Initial Event Analysis Report

Flood event of 16th March 2019

March 2019
## Revision History

<table>
<thead>
<tr>
<th>Revision Ref / Date Issued</th>
<th>Amendments</th>
<th>Author</th>
<th>Issued to</th>
</tr>
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<tbody>
<tr>
<td>19/03/2019</td>
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<td>Mohammed Amjid – CMBC Flood Risk Manager</td>
<td>Flood Programme Board</td>
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Abbreviations

CCTV .............................. Closed Circuit Television
CRT ................................. Canal and Rivers Trust
CMBC ............................. Calderdale Metropolitan Borough Council
EA ................................. The Environment Agency
FCERM ........................... Flood and Coastal Erosion Risk Management
FWMA ............................. Flood and Water Management Act
IT ................................. Information Technology
LFRMS ............................ Local Flood Risk Management Strategy
LLFA ............................... Lead Local Flood Authority
mALD ............................. metres above local datum
NPG ............................... Northern Power Grid
NR ................................. Network Rail
OFAWT ........................... Office of Water Services
RMA ............................... Risk Management Authority
SAAR ............................. Standard Annual Average Rainfall
SPRHOST ........................ Standard Percentage Runoff
YWS ............................... Yorkshire Water Service
1 Introduction

1.1 Background

On Saturday 16th March 2019 flooding of residential properties, business premises, railway infrastructure and the highway was experienced at several locations throughout Calderdale. Generally River levels responded rapidly in response to rainfall although did not exceed maximum levels recorded. The storm event was preceded by prolonged rainfall in the preceding weeks resulting in a saturated catchment which contributed to the flooding experienced. Generally flooding experienced was from the following mechanisms:

- River flowing out of bank
- River & canal interaction
- Overland flows
- Surcharged road gully and sewer outfalls
- Failure of land drainage infrastructure

This interim report is based on raw data available at an early stage following the flood event. This report will be superseded by a Section 19 report. As required under section 19 of the Flood and Water Management Act 2010 CMBC as Lead Local Flood Authority, on becoming aware of a flood in its area, must, to the extent that it considers it necessary or appropriate to:

- investigate the incident;
- identify the Risk Management Authorities (RMAs) with relevant flood risk management functions;
- establish if the relevant functions have been exercised or if it is proposed to exercise them;
- publish its findings in a Flood Investigation Report;
- Consult and inform the relevant Risk Management Authorities of its findings.

Investigating flood incidents requires the collection of precise and useful records to assemble an accurate picture of the flood events. This enables the LLFA to determine responsibilities and examine whether and how Risk Management Authorities (RMAs) exercised their functions in response to the flood.

2 Outline Hydrometric Analysis

2.1 Event Overview

Extensive rainfall caused road closures and property flooding across Calderdale with approximately 100 incidences of varying nature of flooding reported to date.

2.2 Hydrometric Analysis

2.2.1 Rainfall recorded

Rainfall data for the flood event has been obtained from radar based observation and forecasting software provided by Meteo Group and rain gauge sites in and around Calderdale. Figure 2-1 shows the rain gauge locations, forecasted and recorded rainfall for the event.
Rain gauge location plan

Bacup

Gorple Reservoir

Lower Grople Reservoir

Walshaw Dean

Thornton Moor Res.

Halifax Ogden Resr

Great Wolden Edge

Gorple Reservoir
2.2.2 Rainfall analysis

Across Calderdale the storm generally covered an 18-hour period and comprised two peaks. The first peak covered approximately a 7-hour period with quite steady rainfall peaking at around 0800. The second peak generally started at 1100 and peaked between 1300 and 1600 with a significant drop in rainfall from 1700.

Table 2-1 summarises the rainfall totals measured during the storm over a 24 hour period compared to historic events.

