RIVER DERWENT (LAKE DISTRICT) A HISTORY OF FLOODING

Introduction with thanks to the Cockermouth Flood Action Group
No Author to attribute to ... However references at the end.
Only short periods of gauged record, generally less than 30 years, are available to assess the flood discharge that might be expected with a return period of 100 years. There is a requirement therefore for extrapolation of a flood frequency curve well beyond the limits of the record duration. However there is no *a priori* basis for judging which is the best flood frequency distribution or fitting method to use. In most instances but especially when there are outliers in the observed data set, extrapolation using different distributions can lead to widely different estimates. There is no means of judging from the data which of these estimated discharges (and the associated levels on the flood plain) is most likely to be correct and the usual solution is take a mean discharge from a range of different distributions and fitting methods.

Some confirmation to the slope and shape of the flood frequency distribution is provided by making comparisons of flood frequency at several stations within and on adjacent catchments, thus effectively adding to the number of station years of record. However, there is a degree of dependence between the floods experienced on adjacent catchments and, even when considered regionally, the flood record sample may not give a good indication of the distribution of the flood population and in particular for long return periods.

Examination of historical information provides an alternative means of assessing high return period flood discharges and levels. It has the disadvantage that the information is rarely as precise as for the gauged record especially in the assessment of discharge from a reported level. Nevertheless, there are instances where the control at a point on a river has remained with little change over a period of centuries e.g. at a bridge crossing or a mill weir. Some natural sections have also changed little. At these points it may be possible to convert levels to discharge and to combine with the gauged record, as for example was done for the River Wear (Archer, 1987) and for the River Tyne (Archer, 1993).

The main outcome of this review is a description of the extent of flooding during the major floods that have occurred over the period from the mid seventeenth century. This is presented as a flood chronicle with a summary description of each event.

Sources of Information

There are three basic types of information which can be gleaned by a historic study of flooding, to supplement the observed record.

Precise but geographically specific as a record of level at a defined point.

Such information includes gauge boards placed at bridges by local authority or at mills by the mill owners, and flood stones placed by riparian owners. Ideally such information should have the following characteristics:

It should cover an extended period of time and several events.
It should include all events over a threshold within that period.
It should have maintained a constant control of the level discharge relationship within that period, and
It should be located within the catchment and reach of interest.

Such conditions, of course, are rarely achieved, (even in a gauged record) and the best use possible must be made of imperfect records. Measurements made in an adjacent catchment or in a reach further downstream provide clues to the reach of interest, since the weather event which caused the flood is generally more widespread than on the catchment in question.

Such information provides a means of comparing the magnitude of events within a record, and, where records from different sources overlap an extended record of comparative flood magnitude may be synthesised.

Imprecise but spatially widespread

This is the descriptive information contained in newspaper reports, diaries and further back in time, from Quarter Sessions bridge accounts and ecclesiastical records. The main source for this study has been from newspaper accounts.

Newspaper descriptions include much that is of human interest but only limited information which can be used to define the magnitude of the flood. It is only the latter information which has been extracted for the most part, indicating levels or depths on roads and buildings which may still be identifiable. Such details provide a means of assessing the comparative magnitude of floods.

The two principal urban areas within the Derwent catchment which are vulnerable to flooding are Keswick and Cockermouth. Keswick has had its own broadsheet the *Keswick Reminder* published since 1840 and available on microfilm since 1915. However it is mainly an advertising paper and contains virtually no flood information. Other papers purport to cover that part of Cumbria but have been and are based outside it. These include

Cumberland Packet (Whitehaven) 1774 to 1915,
Carlisle Journal, 1801 to 1960s,
Carlisle Patriot (later *Cumberland News)* 1815 to present
Penrith Observer, 1860 onward
West Cumberland Times(Workington) 1874 onward
Westmoreland Gazette (Kendal) 1818 onward

Further information with respect to Cockermouth is contained in books and pamphlets produced by local historian J. Bernard Bradbury including a series on 'Cockermouth in Pictures', and two books *Bradbury's History of Cockermouth* and *Cockermouth and District in Old Photographs*. Flood photographs from this source have been copied to illustrate this report.

Descriptions are generally imprecise and without details of levels reached or the extent of the area flooded. It is therefore difficult to make judgements as to the comparative severity of the events.

Associated meteorological information

The publication British Rainfall 1863 – 1968 (Symons British Rainfall from 1863 to 1900) was inspected to identify potential flood dates and to ascertain the meteorological conditions associated with flooding – thaw, thaw with rain, frontal rainfall, convectional storms etc.

