

Flood Investigation Report

Greater Manchester

26 December 2015



Photo courtesy of Rochdale Borough Council of Rochdale town centre on Boxing Day

Published September 2016



MANCHESTER
CITY COUNCIL



*This report is written to comply with Section 19 of the
Flood and Water Management Act, 2010.*

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Glossary and Abbreviations

Annual Probability	Throughout this document, flood events are defined according to their likelihood of occurrence. The term ‘annual probability of flooding’ is sometimes used, meaning the chance of a particular flood occurring in any one year. This can be expressed as a percentage. For example, a flood with an annual probability of 1 in 100 can also be referred to as a flood with a 1% annual probability. This means that every year there is a 1% chance that this magnitude flood could occur.
Catchment	The watershed of a surface water river system
COMAH	Control of Major Accident Hazards (COMAH)
DCLG	Department for Communities and Local Government
Flooding Asset Register	The register is a record of all structures or features designated by the Environment Agency, the Lead Local Flood Authority, or District Council which have an effect on flood risk. More information on Flooding Asset Registers can be found on Council websites and in Schedule 2 of the Flood and Water Management Act (2010).
Flood Risk Management Function	These ‘functions’ are powers or responsibilities listed in the Act (or related Acts) which may be exercised by a risk management authority for a purpose connected with flood risk management.
GMCA	Greater Manchester Combined Authority
Groundwater flooding	Occurs when water levels in the ground rise above the natural surface. Low-lying areas underlain by permeable strata are particularly susceptible.
Internal property flooding	Flooding to ground floors of properties, including attached garages or outbuildings, and basements/cellars only if used as living accommodation.
LLFA	Lead Local Flood Authority
Main river	A watercourse shown as such on the main river map, and for which the Environment Agency and Natural Resources Wales has responsibilities and powers
Ordinary watercourses (OW)	All watercourses that are not designated Main River, and which are the responsibility of Local Authorities or, where they exist, Internal Drainage Boards.
Reservoir	A natural or artificial lake where water is collected and stored until needed. Reservoirs can be used for irrigation, recreation, providing water supply for municipal needs, hydroelectric power or controlling water flow.
Risk management authorities (RMAs)	Organisations that have a key role in flood and coastal erosion risk management as defined by the Act. These are the Environment Agency, Natural Resources Wales, lead local flood authorities, district councils where there is no unitary authority, internal drainage boards, water companies, and highways authorities.
RFCCs	Regional Flood and Coastal Committees
Riparian owner	Owner of land adjoining, above or with a watercourse running through it.
River flooding (Fluvial flooding)	Occurs when water levels in a channel overwhelms the capacity of the channel.
Surface water flooding	Flooding from rainwater (including snow and other precipitation) which has not entered a watercourse, drainage system or public sewer.
uFMfSW	Updated Flood Map for Surface Water

1. Executive Summary

The impacts of Storm Eva on Boxing Day 2015 caused some of the most widespread flooding ever experienced in Greater Manchester. Prolonged, intense rain falling on already saturated catchments led to river levels rising rapidly. Many rivers reached record levels with some recording levels over 1 metre higher than previously recorded.

This caused significant impacts in local communities affecting homes, businesses, local infrastructure and the environment. Over 2,200 properties flooded internally across 65 communities in 8 Local Authority districts. In addition, tens of thousands of properties experienced disruption due to power loss and road closures.

In response to this event, Local Authorities, the Environment Agency and United Utilities as Risk Management Authorities (RMAs) have worked together to support affected communities and understand what happened. RMAs were heavily involved in the response to the incident both during and after the event. Over 2,450 properties were protected by raised flood defences and over 5,700 properties received a direct flood warning from the Environment Agency. Council staff worked with volunteers in many places to provide intensive emergency response to support affected residents and carry out immediate clear up and waste disposal. Rest Centres were set up by several Local Authorities on Boxing Day for the welfare and accommodation of people displaced by flooding. RMAs have engaged and continue to engage with communities affected through drop-in events and meetings.

The flood investigation report has been produced by the affected Greater Manchester Lead Local Flood Authorities (LLFAs), working in partnership with the Environment Agency, the Manchester Ship Canal Company (MSCCo) and United Utilities under the duties as set out in Section 19 of the Flood and Water Management Act 2010. This report is a factual record of the flooding that happened during the Boxing Day event and how the relevant RMAs responded.

Although the purpose of the report is to provide a factual account of the contributing factors, impacts and responses to the flooding, it does also include a number of recommendations on how to manage future flood risk, which will require the involvement of a number of organisations and communities working together in partnership. Many locations require further detailed investigation and engagement with the affected communities to make sure the full range of flood risk management options are considered and explored.

However, this document is an important first step in the process and will be used proactively to support and inform how flood risk is managed, through collaborative working between RMAs, partner organisations and local communities. Government has allocated £22 million for flood defence projects across Greater Manchester over the six years to 2021 to reduce flood risk to over 5,000 properties, and the relevant authorities across Greater Manchester will continue to bid for more funding in order to manage flood risk. Investment is also likely to come from councils, businesses and other professional partners.

In addition to capital works it will be important for authorities and communities to explore local options to improve resilience as the risk of flooding cannot be completely removed, so it is important that the resilience of our towns and cities is also a key part of the overall strategy for managing the impacts of extreme weather.

The front section of the report provides an overview of what happened and what was affected, along with information about how partners currently work together to manage flood risk and how multi-agency recovery work was organised. There is also a summary of main recommendations across all areas and the principal actions for each of the affected LLFAs. The appendices contain a detailed breakdown of impacts and analysis for each of the affected areas, so that readers can navigate through the report and focus on areas of most interest to them.

Greater Manchester Boxing Day Floods

£150k donated
from Forever
Manchester



Disruption
to
metrolink



37 of 44 river
gauges recorded
their highest ever levels



2,250
properties
flooded



£11.5 million in
infrastructure
damage



7 electricity
substations
damaged

500
businesses
flooded



Grade II listed
building
destroyed



31,200
properties left
without power



70-100mm rain fell in **24 hours**



2,019 properties flooded from rivers



211 properties flooded from surface water



25 properties flooded from sewers



2,454 properties were protected by raised flood defences



4,000 structures have been inspected since the flood



£11.4 million has been made available for home flood protection



Capital spend over the last 5 years: Over £23 million of capital funding in Greater Manchester to increase protection to c. 4000 households

Forecast spend over the next 6 years: £22 million of Grant-in-Aid funding to improve protection to c. 6000 households

Figure 1 Impacts of Storm Eva on Boxing Day 2015

2. Purpose of Investigation Report

2.1 Section 19 Investigation requirement

Section 19 - ‘Local authorities: investigations’ of the Flood and Water Management Act, 2010 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.*

The LLFAs within Greater Manchester, working together and with the Greater Manchester Combined Authority (GMCA), decided that a single report would be produced to capture details of investigations into the Boxing Day 2015 flood. The GMCA has worked in partnership with the Environment Agency and partners to produce this report.

In accordance with Section 19(2), all LLFAs which experienced significant flooding will provide access to this published investigation report via links on their websites.