<table>
<thead>
<tr>
<th>Rain Gauge Name</th>
<th>16.03.19</th>
<th>15.11.15</th>
<th>12.12.15</th>
<th>26.12.15</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bacup</td>
<td>47.8</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Thornton Moor</td>
<td>55.4</td>
<td>81.6</td>
<td>36.2</td>
<td>103.8</td>
</tr>
<tr>
<td>Great Wolden Edge</td>
<td>68.6</td>
<td>68.2</td>
<td>38.6</td>
<td>73.8</td>
</tr>
<tr>
<td>Lower Gorple Reservoir</td>
<td>43</td>
<td>56.6</td>
<td>36.6</td>
<td>102.8</td>
</tr>
<tr>
<td>Gorpley Reservoir</td>
<td>67.4</td>
<td>48.6</td>
<td>34.4</td>
<td>112.8</td>
</tr>
<tr>
<td>Halifax Ogden</td>
<td>51</td>
<td>75.6</td>
<td>40.4</td>
<td>99.2</td>
</tr>
<tr>
<td>Ringstone Edge</td>
<td>62.8</td>
<td>62.8</td>
<td>40.4</td>
<td>71</td>
</tr>
<tr>
<td>Walshaw Dean</td>
<td>44.2</td>
<td>64</td>
<td>38.8</td>
<td>99</td>
</tr>
</tbody>
</table>

For the event of 16 March 2019, from table 2-1, between 44 to 68.6mm of rainfall was recorded with a maximum of 68.6mm recorded at Great Wolden Edge. Lower rainfall totals were recorded in in the headwaters of Hebden Water, this was generally the case for areas north of the Calder compared to catchments south of the Calder. High rainfall intensities were not recorded at any rainfall gauge and initial analysis points to a low rainfall return period of 1-2 years.
2.2.3 Antecedent rainfall conditions

Table 2-2 presents the antecedent rainfall conditions at each gauge site compared to historic events.

<table>
<thead>
<tr>
<th>Event</th>
<th>Duration</th>
<th>Ba cup</th>
<th>Walshaw Dean Lodge</th>
<th>Lower Gorple Reservoir</th>
<th>Gorpley Reservoir</th>
<th>Ringstone Edge Reservoir</th>
<th>Great Wolden Edge</th>
<th>Thornton Moor Reservoir</th>
<th>Halifax Ogden Reservoir</th>
</tr>
</thead>
<tbody>
<tr>
<td>16.03.19</td>
<td>15-days</td>
<td>165</td>
<td>173.2</td>
<td>142</td>
<td>202.8</td>
<td>156.8</td>
<td>173.2</td>
<td>NA</td>
<td>146.4</td>
</tr>
<tr>
<td>15.11.15</td>
<td>15-days</td>
<td>-</td>
<td>144</td>
<td>139.6</td>
<td>154.8</td>
<td>130.8</td>
<td>157.2</td>
<td>177.6</td>
<td>144.6</td>
</tr>
<tr>
<td>12.12.15</td>
<td>15-days</td>
<td>-</td>
<td>202</td>
<td>188</td>
<td>198.8</td>
<td>182.2</td>
<td>176.8</td>
<td>207.4</td>
<td>196.4</td>
</tr>
<tr>
<td>26.12.15</td>
<td>30 days</td>
<td>-</td>
<td>345.4</td>
<td>339</td>
<td>372.4</td>
<td>322.6</td>
<td>299.4</td>
<td>356.2</td>
<td>282.4</td>
</tr>
<tr>
<td>26.12.15</td>
<td>45 days</td>
<td>-</td>
<td>506.4</td>
<td>482.4</td>
<td>544.4</td>
<td>469.2</td>
<td>463.6</td>
<td>524.4</td>
<td>442.8</td>
</tr>
</tbody>
</table>

It can be seen from table 2-2 significant totals of rainfall fell in the preceding 15 days with similar totals experienced as historic flood events of winter 2015.

The Standard Annual Average Rainfall (SAAR) was derived after winter 2015 floods using the Flood Estimation Handbook (FEH), for three locations across Calderdale: Mytholmroyd, Ripponden and Elland. The SAAR at Mytholmroyd, Ripponden and Elland is 1,357mm, 1,367mm and 1,257mm respectively.