Flood Chronicle

1749 22 Aug

An account of a summer convectional storm over the Vale of St John which caused much havoc. is described in West's Guide to the Lakes (1812). This is included in full as there are few available descriptions of the effects of such intense convectional events over small areas in the Lake District.

'On the evening of 22 August, the day having been much hotter than was ever known in these parts, a strange and frightful noise was heard in the air which continued for some time to the great surprise of the inhabitants, rumbling over them like a strong wind. This was succeeded by the most terrible claps of thunder and incessant flashes of lightning flashing over their heads. At the same time the clouds poured down whole torrents of water on the mountains to the east which in a very little time swelled the channels of the rivulets and the brooks so as to overflow every bank and overwhelm almost every obstacle in their way. In a moment they deluged the whole valley below and covered with stones earth and sand, many acres of fine cultivated land.

Several thousands of huge fragments of rock were driven by the impetuosity of the waters on to the fields and some were more than 10 horses could move and one was fairly measured as 19 yards in circumference. A corn mill, dwelling house and stable, all under one roof, lay in the track of one of these currents and the mill from the one end and the stable from the other were both swept away leaving the little habitation in the middle rent open at both ends, with the miller who was old and infirm in bed who was ignorant of the matter till he rose the next

morning and beheld nothing but ruin and desolation. All was covered with large stones and rubbish four yards deep

Something similar to this happened to other places in the neighbourhood along Legberthwaite and Fornside but no lives were lost'.

There are no reports of effects of any sort further down the valley.

1761 21 Nov
There was 'a prodigious flood at Cockermouth which carried away several houses, mills etc.' (Bradbury 1995 from an edition of the *West Cumberland Times)*

1822 2 Feb
The *Carlisle Patriot* reports that 'the oldest person living never saw anything equal to this flood in this part of the country. The Rivers Greta and Derwent, particularly the latter were never known to be so high and the consequent damage is very great'. A wash house of Forge on the Penrith Road (Greta) was completely carried away with all its contents - 80 stone of oatmeal, a fat pig, a washing of clothes and brewing utensils. Dwelling houses nearby and a wool carding factory also suffered severely with the water 4 1/2 feet deep in the latter. The cottages were flooded to the ceiling, which was 'higher by two yards than ever remembered'. The roads leading to Borrowdale, Penrith and Bassenthwaite were totally impassable. Rev Brown of Bassenthwaite was washed off his horse and perished. On the Cockermouth road the water rooted up trees and levelled hedges in all directions

The arches of the new bridge (the two-arch stone Derwent bridge probably completed within the previous two years) at Cockermouth were not found large enough and the road in consequence was completely impassable.

The winter was remarkable both for its 'hurricanes' and storms of rain as for its mildness. The area experienced destructive wind and rain on 1 Dec 1821, whilst only the highest summits had seen a sprinkling of snow through the whole winter. The February floods were accompanied by a southwesterly gale which was also responsible for widespread damage. On the neighbouring River Eden the level at Carlisle was higher than in the great flood of 1771.

1831 8 Feb
The quantity of snow which fell in Keswick and neighbourhood was greater than had occurred for 60 years (1767?) and Greta and Derwent were again in high flood. The thaw was accompanied by a fall of rain of two days continuance. Houses in the inappropriately-named village High Hills near (now a part of) Keswick were in danger of being swept away when the water swept over and destroyed an embankment along the Greta. Water was five feet deep in some houses and foundations were undermined. Inmates of the houses were conveyed

on carts and horses into Keswick. Flood levels at that location were said to be diminished by the breaching of an embankment further upstream at Monk's Hall and the spreading of water over the flood plain. At Briery Hill further upstream mill weir and gates were carried away and the gates of the weir at The Forge were also damaged.

At the head of Bassenthwaite, a newly-erected wooden bridge over the Derwent was destroyed and another a mile upstream seriously damaged. The lakes of Derwentwater and Bassenthwaite were absolutely joined. The high road from Keswick to Cockermouth was rendered impassable and for several days afterward the coaches were compelled to travel by Bassenthwaite on the ancient road past the vicarage near Keswick.

A stone bridge near Uzzicar over the Newlands/Braithwaite Beck was swept away. Gills rising on Skiddaw and other hills have spread out great quantities of sand and stones over neighbouring low-lying farmland

No information was found on Cockermouth.

