successful contacts: 225
Unsuccessful contacts: 94

Severe Warning Message:

Severe Flooding. Danger to life.

A Severe Flood Warning has been issued by the Environment Agency for the River Kent at Kendal, Busher Walk, Jubilee Field, Sandes Avenue and Mint Bridge Rd.

This Severe Flood Warning is for Commercial and residential properties adjacent to the River Kent at Kendal, Parts Aynam Rd, Busher Walk, Queen Kath St, Sandes Ave, Mint Bridge Rd, Parr St Jubilee Field, along the river's edge.

We are forecasting significant rainfall during today and tomorrow. Environment Agency staff are currently inspecting and operating our flood defences and clearing debris screens. River levels are expected to rise very quickly so we are issuing severe flood warnings to enable people to take action.

011FWFNC17C: River Kent at Kendal, Castle Crescent, Aynam Road, Lound Road, Mintsfeet

Flood Warning issued on Saturday 05/12/2015 at 15:11
Sever Flood Warning issued on Saturday 05/12/2015 at 15:48
Severe Flood Warning removed on Sunday 06/12/2015 at 12:25

Date/Time Warning Level Reached: 05/12/2015 16:10
Time customers had to take action: 00:58:50
Customers in Flood Alert area registered on FWD: 553
Contacts (landline, mobile, email etc.) in Flood Alert area registered on FWD: 1059
Successful contacts: 723
Unsuccessful contacts: 336

Warning Message:

A Flood Warning has been issued by the Environment Agency for the River Kent at Kendal, Castle Cres, Aynam Rd, Lound Rd, Mintsfeet.

Flooding is expected for Commercial and residential properties adjacent to the River Kent at Kendal, Castle Crescent, Aynam Rd, Lound Rd, Mintsfeet, Queen Katherine Street, Stramongate, Waterside and Wildman Street. Immediate action required.

Heavy and persistent rainfall is expected throughout Saturday. River levels will continue to rise and further Flood Warnings are likely. Please check for updates throughout the weekend. Operational Teams have closed flood defences and are checking watercourses for blockages.

The river level recording station used for this flood warning is Victoria Bridge.

011FWFNC17D: River Kent at Kendal, Dockray Hall Road, Natland Aikrigg Avenue, Ann Street, Back Lane, Beezon Trading Estate

Flood Warning issued on Saturday 05/12/2015 at 15:22
Sever Flood Warning issued on Saturday 05/12/2015 at 15:55
Severe Flood Warning removed on Sunday 06/12/2015 at 12:29

Date/Time Warning Level Reached: 05/12/2015 17:00
Time customers had to take action: 01:37:24
Customers in Flood Alert area registered on FWD: 609
Contacts (landline, mobile, email etc.) in Flood Alert area registered on FWD: 1054
Successful contacts: 749
Unsuccessful contacts: 305

Warning Message:

A Flood Warning has been issued by the Environment Agency for the River Kent at Kendal, Dockray Hall Rd, Natland Aikrigg Ave, Ann St, Back Lane, Beezon Trad Est.

Flooding is expected for River Kent at Kendal, Natland Aikrigg Ave, Ann Street, Back Lane, Beezon Trad Est, Bridge Street, Canal Head, Castle Street, Dockray Hall Rd, Mintsfeet Rd South, Milnthorpe Rd and Street, Nether Street, Parkside, Riverdale Court, Romney Road, South Road. Immediate action required.

Heavy and persistent rainfall is expected throughout Saturday. River levels will continue to rise and further Flood Warnings are likely. Please check for updates throughout the weekend. Operational Teams have closed flood defences and are checking watercourses for blockages.

The river level recording station used for this flood warning is Victoria Bridge.

011FWFNC19: River Kent at Helsington Mills

Flood Warning issued on Saturday 05/12/2015 at 15:22
Sever Flood Warning issued on Saturday 05/12/2015 at 16:00
Severe Flood Warning removed on Sunday 06/12/2015 at 12:21

Date/Time Warning Level Reached: 05/12/2015 16:10
Time customers had to take action: 00:47:24
Customers in Flood Alert area registered on FWD: 35
Contacts (landline, mobile, email etc.) in Flood Alert area registered on FWD: 117
Successful contacts: 82
Unsuccessful contacts: 35

Warning Message:

A Flood Warning has been issued by the Environment Agency for the River Kent at Helsington Mills.

Flooding is expected for agricultural land and isolated properties adjacent to the River Kent at Helsington Mills. Immediate action required.

Heavy and persistent rainfall is expected throughout Saturday. River levels will continue to rise and further Flood Warnings are likely. Please check for updates throughout the weekend. Operational Teams have closed flood defences and are checking watercourses for blockages.

The river level recording station used for this flood warning is Victoria Bridge.