The above table shows that at Great Wolden Edge approximately 13% of the SAAR fell in the 15-days preceding the storm on the 16 March 2019.

2.2.4 River gauges

Figure 2-2 shows locations of river gauges in Calderdale.

The graphs below show the river gauge measurements at each station. The graphs have been obtained from the Flood Warning Information Service website https://flood-warning-information.service.gov.uk/river-and-sea-levels?location=calderdale. The Environment Agency uses a network of monitoring stations across the country. Each one has its own datum - a height in metres fixed relative to mean sea level. This height is expressed as metres above ordnance datum (mAOD). The river levels stated provide for each monitoring station are all relative to its site datum.
On the event the peak level at Walsden Water gauge station was reached initially at 1400 and remained in that region until 1730. The peak level reached was 0.61m. The highest level recorded at this location is 0.82m on 3rd June 2000.

On the event the peak level recorded at the gauge station was 0.77m reached at 1600. The highest level recorded at this location is 1.146m at 1230 on 26th December 2015.
**River level**

Walsden Water at Todmorden Salford

Check for flood warnings in this area

Latest recorded level 0.53m at 5:15am Tuesday 19 March 2019.

River levels at this location in the last 5 days

4:30PM, 16 Mar
Measured level: 1.55m

On the event the peak level recorded at the gauge station was 1.55m reached at 1630. The highest level recorded at this location is 3.091m at 1230 on 26th December 2015.

**River level**

River Calder at Todmorden

Latest recorded level 0.56m at 5:15am Tuesday 19 March 2019.

Levels: last 5 days and next 36 hours

4:45PM, 16 Mar
Measured level: 1.76m

On the event the peak level recorded at the gauge station was 1.76m reached at 1645. The highest level recorded at this location is 2.768m on 26th December 2015.
River level
River Calder at Todmorden Callis Bridge

On the event the peak level recorded at the gauge station was 1.75m reached at 1745. No data was available for the exact historic level recorded at this location but was approximately 2.5m.

River level
River Calder at Hebden Bridge

On the event the peak level recorded at the gauge station was 2.11m initially reached at 1730 continuing to 18:15. The highest level recorded at this location is 3.628m on 26th December 2015 at 13:00.
On the event the peak level recorded at the gauge station was 1.49m reached at 1645. The highest level recorded at this location is 2.615m on 26th December 2015.

On the event the peak level recorded at the gauge station was 0.86m reached at 1645. The highest level recorded at this location is approximately 1.1m.
River level
River Calder at Mytholmroyd Temporary site

Latest recorded level 1.08m at 5:15am Tuesday 19 March 2019.

Levels: last 5 days and next 36 hours

On the event the peak level recorded at the relatively new temporary gauge station was 3.76m reached at 1745. The highest level recorded at this location is approximately 3m. The preceding records for the nearby station (temporarily out of service) recorded a highest level of 5.735m on 26th December 2015.

River level
River Calder at Brarley

Check for flood warnings in this area

Latest recorded level 0.70m at 5:15am Tuesday 19 March 2019.

River levels at this location in the last 5 days

On the event the peak level recorded at the gauge station was 2.13m reached at 1745. The highest level recorded at this location is approximately 3.1m.
On the event the peak level recorded at the gauge station was 2.11m reached at 1830. The highest level recorded at this location is approximately 3.3m.

On the event the peak level recorded at the gauge station was 2.09m reached at 1830. The highest level recorded at this location is 3.554m on 26th December 2015.
River level
River Ryburn at Ripponden

Check for flood warnings in this area

Latest recorded level 0.31m at 5:15am Tuesday 19 March 2019.

River levels at this location in the last 5 days

On the event the peak level recorded at the gauge station was 1.14m reached at 1745. The highest level recorded at this location is 1.241m on 26th December 2015.

River level
River Calder at Elland

Check for flood warnings in this area

Latest recorded level 0.74m at 5:15am Tuesday 19 March 2019.