1840 ?
It was reported in the *Workington Star and Harrington Gardian* of 28 May 1915 (Notes of the Week).that a nail had been driven into a wall adjacent to the Derwent Bridge between the Soapery and the Mill Field to mark the level that the water had reached. This nail was referred to in some subsequent floods (1852 and 1898) The Derwent overflowed its banks including the reach above the Yearl weir, and the Mill Field was flooded, the water reaching to the boundary wall of the Park at the lower corner on entering the field. The paper provides the ancillary information that the adjacent Derwent Bridge had been built in that year and the identity of those who had driven the nail. The wall was reported to still exist until about 10 to 15 years ago (*pers. comm. J. Thompson)*

1852 2 Feb
Westmoreland Gazette reports that the weather during the previous week at Keswick had been continuous rain and with the rivers in flood, the land between Derwentwater and Bassenthwaite was entirely under water. The mills on the Greta were at a complete standstill but fortunately little damage was sustained.

1852 12 Dec
At Cockermouth during a later event (in 1898) the flood of Dec 1852 was said to be the greatest of the floods of the second half of the century (exceeding the floods of 1856, 1868, 1874, 1891 and 1898. Extensive flooding of industrial premises was recorded including a tannery, a hat factory and a tweed mill. The Brewery and Herbert's foundry also suffered The Main Street and the Goat area were also flooded.

It was reported that at Workington that the overflow had reached nearly to the 'water nail' placed in 1840.

1856 Dec 7
The flood was caused by a sudden thaw accompanied by continuous rains and high winds. The Greta was 'at least three inches higher than ever known' The flat lands between Derwentwater and Bassenthwaite were under water and considerable damage was sustained.

At Cockermouth the whole of The Goat between Derwent Bridge and the half mile stone was covered with water to a depth of 2 to 3 feet. Ferry carts plied for hire and the road past the Goat Mill had become a foaming torrent two feet deep. The flood rendered Cockermouth inaccessible for pedestrians from Papcastle and the Maryport road. It covered the fields between Harris' Mills and the town and The Goat toll bar but also extended nearly the entire length of the main thoroughfare. The Goat and Papcastle Mills suspended work and the Fitz Mill was surrounded

1861 26 Nov
The Derwent rose to a great height at Cockermouth and Workington and the main street in Cockermouth was at one point impassable and "Dr Armstrong and Major Thompson had narrow escapes from being washed off horseback'. At Workington the continuous fall of rain had the effect of swelling the Derwent to a height 'which it had not reached since the memorable flood nine years ago'.

Westmoreland Gazette reported that the rivers in the Keswick area rose to a height not known since 1831. Cottages in the lower part of town were nearly filled with water and they were obliged to leave. The lake of Thirlmere extended itself to the meadows below the Nag's Head, Wythburn. Two bridges across Thirlmere at Armboth were washed away and nearby houses were flooded.

1868 ?
A flood at Cockermouth in this year was mentioned during a subsequent event in 1898 but no documentary evidence was found.

1874 7 October
Prolonged rainfall saturated the catchments before the onset of continuous heavy rain for more than 30 hours with resulting flooding of low-lying land throughout Cumberland and Westmoreland. The Derwent from Keswick to Workington and 'more especially between the latter place and Cockermouth' was heavily flooded. The Derwent at Cockermouth was estimated to be seven feet above its ordinary level and 'some three feet below the great flood thirteen years ago' (1861). It did considerable damage to warehouses along its banks, whilst the River Cocker which was said to be at its highest ever level flooded a warehouse and many houses, from which tenants were obliged to quit. Many of the houses at the back of Main Street were flooded. In Main Street, the water covered the

roadway to a depth of a foot or more. A salmon weighing 34 pounds was caught in mid street.

Communication with The Goat on foot by the normal road was stopped, the river having spread over the fields to the mill race and swept over the road beyond Derwent Bridge. Water stood a yard deep in many houses at the Goat. A woman was drowned when she fell into the tributary Bitter Beck and was swept 300 yards into the Cocker. Herbert's iron foundry was damaged by the Cocker as was a tanyard and butcher's.

1883 29 Jan
A heavy fall of snow was followed within two days by rain and strong winds which caused a complete thaw. Part of Keswick was under water owing to the floods and Derwentwater and Bassenthwaite became joined. In Keswick, the flood waters were 100 yards up the Main street and the Fitz Recreation Ground was partially submerged up to the walls of the farm of Monk's Hall. The road to Portinscale was many feet deep The *Carlisle* Journal suggested that it was the heaviest flood in the Lake District for 20 years but no reference was found to flooding in Cockermouth. In some parts of the Pennines (Bedale) the event produced the greatest flood since 1822.

1891 25 Aug
The *West Cumberland Times* reported that this was the heaviest August floods known at Keswick and it caused much agricultural damage but no houses were flooded. It followed a period of 30 hours of heavy rain.

At Cockermouth the water rushed on to the roadway at the Goat and also flooded the road leading from South Street to Rubby Banks. It caused damage to the Waterloo Bridge (the Barrel Bridge) connecting High Sand Lane to the Castle Brewery. (The bridge had been built in 1887).