2.2 Purpose

This document has been produced as a factual record of the flooding to meet the requirements of Section 19 of the Flood and Water Management Act, 2010. Flooding on the scale experienced takes time to investigate and between December 2015 and publication of this report the authorities have focused much of their activity on supporting those most affected by the flooding. The report does not include options and actions to reduce flood risk for every location that flooded. However, such work is ongoing and the RMAs involved in this report will continue to work together, engaging with communities to identify all potential options for each location. It’s important that this is done thoroughly to ensure the full range of flood risk management options are explored and the right solutions brought forward.

The report sets out where flooding occurred on the 26 December 2015 and which RMAs had relevant flood risk management functions during the event. The report also considers whether the relevant RMAs have exercised, or propose to exercise, their flood risk management functions.

Information has been collated from the following sources;

- site visits and assessments by RMA staff
- topographic survey of flood levels and extents
- door knocking
- details collected at ‘Community Drop-in’ events and from residents and businesses in the weeks after the flood
- addresses of properties claiming the £500 Community Recovery payment
- records of properties flooded
- use of photos, from various sources, taken during or after the flood

- viewing some online or other video footage
- information provided by Fire and Rescue Service, such as call-out logs
- information from some utility companies
- road closure information.
- personal observations from initial responders and Council/utility staff

Whilst every effort has been made to verify flooding at the locations identified, the nature of the data and the methods used to collate this information means that it does not include every occurrence of flooding. This data only identifies where flooding has been reported and is indicative only.

2.3 Scope

This report covers the flooding that occurred on Boxing Day 26 December 2015 and describes what happened and which organisation(s) is investigating for each location where 'significant' flooding occurred. The definition of 'significant' is provided within a policy adopted by GMCA on behalf of all 10 Greater Manchester Lead Local Flood Authorities (LLFAs). This policy provides the following thresholds:

- **five or more residential properties flooded internally**, and/or;
- **economic disruption from commercial property flooding** – could be just one property if sizeable enough and/or;
- **flooding to critical services** such as hospitals, care homes, schools and emergency services.

The occurrence of 'significant flooding' as defined above triggers the production of an Investigation Report under section 19 of the Flood and Water Management Act.

3. Roles and responsibilities

The Flood and Water Management Act (2010) defines flooding as any case where land not normally covered by water becomes covered by water. Flood risk is a combination of two components: the chance (or probability/ likelihood) that a location will flood from any source or type of flooding, and the impact (or consequence) that the flooding would cause if it occurred. The table below describes different sources of flood risk.

Table 1 Source and description of food risk

Source	Description
Fluvial flooding	Fluvial flooding (from either a main river or an ordinary watercourse) occurs when the flow capacity of a watercourse is exceeded, causing water to spill out of the channel into nearby areas of floodplain. These may or may not have been developed or have flood compatible uses. Culverts and narrow channels in built-up areas can make flooding more likely.
Surface water flooding	Surface water flooding is caused by overland flow during periods of sustained or heavy rainfall, causing ponding of water where it becomes obstructed or collects in low lying areas. Local drains and infiltration into the ground are unable to cope with the volume of water present. More impermeable areas can increase the risk of surface water flooding occurring, which is mitigated by drainage systems, but these have a design capacity which may be overwhelmed in times of heavy rainfall.
Groundwater flooding	Groundwater flooding occurs when the water held underground rises to a level where it breaks the surface in areas away from watercourses and drainage pathways. It is generally a result of extended periods of very heavy rain, but can also result from reduced abstraction, underground leaks or the displacement of underground flows.
Highway flooding	Highway flooding occurs when the highway drainage system or the sewers they discharge into cannot cope with the amount of rainfall entering the system. This can be due to the size of the pipes or a blockage in the system.
Sewer flooding	Flooding from a public or transferred sewer (including former section 24 sewers) which enters a building or passes below a suspended floor'. A sewer is classed as overloaded (hydraulic flooding) when the flow from a storm is unable to pass through it due to a permanent problem (e.g. flat gradient, small diameter). Temporary problems such as blockages, siltation, collapses and equipment or operational failures are classed as "flooding other causes" (FOC).
Other sources of flood risk	Canals can flood by overtopping or from a breach of a structure, or collapse of a culvert beneath a canal. Risk of flooding from a canal is managed by the responsible organisation. Reservoir flooding is very rare but occurs when a dam is breached. The owners of reservoirs with an above ground capacity of 25,000 cubic metres or more have a legal duty to have their reservoirs supervised and inspected regularly by experts.

3.1 Relevant Risk Management Authorities

The responsibilities for managing flooding in the UK is divided between different RMAs as defined in the Flood and Water Management Act, 2010. RMAs have powers and duties to manage the different forms for flooding that can occur. The Environment Agency is responsible for taking a strategic overview of the management of all sources of flooding and coastal erosion.

Managing flood risks and flooding requires RMAs to work together. The table below sets out responsibilities (relevant to Greater Manchester).

Table 2 Greater Manchester RMAs responsibilities

Risk from:	Environment Agency	Lead Local Flood Authority	Water company	Highway authority
Main river	✓			
Surface water		✓		
Surface water (from highway)				✓
Sewer flooding			✓	
Ordinary watercourse		✓		
Groundwater		✓		
Reservoirs	✓*	✓*	✓*	✓*
Strategic overview of all sources of flood risk (and the coast)	✓			

*Please note RMAs have different responsibilities for reservoirs such as regulation, asset management and flood incident response

Relevant Risk Management Authorities contributing to this report are:

- Environment Agency
- United Utilities
- 8 of the 10 Greater Manchester Authorities (excludes Stockport and Trafford), namely:
 - Bolton
 - Bury
 - Manchester
 - Oldham
 - Rochdale
 - Salford
 - Wigan
 - Tameside

The Manchester Ship Canal Company (MSCCo) is not an RMA, but has contributed to this report. All Greater Manchester Local Authorities are unitary (single tier) authorities which are both Lead Local Flood Authorities and Highways Authorities. For simplicity they will generally be referred to within this report as Lead Local Flood Authorities (LLFAs).

The diagram below shows the governance and collaborative working structure for the organisations in Greater Manchester that play a role in managing flood risk.