River levels at this location in the last 5 days

On the event the peak level recorded at the gauge station was 2.03m reached at 1930. The highest level recorded at this location is 2.757m on 26th December 2015.
On the event the peak level recorded at the gauge station was 3.98m reached at 1915. The highest level recorded at this location is approximately 4.2m.

River level
River Calder at Copley Bridge

Check for flood warnings in this area

Latest recorded level 0.84m at 5:15am Tuesday 19 March 2019.

River levels at this location in the last 5 days

On the event the peak level recorded at the gauge station was 1.85m reached at 2030. The highest level recorded at this location is approximately 2.0m.

River level
River Calder at Brighouse

Check for flood warnings in this area

Latest recorded level 0.27m at 6:00pm Tuesday 19 March 2019.

River levels at this location in the last 5 days
### Table 2-4: Total rainfall (mm): 16 March 2019 flood event compared to historic events.

<table>
<thead>
<tr>
<th>Rain Gauge Name</th>
<th>16.03.19 Peak level (mALD)</th>
<th>Time Recorded</th>
<th>Highest Recorded Level (mALD)</th>
<th>Date Recorded</th>
<th>16/03 Event Percentage of Highest Peak (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Walsden Water at Walsden</td>
<td>0.61</td>
<td>1400</td>
<td>0.82</td>
<td>03/06/2000</td>
<td>74</td>
</tr>
<tr>
<td>Walsden Water at Todmorden Salford</td>
<td>1.55</td>
<td>1630</td>
<td>3.09</td>
<td>26/12/2015</td>
<td>50</td>
</tr>
<tr>
<td>River Calder at Portsmouth Lennox Road</td>
<td>0.77</td>
<td>1600</td>
<td>1.146</td>
<td>26/12/2015</td>
<td>67</td>
</tr>
<tr>
<td>River Calder at Todmorden</td>
<td>1.76</td>
<td>1645</td>
<td>2.77</td>
<td>26/12/2015</td>
<td>64</td>
</tr>
<tr>
<td>River Calder at Todmorden Callis Bridge</td>
<td>1.75</td>
<td>1745</td>
<td>2.50</td>
<td>-</td>
<td>70</td>
</tr>
<tr>
<td>River Calder at Hebden Bridge</td>
<td>2.11</td>
<td>1730</td>
<td>3.63</td>
<td>26/12/15</td>
<td>58</td>
</tr>
<tr>
<td>River Calder Mytholmroyd Temporary Site</td>
<td>3.76</td>
<td>1745</td>
<td>3.00*</td>
<td>-</td>
<td>125 (70)*</td>
</tr>
<tr>
<td>River Calder at Brearley</td>
<td>2.13</td>
<td>1745</td>
<td>3.10</td>
<td>-</td>
<td>69</td>
</tr>
<tr>
<td>River Calder at Sowerby Bridge</td>
<td>2.09</td>
<td>1830</td>
<td>3.55</td>
<td>-</td>
<td>59</td>
</tr>
<tr>
<td>River Calder at Copley Bridge</td>
<td>3.98</td>
<td>1915</td>
<td>4.20</td>
<td>-</td>
<td>95</td>
</tr>
<tr>
<td>River Calder at Elland</td>
<td>2.03</td>
<td>1930</td>
<td>2.76</td>
<td>26/12/15</td>
<td>74</td>
</tr>
<tr>
<td>River Calder at Brighouse</td>
<td>1.85</td>
<td>2030</td>
<td>2.00</td>
<td>-</td>
<td>93</td>
</tr>
<tr>
<td>Hebden Water at Nutclough</td>
<td>1.49</td>
<td>1645</td>
<td>2.62</td>
<td>26/12/15</td>
<td>57</td>
</tr>
<tr>
<td>Cragg Brook</td>
<td>0.86</td>
<td>1645</td>
<td>1.10</td>
<td>-</td>
<td>78</td>
</tr>
<tr>
<td>River Ryburn at Sowerby Bridge</td>
<td>2.11</td>
<td>1830</td>
<td>3.30</td>
<td>-</td>
<td>64</td>
</tr>
<tr>
<td>River Ryburn at Ripponden</td>
<td>1.14</td>
<td>1745</td>
<td>1.24</td>
<td>26/12/15</td>
<td>92</td>
</tr>
</tbody>
</table>

* Temporary gauge with little historic data. If using the temporary out of service nearby station maximum of 5.74m approximately 70% of the maximum historic peak was observed.