At the village of Branthwaite, the Star Inn was reported flooded.

1894 ?
Tobin reports flooding - date unspecified. Flooding in December 1932 was accompanied by a statement in the *Cumberland News* that it was the biggest flood in Borrowdale for 36 years (1894).

On 11 February there was a severe gale with widespread damage throughout the country. There were accompanying coastal storm surges which affected the Cumbrian coast and flooding on the Derwent (as well as the Eden). No further details were located. In August there were 'disastrous floods' after a 'memorable deluge' mainly on tributaries of the Eden. .

The absence of specific flood information suggests that the later reports were mistaken References in 1932 probably refer to 1898 rather than to 1894.

1897 12 Nov
British Rainfall reported very heavy rainfall in the Lake District. At Barrow House Keswick the daily total was 4 1/2 inches. Further up the valley, the total was 6 inches, whilst at Keswick it was 2 1/2 inches. At Borrowdale Vicarage 8.8 inches fell in 3 days, including 6.94 in a single day. The flood in Borrowdale was the greatest known since September 1890 (date mistaken!). The storm had been preceded by some months of below average rainfall which limited its impact on the rivers. At Bowder End Borrowdale, hedges and fences were for some time out of sight.

Flooding was reported on the River Cocker at Lorton, where the water was up to the window sills of the Low Mill; a rustic bridge was washed away. No information was found on flooding in Cockermouth. The River Marron at Ullock was very high and some cattle were rescued with difficulty. The Star Inn at Branthwaite was flooded. Two young boys were drowned in the River Derwent at Workington.

1898 2 Nov
In common with most of the rivers of the Lake District, the Derwent suffered an exceptional flood.

The *West Cumberland Times* referred to this as the most serious flood in memory in Borrowdale with a total of 8.63 inches at Borrowdale Vicarage (duration unspecified). Bridges were destroyed at Thornythwaite, Mountain View, Longthwaite, Stonethwaite. It entered houses at Mountain View and at Rosthwaite the water was 4 1/2 feet in some houses. The Scawfell Hotel was seriously damaged. At Braithwaite houses were flooded to 3 feet and the bridge was destroyed.

At Keswick the daily rainfall was 3 inches. Thirlmere was full and overflowing. At Threlkeld the water flowed down the railway Derwentwater and Bassenthwaite became united as a single lake. Fitz Park was partially covered and many houses in Keswick on the banks of the Greta were flooded. The *Carlisle Patriot* suggested that ‘it must be a dozen years since there was a similar flood in Keswick’. The *Mid Cumberland and North Westmoreland Herald* stated that ‘the last similar flood occurred 14 years ago (1883?). Skiddaw Street, Wordsworth Street, Blencathra Street and Helvellyn Street were flooded. The lower part of Main Street had up to three feet depth of water. ‘The overflow advanced beyond the Parish Room’. Derwentwater rose to a height of eight feet (another report of 7 feet) above its normal level. Lodore Hotel was damaged through overflow of the falls and the road to Borrowdale was impassable. A dam burst behind the pencil mill at Braithwaite and inundated a number of houses. Powe bridge between Keswick and Braithwaite was partially washed away. The water rose to within 3 feet of the railway line to Cockermouth whilst Bassenthwaite Lake Station was surrounded to a considerable depth.

Further downstream in the reach from Cockermouth to Workington, it was reported that ‘a flood of such extent has not taken place for 45 years’. The River Cocker overflowed the roads and fields at Lorton. The River Cocker overflowed at the bridge and flooded the London and Midland Bank. It penetrated down South Street. Houses between South Street and Cocker Bridge were abandoned. Main Street was completely covered and the cellars in all the houses were flooded. At the Globe Hotel water filled the cellar and backed up to the ground floor. Houses adjoining the District Council Offices had water in them to several feet and the Mechanics Institute Yard was flooded. Water dashed over the Barrel Bridge which became impassable whilst houses in the adjacent High Sand Lane were flooded.

Below the Derwent and Cocker confluence, there was a broad expanse of water and all the houses at The Goat were flooded to the lower window sills and the sidewall of one house fell down. The Sandair cricket ground was covered.

West Cumberland Times reported bystanders discussions of previous floods and that documentary evidence was produced of floods in 1852, 1856, 1868, 1874 and 1891 with the event of 1852 being said to be the highest on the Derwent below the confluence.

Between Cockermouth and Workington hundreds of acres were under water and in some places it washed over the railway line. The penny bridge near Broughton Cross was almost submerged and at Camerton the passenger’s bridge was damaged when struck by a floating tree trunk. The lower rooms of Camerton Hall were flooded.