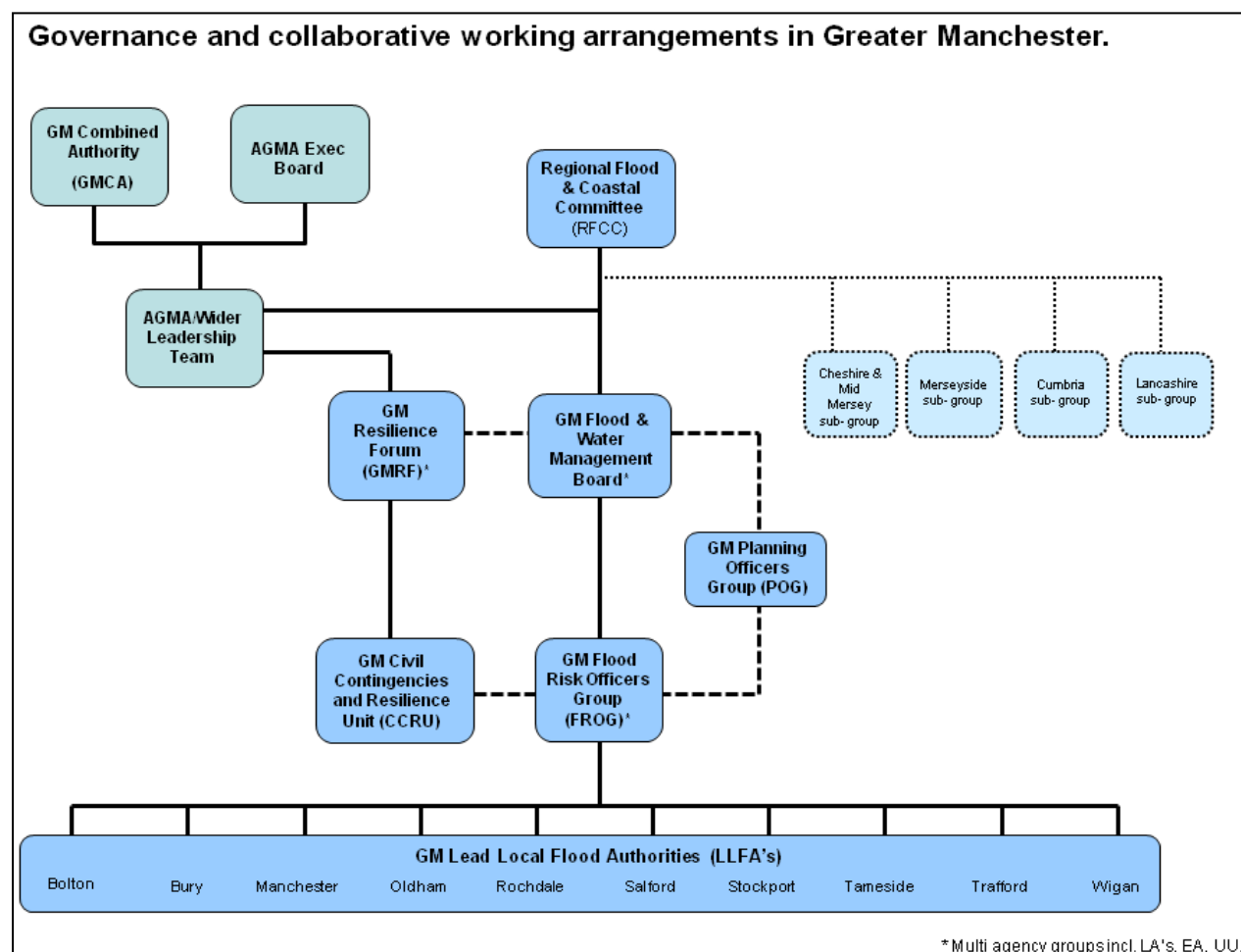


Figure 2 Flood risk governance structures in Greater Manchester

3.2 Manchester Ship Canal Company

The Manchester Ship Canal (MSC) is operated by the Manchester Ship Canal Company, a wholly owned subsidiary of Peel Holdings and part of the Peel Ports Group. The MSC is an important watercourse in Greater Manchester, Merseyside and Cheshire. It passes through seven Lead Local Flood Authority areas, Salford, Manchester City, Trafford, Warrington, Halton, Cheshire West and Chester and Wirral. Opened in 1894, the MSC is a 36 mile (58 km) long canalised river, flowing from Manchester City Centre to the Mersey Estuary. Approximately 65% of fluvial flows entering the Mersey Estuary pass along through the Canal. During times of high flows, it takes all upstream river flows at Salford and approximately 70% of all upstream river flows at Warrington. Five sets of lock gates along the length of the canal operate automatically to maintain a safe navigation along the length of the canal, as set out in the MSCCo's water level control - operational protocol. Safe navigation is limited by a minimum depth of water in the canal or a minimum clearance below bridge crossing to permit safe ship passage. The canal is managed in a way that minimises the risk of flooding.

To enable effective strategic management of flood risk associated with the MSC, a specific Flood Risk Partnership Group has been formed with representatives from all seven LLFA's, the MSCCo and the EA. This group first met in November 2015, meets routinely every 6 months and is supported by sub-groups that address specific issues / concerns. This group should enable a better understanding of flood risk issues and improved collaboration to develop between partner organisations.

4. Flood Impacts

4.1 Before and during the flood

2015 was the sixth wettest year on record. December's weather was substantially warmer than normal and this warmer air carried more moisture resulting in twice the long-term average December rainfall total, creating saturated catchment conditions over large parts of the Irwell catchment. The heaviest rain from Storm Eva on Christmas Day and Boxing Day was experienced over Pennine areas, mostly North of Manchester. In the preceding days, soils in these areas had become saturated and close to capacity.

The nature of the catchment response was exacerbated by the volatility of the weather patterns, which did not track as forecasted. Some parts of Greater Manchester's catchment, like the upper Irwell, respond rapidly to rainfall even under normal conditions. The combination of prolonged average rainfall, saturated catchments, rapidly responding rivers and heavy showers on and around the 26th resulted in an extremely rapid onset of flooding. The sheer speed of response made the flooding very difficult to predict, and placed a huge strain on the relevant authorities and responders and their ability to co-ordinate pre-emptive activities. Water levels rose rapidly in the Rivers Irwell, Roch and Glaze.

The sudden onset, extent and depth of the flooding was unprecedented and meant that its impacts across Greater Manchester were devastating. Depths were so great in parts of Bolton, Bury, Salford and Rochdale that some residents were evacuated by boat, tractor and wheelie bin. For some areas this was the worst flooding for a generation.

4.2 Rainfall

Figure 3 below shows a snapshot of rainfall intensity across Greater Manchester at 8am on Boxing Day. Rainfall from Christmas Day to Boxing Day was heaviest in the upper parts of the River Irwell catchment to the North of Manchester - up to 128mm fell in a 36 hour period. This contrasted with 57mm over the upper Tame, but much less in other parts of the Mersey catchment where 25mm was typically recorded and impacts were minimal.

Analysis has shown that 6 hour rainfall totals were unusual but not extreme, whereas some 24 and 36 hour totals in the upper Irwell catchment have been assessed as having a likelihood of occurring only once in 50 to 100 years. Catchment responses were more extreme because rain was falling on completely saturated ground after many weeks of higher than average rainfall – 2015 was the sixth wettest year on record and December rainfall was twice the long term average.

Further detail can be found in Appendix 3 which includes a tables showing the heaviest rainfall in the River Irwell catchment North of Manchester with totals of up to 51mm, 109mm and 128mm falling in periods of 6, 12, 24 and 36 hours respectively.