011FWFNC29: Stock Beck at Sandylands, Sandylands Road, Calder Drive and Anne St areas

Flood Warning issued on Saturday 05/12/2015 at 12:07
Severe Flood Warning issued on Saturday 05/12/2015 at 16:06
Severe Flood Warning removed on Sunday 06/12/2015 at 12:06

Date/Time Warning Level Reached: 05/12/2015 12:30
Time customers had to take action: 00:22:20
Customers in Flood Warning area registered on FWD: 87
Successful contacts: 73
Unsuccessful contacts: 14

Appendix 5: Public Consultation Feedback

Feedback provided North East Kendal Flood Action Group.

1) There is a great deal of concern regarding the inadequacy of the Stock Beck system and the existing urban and highway drains in north east Kendal to deal with rainfall arising on Hay Fell and Benson Knott, plus surface water runoff from the increasing urban area itself. This problem affects much of east Kendal especially Ann St/ Castle Street where Stock Beck enters the Kent. .

2) During the flood event, residents on Rydal Road, and in Jenkins Crag Sheltered Housing complex at Jenkins Crag Court, observed the drainage systems in the car park to the west of the Sheltered Housing surcharging at 13:30 on 5th December, with the water then flowing towards the rear of properties on Whinfell Drive. Two properties flooded to approximately 600mm in spite of several hours of pumping by the fire service.

3) Drainage flows from this (northerly) section of the development, and from another watercourse through the site, enter a culverted ordinary watercourse that flows west down Kentdale Road towards Jenkin Rise, and then flows in a southerly direction down Jenkin Rise before joining the Stock Beck culvert near the Post Office on the junction of Eastgate, Jenkin Rise and Sandylands Road. Immediately to the southwest of this confluence, on a footpath on Eastgate, the culvert roof was damaged due to the water pressure. The first properties in Sandylands believed to be affected by flooding at around 13:30 are next to this junction.

4) During the flood event on Sat 5th December, people in Rydal Road observed water flowing off the fells into the attenuation pond serving the southern section of the new development to the rear of 31 Rydal Road. The attenuation pond, which is situated to the rear of their property, filled and overflowed. This resulted in a significant depth of water building up behind the boundary wall to the rear of their property. Local residents subsequently took action to knock down the boundary wall to the north of their property next to a row of garages, which allowed the water to drain away from their property and into the local drainage network. This action prevented internal flooding of the property, but diverted the water, probably to join the ordinary watercourse on Kentdale Drive described above.

   Prior to the new developments, the attenuation pond was a natural swamp/pond that provided storage for water draining from the fellside including a spring that appears in high rainfall events that was drawn to the attention of SLDC during the planning process. The natural topography of the fields to the rear of Rydal Road allowed flood storage capacity during times of heavy rainfall, as the pond level would rise and spread across the fields. At the time of the flood event this part of the site was undeveloped, apart from the raising of ground levels to create building platforms, which limited the attenuation pond capacity. A formalised bund had also been added to the western edge of the pond. Since December 5th, houses have been built on the site, presumably further increasing impermeable surfaces and resulting surface runoff from the development.

   These observations indicate that the attenuation pond is not of sufficient capacity to cope with the surface water discharge from the new development in addition to the surface and underground flows from the fellsides to the east.

There were also previously swamp/pond areas on the northern part of the development at and above Jenkins Crag Court. Storage capacity upstream of Sandylands has now been lost and local residents feel that any mistakes need to be corrected if further severe flooding is to be avoided as climate change continues.

5) On the 11th May site visit, when we visited this area, Doug Coyle stated that he would organise a meeting with the developers (Russell Armer) to discuss the issues arising with respect to the development. Has this meeting been held? Maggie and members of the group have requested that they be allowed to have a joint meeting with the developers and the County Council.

   South Lakes Housing Association, together with Russell Armer and Impact Housing, have commissioned RG Parkins to produce a report on the flooding in Sandylands and Whinfell Drive area taking account of flooding mechanisms observed on 5th/6th December.

6) As part of the appraisal of options to manage flood risk in Sandylands, account needs to be taken of the significant amount of flow that enters the estate from the springs, issues, overland and underground flows off fellsides to the east of the estate, such as Jenkin Crag, Hay Fell, Benson Knott and in the Birds Park area. (Note that the Stock Beck system collects all these to converge in the Ann St/Castle Crescent area). When calculating design flows and flood storage relating to Birds Park Reservoir, account needs to be taken of artificial catchments that were (omit UU - who now have responsibility but did not construct the original system) designed to drain into both Reservoirs, as well as the catchment area identified from FEH analysis

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7) Residents on Rydal Road observed the drainage systems in the car park at the Sheltered Housing complex at Jenkins Crag Court surcharging at 13:30 on 5th December, with the water then flowing towards the complex.

8) Shap Road and Appleby Road – 16:00 reported flooding to properties on Appleby Road, initially through the floors.