At Workington little damage was done though observers remarked that if the flood had been accompanied by a high tide the effect would have been far more serious. Water covered Hall Park and it was reported that a spike driven into a wall just entering Millfield, to show the height of a previous high flood (1840) was surpassed. The water flowed over the railway line near the Workington Bridge Station and washed sleepers off the line.

At Branthwaite the water was 7 to 8 inches over the first step of the Star Inn.

1918 16 Oct

There are subsequent references to a flood in the early part of October 1918, but there is limited information in contemporaneous papers, either because of wartime restrictions on reporting or due to more momentous events to describe.

Brief reference was made to rain and floods with a total of 3.37 inches falling at Whitehaven between 14.00 on 15th and 0700 on 16th. It was said to be the worst flood in 40 years in the Broughton district and that most of the land between Ribton Bridge and Miser Bridge was submerged, but no reference was made to

Keswick or Cockermouth. Bradbury (1994) however includes photographs of flooding of the Main Street of Cockermouth during the event.

Based on the comparative statements made in the description of the flood of 1938, and photographs in Bradbury (1995) of the Barrel Bridge being overtopped (Figures 1 and 2), it is believed that the flooding in Cockermouth arose largely from the River Cocker.

1924 23 Dec to 29 Dec

A series of storms over the period from before Christmas to New Year brought widespread flooding and damage from gale force winds and resulting tidal flooding.

On 23 December there was heavy flooding of the Brigham district of Keswick. It is not clear if this was from the Greta or from small culverted watercourses. A culvert in Chestnut Hill burst and the water rushed through an adjoining house. At Brigham a lake was formed from the foot of the Brow to Brigham School and many houses were flooded. It was stated that it was about 14 years since such a flood took place (?).

On 27 December after further rainfall the River Greta rose to a level which exceeded a mark on houses near the pencil mill showing the level of a flood 80 years ago, by 18 inches (1852? 1856?). The Penrith Road near the mill was under water and the flood reached into Greta Street and penetrated some houses. Keswick Park was flooded to 1 to 2 feet deep. Brigham was again flooded with 2 to 3 feet of water in houses.

Villages in Borrowdale were affected with reports of serious flood losses in Stonethwaite, Rosthwaite, Seathwaite and Seatoller. From Embleton to Threlkeld, fields were flooded; the Braithwaite, Portinscale and Borrowdale roads were deep under water. Thirlmere reached an unprecedented height and there was a strong (but mistaken?) opinion amongst the residents of Keswick that the severity of the flood was due to the method of release of water from the reservoir.

Flooding of Cockermouth first occurred on 23 December but conditions became even worse on 29 December with flooding at The Goat. The lower part of Waterloo Street was also flooded, due to blockage of a culvert. At the Goat, the water was not high enough to pass through many doors. The field beside the Derwent between the high road and the Mill was under water. Sandair was flooded. The River Cocker was only a matter of inches below Brewery (Barrel) Bridge. Seaton Road from Brown's corner to Ivy Lodge was flooded to more than 1 foot. At Camerton. the Hall Park was like a lake.

1927 2 Nov

The effects of this storm on the Derwent were mainly described in terms of the effects of the wind damage rather than the ensuing flooding, as winds in the

valley reached 60 mph whilst 1.8 inches of rainfall fell. the two lakes were almost joined together by the floods. Keswick School playing field was inundated. The Braithwaite Burn again broke through its banks and flooded agricultural land. There were also reports of land flooding in the vicinity of Threlkeld and loss of sheep.

No reports were found of flooding in Cockermouth but Camerton Hall Park and the field to the east of the Miser bridge were flooded and water was deep over Carr Meadow.

1931 3 Nov
Cockermouth was flooded with water into Main Street, High Sand Lane, Waterloo Street and the Goat. No information was available elsewhere.

1932 18 Dec
Flooding occurred after three days of almost continuous rain with a fall of 4 inches in the Keswick area and more than double that in the Borrowdale valley. Nearly 3 inches fell in one day at Keswick and 6 inches in Borrowdale. In Borrowdale it was said to be the highest flood for 36 years (*Cumberland News*) and more generally the *Carlisle Journal* reported that the floods were the most extensive experienced for over 40 years in the area between Keswick and the coast.

Low-lying land between Thirlmere and Keswick was inundated as Thirlmere overflowed. The Greta at Keswick threatened to overflow but it fell short by a few inches and there was no serious flooding there.

With the highest rainfall over Borrowdale, Derwentwater and Bassenthwaite were said to be the biggest and highest ever known having become one lake The water was up to the edge of the pathway down to Friar's Crag. Boat landings and sheds and their contents were washed into the lake. The boathouse on Derwent Island was almost submerged. Downstream, the River Derwent overflowed at Portinscale Bridge and at Braithwaite Bridge and in the main road in both places was 2 to 3 feet under water.