From table 2-4 a number of key observations can be made. As a result of Walsden Water flowing out of bank at Bridge 96 (near Walsden Railway Station) a lower level was recorded Todmorden Salford Gauge Station. Generally the peak level observed was around 64 and 78 percent of the maximum historic peak recorded. Walsden Water at Walsden recorded a peak of 0.61m, although 74% of the maximum historic peak, on 26/12/15 a level of 0.619 was recorded therefore the event of 16/03/19 was 98% of the peak recorded on 26/12/15.

Generally higher peaks have been recorded in line with rainfall gauge records. This is specifically observed in the Ripponden catchment. Lower peaks at Hebden Bridge can be explained by the lower rainfall totals recorded and to some degree possibly by surcharge flows flooding the highway at Callis Bridge. Nevertheless, for an accurate conclusion further investigations need to be carried out as part of a S19 investigation. River Calder levels recorded at Brighouse were 93% of the maximum peak although the date of the maximum peak is unknown. For the Calder the peak wave took 4.5 hours to pass through the borough.
3 Flood Impact and Mechanisms

At this early stage after the event an accurate picture of the flood outline and its impact is difficult to quantify. From data available and compiled to date the subsequent paragraphs summarise impact of the known flooding mechanisms experienced.

3.1 Reports of Areas Impacted

3.1.1 Walsden

Following a prolonged period of rain, flooding occurred in Walsden, the exact onset of flooding is currently being investigated. Bridge 96, the railway bridge upstream of Square Road, is a known constriction to flow and was overtopped by rising river levels. Once on the tracks the water flowed down the line through Winterbutlee Tunnel towards Walsden station. Train services were suspended and Rochdale Road closed from Walsden train station to the bottom of Hollins Road.

Flooded train tracks at Walsden

Further reports of basements flooding were received; data is being collated to investigate these. Henshaw Road was impacted by overland runoff resulting in large volumes of debris landing on the road.

Impact at Henshaw Road
3.1.2 Todmorden

As a result of the prolonged rainfall, flooding has been reported at a number of sites in Todmorden. At least 20 properties were impacted and flooding observed to approximately 2ft in depth, at this stage reports indicate that most of the impact was confined to basements/cellars. A number of businesses were also impacted. Significant ponding occurred outside the new Lidl Store. The cause and mechanism of this flooding is not confirmed at present and further investigations are ongoing. The A646 was flooded at several locations and closed for a period of time between Mytholmroyd and Todmorden.

Flooding outside new Lidl Todmorden

Flooding at A646 Callis Bridge

Flooded cellar in Todmorden
3.1.3 Hebden Bridge and Mytholmroyd

In Hebden Bridge reports of flooding from overland flows and basement flooding were received. At least 20 properties in Mytholmroyd were reported to have experienced cellar flooding. Flooding of the A646 occurred; at this stage it is assumed this was due to surcharged outfalls. In light of a significant peak in the river level, generally temporary defences at Mytholmroyd FAS worked well although reports of seepage contributing to existing flows on the highway were received. Scaffolding planks of temporary works within the river had become dislodged but were secured by CMBC staff and flood wardens preventing a blockage downstream.

River levels at Mytholmroyd Flood Alleviation Scheme construction site

Flooding on A646 Mytholmroyd

General view of river level
3.1.4 **Sowerby Bridge**

Reports of property flooding were received and are to be investigated further. The main areas impacted were Greenups Mill, commercial premises around Victoria Bridge and business located on A58 between the junctions of Elland Road and Kenworthy Lane. Also, businesses at Mill House Lane.