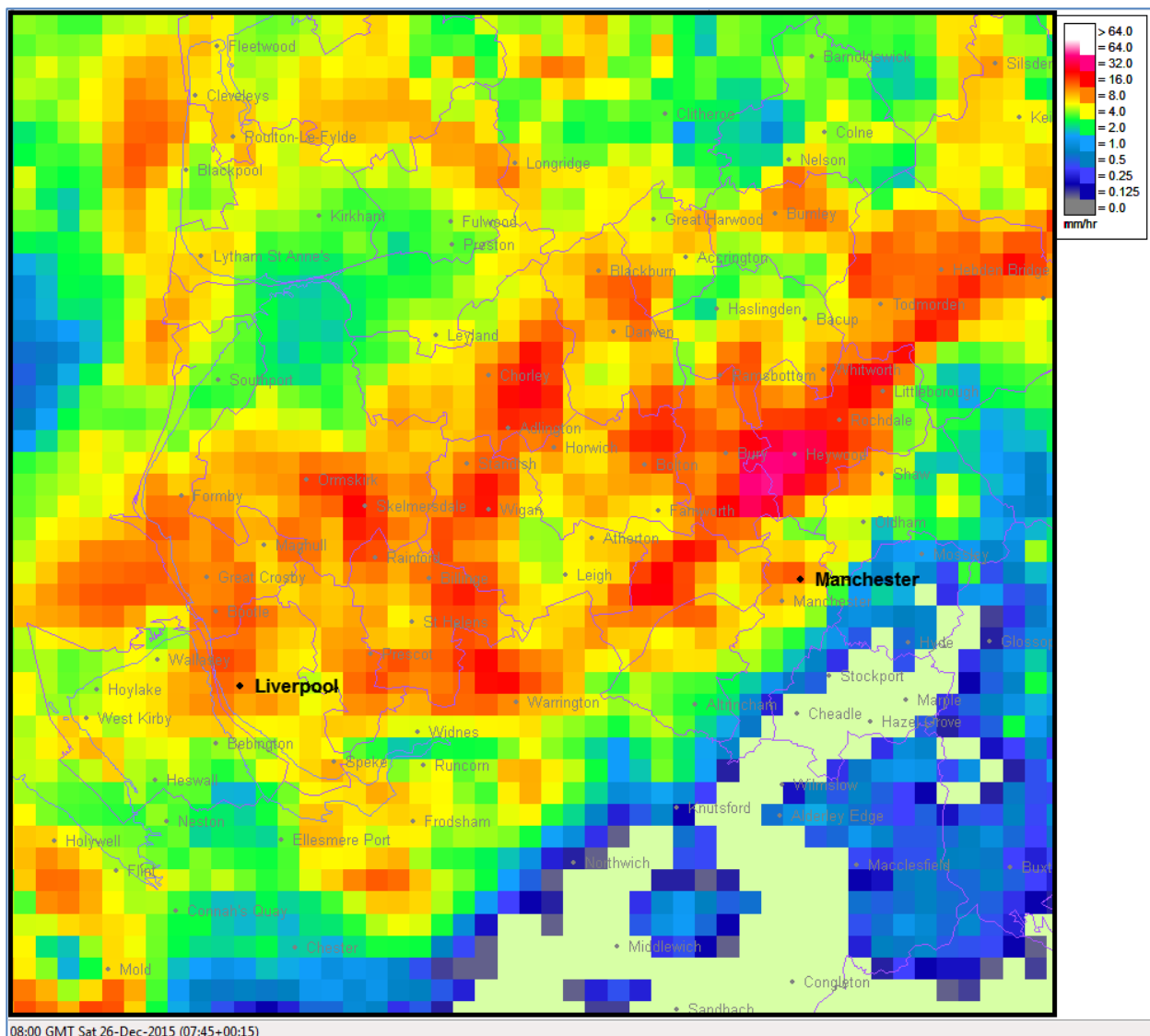


Figure 3 Rainfall intensity across Greater Manchester at 8am on Boxing Day

4.3 River levels

As a result of the heavy rainfall over Christmas Day and Boxing Day rivers across Greater Manchester responded rapidly. 37 of 44 gauges in the River Irwell, Roch and Croal catchments recorded their highest ever levels. The river level for the River Roch on Boxing Day, at its downstream confluence with the Irwell, was 1.1m higher than anything recorded in its 64 year history.

Further information can be found in Appendix 3 which includes a table of river levels across Greater Manchester where flooding was experienced. It provides comparisons with previous high flows/floods. In most cases the Boxing Day river level was the highest ever recorded (Rank = 1).

Figure 4 and Figure 5 below show river levels in the Irwell and Roch over the course of Boxing Day. These figures demonstrate just how quickly river levels were rising in response to the rainfall, due largely to the already saturated nature of the catchment from a month of double the average amount of rain.

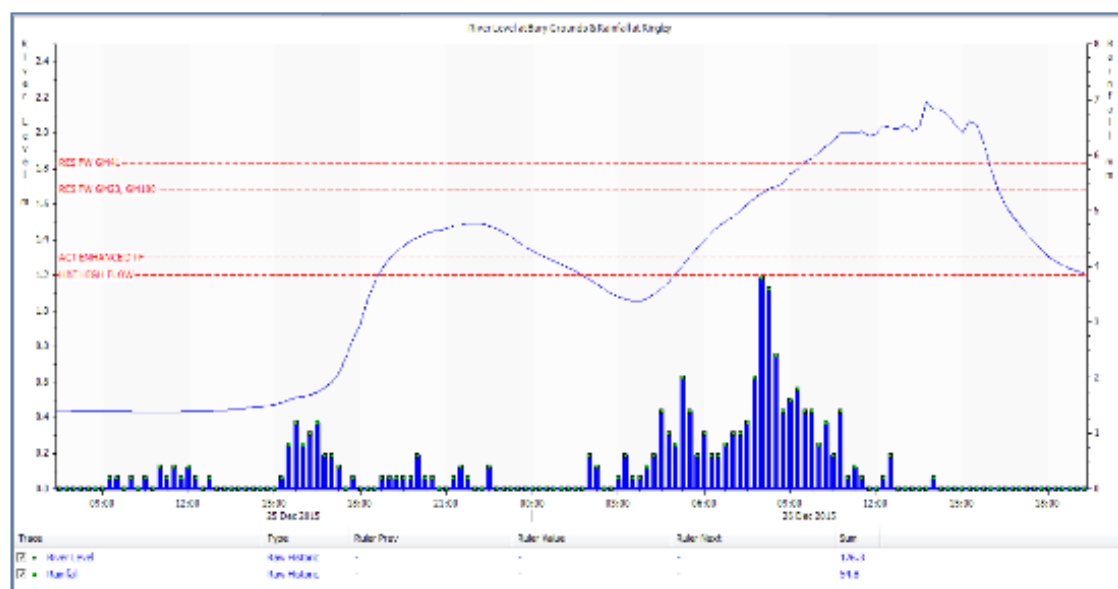


Figure 4 River levels on the River Irwell level at Bury and the corresponding rainfall at the nearest rain gauge