The main damage was done however downstream at Cockermouth from the sequential effects of the Derwent and Cocker. The Cocker rose rapidly on Friday 16th, then subsided but later rose again to a peak around 0400 on 17th, flowing over the Barrel Bridge and into the houses on High Sand Lane. During the 17th the Derwent started to rise and between 2300 on 17th and 0100 on 18th it overflowed and rushed down streets finishing up with 3 feet of water at the junction of Main Street and Sand Lane. The Main Street was inundated to a depth of 2 feet for 300 yards. It was in the Globe Hotel to a depth of 8 inches. In side streets and alleys over 100 houses were completely isolated, and in some 'it was barely a foot from the ceilings of the kitchens and parlours'. 'It went up Lindsey's yard and Irving's court like a torrent' . In the thoroughfare behind Main Street on

the banks of the Derwent, water flowed like a millrace and inhabitants were confined to upper rooms. Houses in High Sand Lane and Waterloo Street were flooded to half way up their windows.

Two hundred people in the area known as The Goat were marooned. Sandair cricket field was under water eight feet deep and the rugby field was little better. All roads into the town were impassable for more than an hour.

Four photographs which appeared in the Cumberland News are reproduced as Figure 3. Two photographs from Bradbury (1995) show the River Cocker again overtopping the Barrel bridge are reproduced as Figure 4 and 5. Figures 6, 7 and 8 (again from Bradbury, 1995) show Cockermouth Main Street looking towards the Mayo statue, a fisherman in the Main Street and the River Cocker taking a short cut down South Street, looking towards Quaker Bridge.

Although both Cocker and Derwent caused flooding it was the effects of the River Derwent which were more serious during this event.

The river Derwent caused damage to land and property in the Great Broughton district, inundating several hundred acres of land. A house at the Penny Bridge Great Broughton was surrounded and the road from Great Broughton to the main Cockermouth Workington road was impassable at Stoneybeck Lane. The roads from Great Broughton to Ribton and Camerton were also flooded several feet deep in places. At Carr Meadow the footpath to Camerton Parish Church had water spread over 100 yards. At Salmon Hall the water reached the top of the railway fencing. At Workington it inundated the Mill Field and flooded houses in Park View to a depth of one foot.

Flooding also occurred in Carlisle from the River Eden but more unusually also at the Maryport suburb of Grasslot from a small channel. Sixty houses and several shops were flooded and only two streets were unaffected. Floods were unknown there to ‘all residents under 40 years of age’.

1938 29 July

Very heavy rainfall occurred in the upper part of the catchment with a daily total of 6 to 7 inches as Borrowdale, 4 to 5 inches at Newlands and Braithwaite. As a summer flood, the inundation of agricultural land had a much more damaging effect than the more common winter floods. Derwentwater and Bassenthwaite were joined together but Keswick itself was free of floods. Thirlmere was so low that it was capable of taking all the flood water and did not overflow. Footbridges at Scafell Hotel and at Styhead were washed away and at Mountain View the water almost reached the houses. Traffic to Cockermouth was diverted to the Castle Inn side of Bassenthwaite to avoid deep flooding at Braithwaite and Portinscale.

In Cockermouth on this occasion the River Cocker alone was responsible for the flooding of the Main Street, although the Derwent later overflowed into the lower part of the town. The Main Street was flooded to a depth of 3 feet and *Carlisle Journal* reported it to be the worst flood there since 1918. The Cocker rose very rapidly. When shops were first opened there was no sign of a flood but early customers had to leave by the back to avoid the rising water. The water rose over the Quaker Bridge connecting Lower South Street and Cocker Lane; it was pounded by tree trunks and it cracked in the centre and most of the steel railings and stone masonry were swept away. The Barrel Bridge collapsed at 1330. A large part of the town suffered losses and many houses and shops were damaged. Challoner Street was converted into a roaring torrent, three feet deep. On a lane off Market Street water was lapping the tops of ground floor doors. Horseman Street suffered from the backing up of drains. The proprietor of Huddart's shop on the Keswick side of the Cocker Bridge had to leave for safety; he said that in 1918 the flood did not reach the top stair of the cellar whilst on this occasion it was 2 feet over it. The shop was later demolished and the business moved next door and is still there. A South Street resident of 50 years who had 4 feet of water in her living room said it was the highest experienced, the previous highest being in Oct 1918. A 15 lb pike was caught in the Main Street.