9) Sewers to the rear of properties at the western end of Sandylands Road were seen to be surcharging, lifting manhole covers to several feet. Similar water pressures were seen inside the Spar.

10) The basemapping used does not show the new and ongoing developments to the rear of Jenkins Crag Court Sheltered Housing. Maps in the report need to be updated to reflect these developments.

11) Cllr Shirley Evans questioned when the repair works would be carried out at the Stock Beck FSB.

12) The group don't like the use of the 'small catchment' description in relation to the eastern Stock Beck Trib. Amend to reference area that the catchment drains.

13) It was requested that EA contact UU to find out whether they have rainfall data for Birds Park Reservoir, which would add further local context to the rainfall event in this catchment. The flood investigators could also compare it with rainfall data that Colin Keron of Reservoir Cottage,

situated next to Birds Park Reservoir, recorded in his daily-read gauge. Colin's readings are believed to be much higher than those recorded in EA network gauges referenced in the report, and Maggie asked if the discrepancy could be followed up. *Recorded rainfall data kindly provided by Colin Keron is attached to these appendices.*

13) The group challenged the scour mechanism quoted relating to the outfall structure on the Eastern Stock Beck Trib. This scour behind the structure had been discussed with Doug Coyle and Tom McCormick on the 11th May and was agreed to be the result of significant flow from an outfall pipe on the right bank flowing into discharge from the outfall, with the subsequent turbulence causing the scour. Doug Coyle had been asked to investigate the source of the outfall.

14) Residents of Lowther Park had contacted the FLAG and requested that the flooding there was referenced in the FIR, so as to ensure that Lowther Park was not forgotten in any appraisal of options to manage flood risk. It is noted that Lowther Park had also been constructed on a natural flood storage area, and that 70 houses there would have flooded if unauthorised pumping were not carried out. Also that Willow Drive properties were upstream to the drain used to discharge the pumped water, and that the Stock Beck Action Group had previously identified another small watercourse that sometimes affected Willow Drive. Could this be investigated also?

15) Request for amended wording of action relating to monitoring the discharge of planning conditions. Suggested re-wording to read *'Review the discharge of planning conditions relating to flood risk for recent developments in Kendal to determine whether flood risk has been increased to surrounding areas as a result of recent development. Monitor the discharge of planning conditions relating to ongoing developments to ensure flood risk will not be increased as a result of new development.'*

Feedback provided by the Benson Green & Sandes Avenue Flood Action Group.

During consultation with the Benson Green & Sandes Avenue Flood Action Group, the group raised concerns that the gauged peak level on the River Kent of 44.70mAOD at Victoria Bridge, downstream of Benson Green, did not represent peak flood levels experienced locally at Benson Green. Concern was also raised by the Flood Action Group on the effect Victoria Bridge had on flood levels upstream, as it was thought the bridge had reached capacity and therefore artificially raised water levels.

To address these concerns, Jonathan Coates agreed that additional information on wrack levels recorded on the riverside path adjacent to Victoria Bridge at Benson Green, in comparison with the soffit level of Victoria Bridge, would be added to the report. This information has been included within Area 6 on page 44.

Recorded rainfall data kindly provided by Colin Keron of Reservoir Cottage from daily-read rain gauge.

Readings generally taken early evening – between 6–8 pm

NOVEMBER 2015

Date	Rain	Max	Min	Date	Rain	Max	Min
1	1	13	8	16	7	11	4
2		11	5	17	16	10	1
3		6	3	18	27	9	4
4	3	10	7	19	4	10	3
5	8	11	7	20	2	6	1
6	10	11	9	21	2	6	-4
7	17	11	8	22		4	-2
8	19	11	5	23	1	3	-3
9	36	11	5	24	19	6	1
10	3	13	10	25		8	1
11	23	12	7	26	6	8	1
12	10	10	4	27	15	9	1
13	8	7	3	28	10	5	0
14	5	7	3	29	10	8	2
15	57	11	4	30	14	8	-1
	200				328		

DECEMBER 2015

Date	Rain	Max	Min	Date	Rain	Max	Min
1	13	8	-3	17	3	10	8
2	10	8	3	18	8	8	8
3	16	8	0	19	30	12	8
4	4	9	2	20	36	10	6
5	33			21	15	8	3
6	33			22	33	10	4
7	5	11	0	23	1	7	3
8	28	9	4	24			
9	11	8	1	25			
10	19	8	2	26	95	9	1
11	6	5	0	27	1	10	0
12	2	2	-3	28	6	8	3
13	28			29	5	9	4
14	1	5	0	30	8	11	3
15	4	7	3	31	14	4	1
16	8	10	6		365		
	319				584		

October 2015

The very dry autumn ended oct 21st

21st	14 mm
22	-
23	2
24	4
25	1
26	3
27	-
28	14
29	9
30	15
31	10

Storm Desmond started around 4.00pm on Fri 4th - I was painting outside !!!