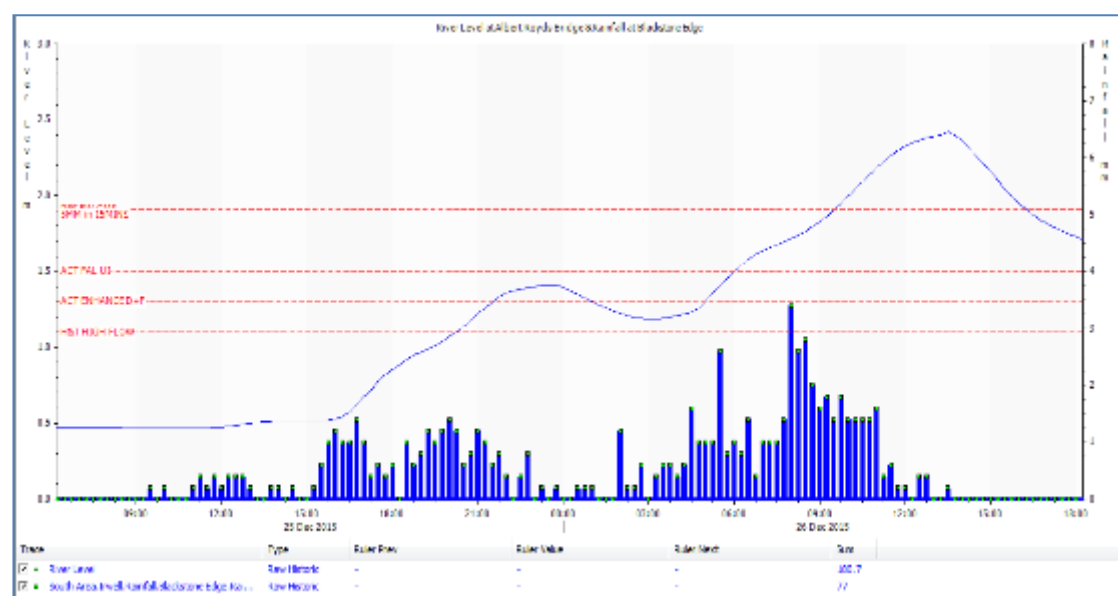


Figure 5 River levels on the River Roch upstream of Wardleworth and corresponding rainfall

4.4 Locations Affected

The map below shows the geographical scale and extent of flooding impacts across Greater Manchester. Over 2,200 properties were affected, as well as businesses, road and transport links, utilities and other local infrastructure assets.

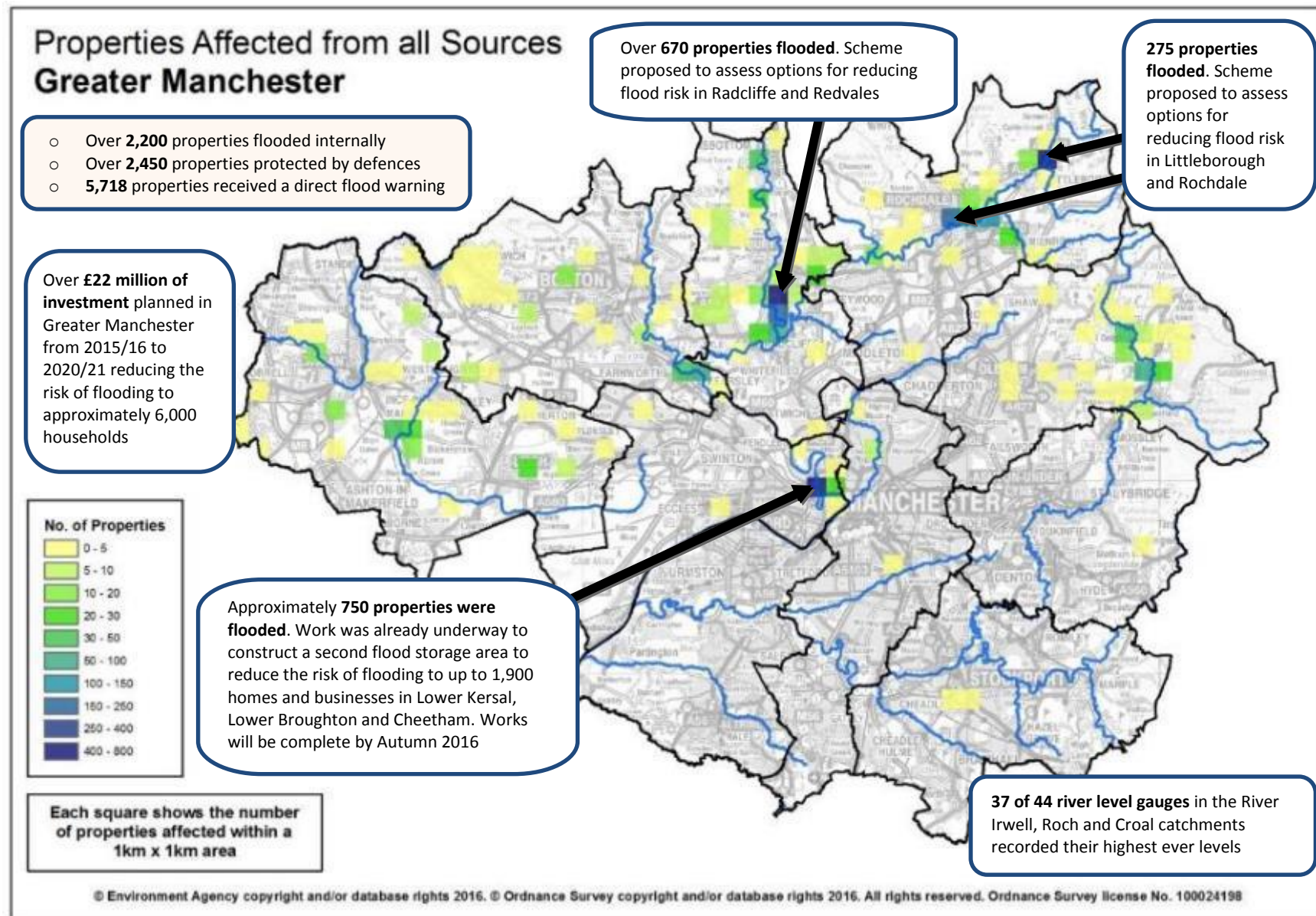


Table 3 provides a breakdown of all the specific locations affected and shows that over 80% of the flooding was caused by main rivers. It also shows that 1, 649 properties were flooded in 3 principal locations; Salford (750), Radcliffe/Redvales (670), and Littleborough/Rochdale (229). An EA-led scheme is already underway to construct a second flood storage basin to reduce flood risk in Salford. The scheme is worth approximately £10 million, and is a partnership between EA, Salford City Council, and Salford University and will reduce the risk of flooding to 1,900 properties in Lower Broughton.

The table below shows all the locations with internal flooding to properties from any source (internal flooding is defined as flooding to ground floors of properties, including attached garages or outbuildings, and basements or cellars if used as living accommodation), including 30 places with 5 or more properties affected. Cellars are often either unused, or used just for storage or white goods. Flooding of cellars has not been included within statistics for 'internal property flooding' unless they are habitable accommodation.

Flood defence scheme proposals are being investigated for Radcliffe/Redvales and Rochdale/Littleborough, with the Environment Agency working in partnership with the respective LLFAs to work up flood risk management options for these areas.

Many locations suffered severe impacts such as Prestolee/Stoneclough and the Radcliffe Riverside estate, Bury, where flooding inside homes was up to head height. Also, Many Local Authorities had to respond to flooding at multiple locations from multiple sources, such as across the boroughs of Wigan, Bolton and Rochdale and Bury.

In total 65 communities across 8 LA districts (not including Stockport, as impacts were less than the definition threshold for significant flooding) were impacted, making this the single largest flooding incident to affect Greater Manchester for over a generation.