Observed from Derwent Mill Bridge the Cocker was riding 6 feet higher than the Derwent, pounding against the remains of Barrel Bridge. During the night the Derwent rose to flood properties, but in the meantime the Cocker had subsided. It was said that additional square arches added to the Goat Bridge kept most of the Goat free of floodwater and only houses at the lower end were affected.

After the flood hundreds of tons of gravel were found deposited near the junction of the Derwent and Cocker 100 yards below the wrecked Barrel Bridge. The *Carlisle Journal* published a page of flood photographs which are reproduced as Figures 9 to 18 as follows:

- A view of the Main Street from the Globe Hotel
- Surcharged water upstream from Cocker Bridge emerging from beneath the Midland
  Bank
- Challoner Street transformed into a roaring torrent
- Policeman assisting stranded shoppers
- River Cocker overtopping the Barrel Bridge
- Main Street Cockermouth
- A view of the River Cocker from Cocker Bridge
- Pedestrians viewing the flood from the corner of Station Street and Main Street
- The broken Jubilee footbridge at the foot of Cocker Brow
- The extreme turbulence of the Cocker flowing into the Derwent below Barrel Bridge.

A further three photographs are reproduced from Bradbury (1995) as Figures 19, 20 and 21 as follows:

- South Street leading to Challoner Street
- Waterloo Street
- Surging and turbulent flow over the remains of Barrel Bridge.

Workington escaped with little damage, although at the Workington Bridge Station, trains had to travel through water three feet deep which partly covered the platforms. The Grasslot area of Maryport was again flooded and even more seriously than in 1932.

The Rotarians of Cockermouth opened a Flood Relief Fund and many houses were supplied with coal.

1954 29 Oct

Cumberland News stated that the floods were the worst in 20 years. there was more than 8 inches of rain at Seathwaite over the weekend. *Keswick Reminder* reported that Derwentwater and Bassenthwaite were joined as one mighty sea. 'It has happened many times now; in fact it is almost tradition'. The burghers of High Hill boarded their gates and doors and the water flowed round the corner of Crosthwaite Road and into the street. It did not, however get into the houses. It overflowed and flooded the Howrahs between Keswick School of Industrial Arts and Portinscale Bridge.

At Cockermouth it was said that flood prevention work particularly the increased bridge capacity, done just before World War II was believed to have prevented damage of the 1932 proportions above the Goat Bridge. Some houses in Waterloo Street were flooded and it overflowed the doorsteps of some 20 houses in the Goat. The Sandair cricket ground and adjoining fields were under water. Police houses in Castlegate were flooded to a depth of 6 inches.

1954 2 Dec

This was the culmination of an exceptionally wet autumn; more than 2 inches of rain fell at Keswick. The *Keswick Reminder* stated that 'this was probably as big a flood as any known. The *West Cumberland Times* noted that Derwentwater was 7 feet above normal level and 1/4 inch higher than the record of 1861. Seatoller, Newlands and St John in the Vale were cut off by water 4 feet deep on the roads. The River Greta overflowed into Keswick Park and houses in Crosthwaite Road and High Hill were flooded to a depth of 2 to 3 feet. Keswick Pavilion was flooded. Children at Keswick School were sent home when the flood water entered the grounds and penetrated into the school. Portinscale Bridge was damaged by the flood (Figure 22).

At Cockermouth The River Cocker was appreciably lower than in October but the Derwent was much higher and the Goat suffered more severely. It is noted that

whereas the Derwent at Keswick reached a peak on the afternoon of Thursday, the peak in Cockermouth was at 0300 to 0400 on Friday.

1963 Mar

The Barrel Bridge, destroyed in the 1938 flood was not replaced until the beginning of 1963 (Bradbury, 1995). Work on the bridge was completed on a Friday but during the following weekend the Cocker rose and washed the supports away. The stonework was raised 18 inches and the bridge retrieved from the river and re-erected. Although the date of this occurrence was not noted, it may have been the snowmelt flood of 6 March which caused very high levels on other rivers in the north of England.

1966 Aug

An intense summer thunderstorm centred to the east of Cockermouth resulted in flooding neither from the Cocker nor the Derwent but from the minor tributaries of the Cocker, the Tom Rudd Beck and Bitter Beck. A culvert at Butts Fold collapsed blocking the channel so that water poured downs St Helen's Street flooding about 50 houses and shops as far as Cocker Bridge. No 9 Kirkgate (now demolished) had water 4 to 5 inches in the house. The height of the water in the Market Place is shown on the door frame of Banks' ironmonger shop by a line 31 inches above pavement level. Tom Rudd Beck also overflowed and flooded the Skinner Street area.

As a consequence the Bitter Beck Scheme was prepared which involved the reculverting of the beck. At the same time many old vulnerable buildings were demolished including the lower end of Kirkgate

Flood Seasonality

The floods listed in the above descriptions (but excluding the very localised events of 1749 and 1966) may be considered in terms of their seasonality of occurrence.