![Flooding at Greenups Mill (Image: Cllr Adam Wilkinson)](image)

3.1.5 **Elland**

Park Road at Elland was significantly impacted as a result of the River Calder spilling into the Calder and Hebble canal which in turn flowed onto Park Road. Flooding to properties was experienced with pumps operating in most cellars and PLP in place.

![Flooding at Park Road Elland](image)
3.1.6 Brighouse
Reports have been received of flooding from surcharged outfalls in and around Rokt Climbing and River Street. From early investigations carried out Rokt Climbing (Briggate) deployed their own pumps to deal with what they considered to be surcharged sewers and drains although they still suffered some basement flooding. PLP at Rokt prevented flooding from the river. Similarly, John Drury soap manufacturers deployed two pumps to protect the houses at River Street (successfully); one to deal with what appeared to be surcharged sewers/drains, the other to deal with a surcharged watercourse outfall.

Businesses in the area of Clifton Beck reported that the watercourse was very high but didn’t break it banks.

3.1.7 Other issues
Numerous reports have been received of property and highway flooding in Siddal, Bradshaw, Mixenden, Greetland, Ripponden, Midgley, Luddenden and Boulderclough. In many cases action taken by residents prevented greater impact. Further investigations are ongoing and the result of these will be detailed in the Section 19 report. Hebble Brook and Ovenden Brook trash screen are remotely monitored and had to be cleared again in the afternoon of 16th March.

4 Emergency and Operational Response
On receipt of the rainfall warning, prior maintenance work was carried out at known highway and land drainage infrastructure that frequently blocks and results in flooding. The Hebble Brook and Ovenden Brook trash screens were cleared as well as other trash screens both by CMBC and EA. Prior to the event general consensus was that there was considerable uncertainty around exact impacts with varying levels of severity of rainfall forecasts received. From figure 2-1 it can be seen that rain gauges, on the whole, recorded much higher total rainfall in comparison to radar forecasts.

Flood alerts and warnings were issued and flood sirens operated. Technical or power issues were encountered in operating the Walsden and Todmorden flood sirens. Social media was used as key communication tool by all partners informing of flood alerts, warnings, advice on response, flood impact and transport issues. Flood stores were opened and sandbags deployed where possible.

An Area Incident Room was opened by the Environment Agency and an incident room set up by the Council at Battision Road ensuring a partnership multi-agency response. The Council’s emergency response was led by CMBC Emergency Planning with representation from Highways, Flood Risk Management, Fire and Rescue, Police and Community Safety and Resilience. The police did open a separate operations room although maintained representation at Battision Road. All partners in the incident room had operatives on site responding to and managing incidences.

The use and impact of flood wardens proved to be very useful in managing the incident. Use of technology such as CCTV, radio communication and telemetry at key sites helped considerably in managing the event as it unfolded. All operatives on site including flood wardens worked well in managing incidences and ensuring access and egress through the borough.

A debrief of the response has been held and key points identified to investigate further as part of a Section 19 investigation with recommendations on lessons learned.

Recovery works to date include maintenance activities on impacted highway drainage and land drainage infrastructure. Data is being compiled on reported incidences of flooding and teams from both EA and the Council will continue visiting properties to understand the extent and impact of flooding experienced. A comprehensive investigation will be carried out as required by Section 19 of the FWMA as detailed in Section 1.1.

A data collection exercise will be carried out requesting data from the following partners:-

- The Environment Agency,
- CMBC teams,
- Network Rail,
- Canal & River Trust,
- Yorkshire Water Services,
- The Met Office Flood Forecasting Centre
- Meteo Group.
The data to be requested will cover the following areas:

- Flood warning and guidance information,
- Hydrometric data – including rainfall depths, river flows and levels,
- Reports from officers and operatives of what happened during the flood event,
- Reports logged at the customer contact centre,
- Photographs and video footage – including footage from the internet,
- Surveyed flood levels taken from ‘wrack marks’ after the flood event,
- Online news reports,
- Flood extent outlines plotted from surveyed flood levels and local knowledge.