Table 3 Locations affected by internal flooding

Location	Main River	Ordinary Watercourse	Sewer	Surface Water	Grand Total
Bolton	87	4	6	19	116
Blackrod	0	0	0	2	2
Bolton	1	0	0	1	2
Brightmet	0	0	0	3	3
Darcy Lever	8	0	0	0	8
Great Lever	0	0	0	3	3
Horwich	12	2	6	0	20
Lostock	7	0	0	0	7
Prestolee and Stoneclough	57	0	0	0	57
Smithills	2	6	0	0	8
Tonge Moor	0	0	0	1	1
Westhoughton	0	2	0	3	5
Bury	734	15	0	59	808
Bradley Fold	0	0	0	2	2
Brightmet	0	0	0	4	4
Bury	0	0	0	15	15

Location	Main River	Ordinary Watercourse	Sewer	Surface Water	Grand Total
Bury Centre	6	0	0	1	7
Pioneer Mill	19	0	0	0	19
Prestwich	0	0	0	2	2
Radcliffe and Redvales	644	7	1	19	671
Ramsbottom	43	0	0	11	54
Summerseat	11	0	0	2	13
Tottington	0	8	0	1	9
Unsworth	0	0	0	2	2
J2 Business Park, Bury	10	0	0	0	10
Manchester	37	0	0	0	37
Cheetham	27	0	0	0	27
Hendham Vale	10	0	0	0	10
Oldham	29	18	0	75	122
Austerlands	0	0	0	1	1
Castleshaw	0	2	0	0	2
Delph	16	9	0	17	42
Diggle	0	1	0	3	4
Dobcross	1	0	0	0	1
Grasscroft	0	2	0	7	9
Greenfield	0	0	0	3	3
Lees	0	0	0	3	3
Oldham	0	0	0	8	8
Roebuck Low	0	0	0	1	1
Royton	0	2	0	0	2
Shaw	0	0	0	11	11
Uppermill	12	2	0	21	35
Rochdale	288	1	0	34	324
Belfield	10	0	0	0	10
Heap Bridge, Heywood	10	0	0	0	10
Hooley Bridge, Heywood	20	0	0	0	20
Littleborough	158	0	0	17	175
Milnrow	1	0	1	9	11
Rochdale (disperse properties)	0	0	0	8	8
Rochdale Town Centre, including Mitchell Hey and Sparth Bottoms	54	0	0	0	54
Wardleworth and Hey Brook	35	1	0	0	36
Salford	750	0	0	0	750
Lower Broughton	750	0	0	0	750
Wigan	48	8	15	23	93
Abram	11	4	0	0	15

Location	Main River	Ordinary Watercourse	Sewer	Surface Water	Grand Total
Ashton	0	0	2	0	2
Aspull	0	0	0	4	4
Atherton	0	0	1	0	1
Beech Hill	0	0	1	1	2
Billinge	0	0	0	4	4
Haigh	0	0	0	4	4
Hindley	5	0	3	0	5
Lilford	14	0	0	0	14
Orrell	0	0	1	1	2
Platt Bridge	18	0	0	0	18
Scholes	0	0	1	0	1
Standish Lower Ground	2	2	2	0	6
Tyldesley	2	0	2	0	4
Whelley	0	2	0	0	2
Worsley Mesnes	0	0	1	8	9
Stockport	0	0	4	0	4
Borough wide	0	0	4	0	4
Tameside	0	0	0	1	1
Mossley	0	0	0	1	1
Grand Total	1,973	46	25	211	2,255

For more information refer to the sections under the respective Local Authority area in Appendix 1. Within the Appendices there are maps for whole Local Authority areas and street level maps for each place with significant flooding (> 5 properties).

4.5 Infrastructure Impacts

Flooding in December 2015 exceeded the defence levels required by guidance for infrastructure resilience. Work is now underway to review appropriate defence levels and any necessary investment plans arising from higher flood levels and increased probability of flooding.

Electricity Supply

Over 31,200 properties across Greater Manchester were without power as a result of the Boxing Day floods (Table 4). 143 Properties were off supply for two days due to access issues following the flooding, 1 property was off supply for three days due to access issues following the flooding, 3 properties were off supply for more than four days due to no access at the properties. Seven sub-stations were damaged by floodwater, in Rochdale (2), Littleborough (1), Radcliffe (3) and near Horwich (1). Some sub-stations which flooded provide supply to properties via secondary sub-stations. 30 mobile generators were mobilised by Electricity North West to provide a temporary power supply, mostly to properties not directly affected by flooding.

A control room at a Rochdale sub-station flooded to a depth of 1.5m causing extensive equipment damage. It is estimated to cost approximately £7m to repair this damage.

Table 4 Locations affected by power loss

Location	Number of properties
Rochdale	18,550
Wigan	4,250
Radcliffe, Tottington and Ramsbottom	3,200
Bolton	1,000
Littleborough	1,000
Delph	950
Salford	250
Total	31,200

A hydroelectric plant adjacent to Rochdale bus station was damaged and will cost about £80,000 to fix. There was significant damage to the foundations of a high voltage electricity pylon at Warth, Bury.

Bridges

Several small bridges were damaged or displaced by the flood. Some bridges over rivers were closed pending structural inspection after river levels receded. Extensive permanent repairs at multiple locations are complete, ongoing, or planned.

- Two bridges carrying cables at Milltown Street and Lomax Street, Bury were destroyed. This damage has been temporarily overcome using a new overhead line and re-routing an existing supply.
- The Waterside Restaurant in Summerseat, collapsed into the River Irwell. This also caused the partial collapse and subsequent closure of the associated masonry arch bridge. No-one was in this building at the time, however the event made national TV coverage. The bridge remains closed to traffic.



Picture 1 Waterside Restaurant at Kay Street Bridge, Summerseat

Transport

Public transport on Boxing Day operates on a reduced service so disruption was not as extensive as on a normal working day. However, there was significant disruption to transport services across Greater Manchester, including:

- **Trams** - Metrolink tram infrastructure more generally proved to be fairly resilient as platforms are higher than other tram networks, so cabinets and wiring are protected to a certain extent. Costs were incurred by TfGM for replacement buses, inspections, clean-up and revenue loss. Transport for Greater Manchester (TfGM) reported that some tram services and infrastructure was disrupted:
 - Tram services between Shaw/Crompton to Rochdale town centre and between Whitefield and Bury were stopped during the flood.
 - The transport interchange (tram and bus terminus) in Rochdale town centre was closed on Boxing Day due to flooding, flood damage and loss of power supply but was operating again the next day.

- **Railways** - There was extensive damage to railway assets in the region. There were no rail services on Boxing Day so the main disruption was on the 27 December when most of the first services of the day ran on 'route proving' to check routes were passable. Disruptions included :
 - The Rochdale to Hebden Bridge service was unable to run until 28 December, to allow time for floodwaters to recede and for repairs.
 - A landslide at Corley disrupted the Bolton to Preston service.
- **Roads** - Road closures and diversions were put in place in the worst affected areas due to impassable/closed roads and damaged bridges. Bus services were curtailed or diverted as a result.
 - The M66 near Bury and M62 near to Prestwich/Whitefield junction 17 both had standing water on them which closed lane 1 and the hard shoulder for a short period. Highways England's maintenance crews cleared gullies. No road closures were necessary.
 - Many traffic lights around Rochdale were not working due to power loss. A small number were affected up to 30th December.

Gas Supply

A footbridge carrying a sewer and gas main collapsed and was washed downstream at Radcliffe. This ruptured the gas main causing a fire and explosion, but the situation was quickly under control by the emergency services and Gas Services Company. 900 domestic properties were affected by low pressure but did not experience a loss of supply. 2 non domestic supplies had to be isolated.