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	3	0	0	0	0	1	1	0	3	6	5

By far the predominant flood period is in the last three months of the year when 14 (70%) of the listed floods occurred, with 3 in October, 6 in November and 5 in December. Only two floods (in February 1831 and December 1856) are described as having a major snowmelt component. Summer floods are notably lacking with the exception of the lower magnitude 1891 flood and the exceptional event of July 1938.

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Channel changes in Cockermouth

There have been significant changes to the river channel in Cockermouth which have affected the liability to flooding from the main rivers. A comprehensive description has not been possible but the following is noted.

Through the nineteenth century and up till the mid 1930s, gravel was extracted from the river for housebuilding and road repairs. The workhouse used a handcart to transport cobbles of which men had to break two bucketloads in return for bed and breakfast; the workhouse closed in the 1930s.

After the flood of 1932 a more concerted effort was made and gravel was extracted and deposited on land which was later to become the Memorial Gardens. In 1936, two breakwaters on the mill side of the Derwent designed to divert water across the river were removed. Three square arches were added at the northern end of Derwent Bridge in an attempt to reduce flooding at the Goat. (Nevertheless, although the 1938 flood was primarily a Cocker flood, some houses on the Goat were still flooded.)

After the 1938 flood a letter to the *West Cumberland Times* pointed out that progressive changes in the lower course of the Cocker had increased liability to flooding, notably an increase in the height of the Fitz Weir and a reduction in the channel width. The writer recommended that the weir should be take out. Information was not available concerning consequent changes.

In 1947 the lower end of the Cocker was deepened, material being deposited below Waterloo Bridge on the left bank of the Derwent and in July 1969, gravel was removed and deposited on the same bank between the Mill Bridge and St Joseph's Church. In 1975 gravel was extracted below Mill Bridge for use in constructing the A66, but this was not specifically geared to flood protection.

Conclusions

1. The potential for flooding on the River Greta through Keswick has been reduced by the construction of Thirlmere at the end of the nineteenth century. Water resources operating policy results in the reservoir being drawn down for long periods especially in summer, thus providing flood storage. However there is no active reserve flood storage policy and there is still the potential for heavy storm inflows to coincide with a full reservoir, especially in winter months. On these occasions the outflow from the Thirlmere catchment is reduced by reservoir attenuation but, examination of flood frequency curves for the Greta catchment suggests that at high return periods the flood discharge will be little different from the natural catchment.

The continued flood potential of the River Greta to cause flooding was illustrated by the very serious flooding which occurred in 1985 when 70 properties were flooded. Subsequent flood alleviation works in 1987 and 1988 are designed to protect against the recurrence of such an event.

2. Derwentwater and Bassenthwaite are essentially uncontrolled lakes and exercise a very strong natural attenuating effect on inflows to these lakes. Attenuation is enhanced by the spreading of waters over the intervening lowland between the lakes. Descriptions suggest that the joining of the lakes is a feature of all the larger historical events described in the chronicle and probably much more frequently.

3. The Buttermere and Crummock Water Lakes also have a natural attenuating effect but because of their smaller size, the attenuation is less than on the River Derwent. In addition the channel to the confluence at Cockermouth is shorter and steeper than the Derwent. Crummock Water also has an outlet control and the lake is used as a source of water supply for Cockermouth and the coast. However the operating rules permit the level only to be drawn down to the base of the sluice when it is still effectively a full reservoir. There is therefore no additional flood reduction due to storage.

4. Flood attenuation on the Derwent both from the lakes and from flood plain storage along its course, results in long lag times. As a consequence, flood peaks on the Rivers Cocker and Derwent at Cockermouth tend not to coincide. Historical accounts suggest that the peak on the Derwent is typically 12 hours or more after the Cocker. A very unusual spatial and temporal distribution of rainfall would be necessary to create such coincidence and must be considered very rare.

5. Cockermouth has, in the past been flooded by both the River Cocker and by the River Derwent, which can cause flooding independently of the condition of the other. Historical descriptions do not always distinguish the source. However the River Cocker was primarily responsible for flooding in 1938 and probably in 1918 and the River Derwent in 1932. The same property may be flooded from either river. Property may be flooded sequentially by the two rivers in a single event (e.g. 1932) but with an intervening lull whilst the Cocker falls and the Derwent is rising. The effects of a given discharge in one river may depend on the tailwater level in the other and a combined hydraulic modelling will be required which incorporates typical hydrograph lags and durations from the two rivers. This should be established by a more detailed examination of recorded data from extreme gauged events.

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