The reading on 26th Dec storm 'Frank' is probably a substantial underestimate as we were away over christmas, returning early afternoon when the raingauge was overflowing

JANUARY 2016

Date	Rain	Max	Min	Date	Rain	Max	Min
1		2	-3	17			
2	2	7	-3	18	5	4	-2
3	15	6	3	19	1	3	0
4	2	5	1	20		4	2
5	1	7	3	21	4	3	-5
6	8	4	2	22	22	8	2
7	7	4	-3	23	1	7	3
8	2			24	18	9	4
9	12	5	-1	25	2	10	5
10	8	5	1	26	35	8	4
11	3	3	-3	27	18	8	3
12	4	4	-1	28	7	5	1
13	6	2	-3	29	1	8	3
14	5	2	-3	30		5	0
15		3	-4	31	5	4	0
16					127		

35 202

3 days no rain ea

FEBRUARY 2016

Date	Rain	Max	Min	Date	Rain	Max	Min
1	9	8	2	16	1	3	-6
2	2	5	1	17	17	5	0
3	3	5	-1	18	1	4	-4
4	7	8	1	19	21	6	-2
5	14	7	3	20	15	6	2
6	12	6	0	21	14	8	3
7	10	5	1	22	1	7	0
8	14	6	1	23			
9	9	5	0	24			
10		4	-2	25			
11	1	3	-3	26			
12		5	-2	27			
13		4	-3	28			
14		4	-4	29			
15		2	-4				

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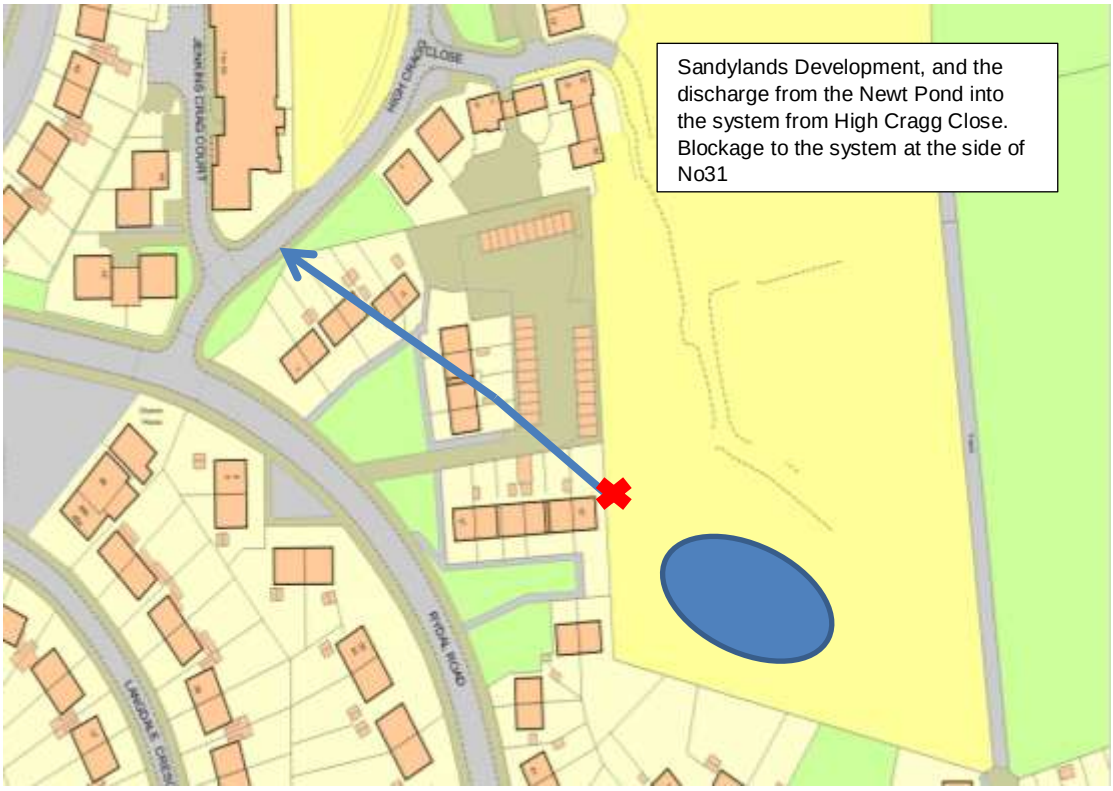
Appendix 6: LLFA Drainage investigations

1. Sandylands Newt Pond Investigation



2. Low Garth culverted water course.

3. Allotments to Windermere Road

4. Bleaswood Road , Oxenholme

5. Kentdale Road Culvert

6. Jenkins Crag Court

Capacity issue of surface water storage system being investigated by UU and housing association