Environment Agency Assets

There are numerous reports of damage to assets and sections of watercourses where there are masonry linings, boundary walls and erosion protection measures such as gabion baskets.

- Environment Agency river flow/level gauging stations were damaged including the complete destruction of the gauging station at Prestolee near Bolton and at Pioneer Mills, Radcliffe, both on the River Irwell. There was severe electrical damage to the station at Lower Broughton, Salford. These stations provide information to trigger flood warnings for properties nearby.
- The Environment Agency's Bedford Pumping Station, near Leigh and its associated flood storage basin at Lilford Park protected around 800 properties from flooding on Boxing Day; 14 homes were however flooded, believed to be due to debris build up affecting the operation of the sluice gates. The debris has been cleared and the gate mechanism settings have been altered in response. For further resilience, extra temporary pumps were put in place for an interim period. In addition, a new procedure has been tested and adopted which involves placing temporary barriers to re-route floodwater back into the watercourse and the Council intend to undertake some drainage work and ground level alterations.

Wastewater Treatment

- Bury wastewater treatment works was flooded and a number of the treatment processes were affected. A recovery plan was agreed with the Environment Agency to bring the works back to normal operation as soon as possible. Rochdale and Urmston WWTW suffered flooding but damage was minimal. Pumping stations at Prestolee were also affected.
- United Utilities laid 800 m of temporary pipeline after the collapse of a pipe bridge at Kearsley pumping station.
- United Utilities laid a 750m temporary pipeline diversion and associated pumps after the collapse of the Lomax Street footbridge in Radcliffe.

Water Supply

Parts of Rochdale lost water supply or experience reduced pressure on the 27th December because telemetry to a service reservoir was damaged. Flood water in Rochdale caused power failure to multiple Water Treatment Works (WTW) on the 26 December 2016. United Utilities supplied

generators to key WTW, however it was unsafe to connect them until the 27 December. Customers continued to experience issues with pressure and supply until power was restored on the 29th December.

Manchester Ship Canal

Through the MSC Flood Risk Partnership Group, MSCCo/Peel Ports agreed to provide a statement that describes the flood event from their perspective. Their statement is reproduced in Appendix 2.

During the flooding there was erosion of the canal bank adjacent to a Control of Major Accident Hazards (COMAH) facility immediately downstream of Mode Wheel locks. Precautionary measures were taken by the site operator to empty the oil tanks closest to the canal to mitigate against a potential environmental incident if the tanks had been undermined.

Hydraulic modelling of the flood event conditions indicate that the water levels upstream of the canal, at locations where flooding was experienced, were independent of water levels on the canal. How the canal was operated therefore did not affect those communities that flooded upstream. At Broughton, the location to flood from the River Irwell closest to the canal, the water levels were dictated by the size of the flow and the obstruction to this flow caused by Hough Lane Footbridge that was increased during the event by debris being trapped against it.

4.6 Other impacts

Environmental Impacts

The impacts of the floods upon the environment are varied and the longer term impacts from the Boxing Day event will become clearer as ecological monitoring takes place over the coming months. Potential impacts in Greater Manchester include:

- **Water Quality** is likely to have been affected through a combination of combined sewer overflow (CSO) discharges, inundation of waste water treatment works and waste materials and fine sediments and other contaminants being washed into watercourses. Bury wastewater treatment works was flooded and a number of the treatment processes were affected. A recovery plan was agreed with the Environment Agency to bring the works back to normal operation as soon as possible. Although treatment was reduced it is worth noting that the discharge was more dilute than usual due to the high volume of storm water in the system.
- **Habitats.** The recent flood and associated CSO discharges and deposition of debris are expected to have caused short-term detriment to habitats and biodiversity. The flood waters have potentially spread an invasive species, such as Himalayan Balsam, Giant Hogweed and Japanese Knotweed into new areas in the catchment.
- **Fish.** No reports of direct impacts to wild fish were received after the flood, though some will have been stranded or displaced and spawning gravels covered or scoured.
- **Gravel management.** Large quantities of material were mobilised and transported down rivers catchments during the flood. Sediment transport and deposition is a natural process which can provide excellent habitat for fish and invertebrates and create or alter natural meanders. In some cases, gravel and masonry rubble were deposited in areas where it might increase the risk of flooding or bank erosion. The Environment Agency is assessing these risks and will seek removal of gravel, often by the riparian landowner, but otherwise by its own workforce, where there is a clear link between gravel accumulation and flood risk.
- **Waterlogged ground** resulted in some slope failures (landslides) adjacent to watercourses. These can result in increased flood risk and erosion of the opposite bank, especially if the landslide results in trees falling into the watercourse.

Public Health Impacts

Following the flooding water quality was monitored closely due to the damage to Bury wastewater treatment works, specific advice was given to those intending to use the affected watercourses for recreation and no ill effects were reported. Flood basins and flooded public spaces were managed in

accordance with relevant guidance and sampled were necessary to ensure they were suitable for the public to use again.

Flooding is known to have longer term effects on mental health, mainly due to the damage and protracted disruption caused to homes and livelihoods. The psychological impacts of the 26th December 2015 flooding are not yet fully known however the stress caused to those affected has been clear.

Many people affected by flooding were highly vulnerable due to health, age, income as well as other factors.

5. Response and Recovery

5.1 Multi-Agency Response

The Greater Manchester Strategic Coordination Group (SCG), a multi-agency group which sets the strategic direction for an incident, was established at 13:00 hours on Boxing Day. Shortly afterwards, the SCG declared a major incident. SCG tele-conferences then took place at two hourly intervals until 23:00 hours. The final SCG was held at 09:00 hours on 27 December, as the incident progressed into recovery and a Recovery Coordinating Group (RCG) was formed.

Teams from the Local Authorities, Environment Agency, United Utilities, Greater Manchester Fire and Rescue Service, Greater Manchester Police and the North West Ambulance service were on the ground in flood locations on Boxing Day, acting to minimise flooding and to support and assist those affected. Other utility companies, Highways England and Transport for Greater Manchester were also in operation.

Local Authorities were heavily involved in response to the incident both during and after the event. Council staff worked with volunteers in many places to provide intensive emergency response to support affected residents and carry out immediate clear up and waste disposal. Rest Centres were set up by several Local Authorities on Boxing Day for the welfare and accommodation of people displaced by flooding, either through property damage, access difficulties or loss of power supply. Local responses often involved the input of social and health care providers, local food banks and charities, working both at rest centres and within affected communities. Some locations are listed with local flood information in the appendices.

Councils have also undertaken an assessment of the damage caused, and have carried out surveys and structural reports of bridges, culverts and other structures to inform priorities for repair work. Significant repairs to infrastructure across Greater Manchester were required, including repairs to highways, cycle paths, footpaths, river channels, retaining walls and drainage systems. An extensive cleanup operation followed the event, both collecting and disposing of waste and debris from the event.

Flooding of Rochdale Council's town centre office affected computer servers, which made communications and co-ordination of flood recovery more difficult. A functional operations base was quickly established at Rochdale Town Hall.

Greater Manchester's SCG established a multi-agency Recovery Coordinating Group (RCG) to set the strategic direction of the recovery. The initial RCG teleconference was held at 18:00 on 27 December 2015. RCG meetings continued until March.

In response to weather warnings, Electricity North West used network interconnection to transfer several thousand customers onto sub-stations outside of the affected areas. This provided limited capacity, so supplies were still lost despite this precaution when sub-stations were inundated and defences overtopped. When flood levels had fallen, Electricity North West deployed its field teams and those from other Distribution Network Operators to carry out emergency repairs to restore supplies to customers.

United Utilities experienced an elevated number of calls and enquiries from the public between 25th and 31st December. Wastewater incidents recorded following calls from customers were 144% higher than usual and United Utilities staff attended over 344 sites.

United Utilities received reports of internal sewer flooding from 6 properties, a further 45 reports were received from properties flooded externally from sewers. United Utilities staff carried investigations at all affected properties and a range of other works including - CCTV surveys, jetting of sewers, post event clean up, pumping of water and root cutting etc. In addition Local Authorities have also reported a further 18 properties flooded internally from sewers.

Details of Incident Management have been reviewed by the Greater Manchester Resilience Forum as part of a Multi-Agency Debrief. The debrief will ensure that the experience and lessons learnt from the Boxing Day flooding are used to inform future incident response and recovery procedures.

The MSC Flood Risk Partnership Group, formed in November 2015, have discussed what could be learnt from this flood event and what improvements could be made to prepare for and respond to a similar future incident. The actions agreed by the group are presented here in Table 5.

2,450 properties benefited from protection, such as raised defences and from operational activities, such as debris screen clearance at culverts and operation of pumping stations.

5.2 Flood Warnings

The Environment Agency issues flood warnings throughout England and Wales. Flood warnings aim to give time for communities to prepare for flooding from main rivers. It is currently not possible to provide flood warnings for other sources of flooding. The Environment Agency's power to provide and issue flood warnings is permissive and not a statutory duty; it aims to give flood alerts, flood warnings and severe flood warnings with as much advance notice as possible, however, this may not always be feasible.

Weather patterns are always inherently unpredictable, and so weather forecasting is never certain. Parts of the catchment area affected by Storm Eva are known to have rapid response times, which results in river levels in these areas rising rapidly. The rapid pace of the event undoubtedly contributed to the impacts, leaving emergency responders little time to co-ordinate pre-emptive activities and communications.

The rapid onset of the Boxing Day event put the Flood Warning Service under tremendous pressure to provide warnings as the observed weather began to deviate from its forecasted track and rainfall totals increased by double. Over 5,700 properties were issued a direct flood warning in the space of 8 hours on Boxing Day, however, given the extreme nature of the incident, changes to forecast and rapid onset of flooding meant some warnings were not issued.

The Environment Agency is already in the process of making improvements to key areas and considering increases to warning coverage. Warning thresholds (based on river levels at gauges) are being reviewed, where verified data is available, and amended if appropriate. Assessments will be done to see if any areas which flooded from 'main rivers' should be offered a direct Flood Warning service in future, if this is not currently available. Local communities are involved in this process and are consulted on opportunities to improve or extend the Flood Warning service.

 FLOOD ALERT Flooding is possible Be prepared	 FLOOD WARNING Flooding is expected Immediate action required	 SEVERE FLOOD WARNING Severe flooding Danger to life
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floodline 0345 988 1188 / 0845 988 1188 (24 hours)

5.3 Communications and community engagement

Within three days of the flood, 36 of the 65 communities affected by flooding were visited by Local Authority and Environment Agency staff, and many more in the weeks following. They provided support and assistance with drop ins, gathering information and offering welfare support.

To date the RMAs have engaged with communities affected through drop-in events and meetings: two in Bolton, two in Bury, one in Oldham, two in Rochdale, three in Salford and one in Wigan. The events were attended by respective Local Authorities, the Environment Agency and United Utilities.

The various RMAs continue to support communities in setting up Flood Action Groups, and in developing

community as well as individual resilience through flood plans, of which the Flood Warning Service is a part. Community flood action groups were involved in the immediate response and continue to work with RMAs as part of ongoing recovery.

Six media interviews were undertaken in January focusing on the Boxing Day floods in Greater Manchester, with the aim of increasing public awareness of the incident and ensuring public safety while recovery and repair works were undertaken.

To date, the Environment Agency has engaged with over 30 MPs whose Constituencies were affected by flooding in order to provide them with the facts and information they need to support their constituents and provide local points of contact within LLFAs and the Environment Agency.



Picture 2 Hole appeared due to Pickhill Brook culvert collapse below

5.4 Asset inspection and Future Maintenance

The Environment Agency is responsible for carrying out inspections of assets on main river e.g. walls, embankments, culverts and river banks (natural or manmade). Local Authorities do similar for other watercourses and drainage networks and United Utilities look after the sewer network. Following the flooding that took place on Boxing Day visual inspections were undertaken by RMAs across all affected areas where significant flooding was reported and where it has formal flood defence assets such as walls and embankments. Nearly 4,000 assets were inspected in the first 6 weeks of 2016, and £2 million of asset repair work is scheduled to be complete by autumn 2016.

Visual inspections are primarily to record the condition of flood risk assets. Checks are also carried out on structures which influence flood risk, such as screens (grilles upstream of culverts) and flood gates. Conditions of assets are recorded in an asset register. All Environment Agency assets were inspected by the second week of January 2016. 24 formal flood defence assets are recorded as having some damage following the floods and one wall completely failed at a residential Care Home next to the River Roch at Littleborough.

The gap in the flood wall was sandbagged immediately after the flood as a short term contingency measure; with the wall rebuilding works was included in an emergency repair programme. Minor repairs on other walls/ embankments on the River Roch at Rochdale and Littleborough are also programmed. Several debris screens around Bolton require repairs following damage.



Picture 3 Collapsed section of flood wall at Littleborough

There were two reports of culvert collapses received after the flooding. One was on Dean Brook at Smithills near Bolton and the other was on Pickhill Brook, Oldham.

Records of blockage in the river channel, such as trees and other debris, were recorded by the Environment Agency as 'incidents'. This also includes the recording of gravel shoals (deposits in the river channel), shale beds and excessive silt. Following the Boxing Day floods the Environment Agency have had nearly 400 incidents reported by the public and its own internal staff. These have been reviewed, visited by operational staff and had follow-up calls back to members of the public. The categories of problems reported are shown in the table below.

Following the flooding, the Environment Agency has had reports of large accumulations of stones, gravel and silt in the rivers. As part of the recovery programme, its funding bid has included several sites where gravel has typically been removed at intervals of several/many years previously. Each of these potential sites is being reviewed in conjunction with Geomorphologists (specialists who advise on sediment movement and build-up in rivers) prior to planning or carrying out any work. In addition, revised flood risk computer modelling is being fast-tracked to provide good evidence on the risk presented by gravel in these key locations. On review, it may be decided that some works are not required. Work has started on some clear-cut sites where there is recent evidence to support the case for removal.

5.5 Future investigation of options

Details of potential improvement options are beyond the scope of this Section 19 Report. The RMAs mentioned against each location within Appendix 1 will lead on investigation of appropriate options if flood mitigation measures are to be pursued. Places where flooding affects most properties and most frequently will have the highest priority in any such investigations.

6. Summary and Conclusions

6.1 Scale and impacts

The Boxing Day flood was the largest on record across Greater Manchester with 37 of 44 gauges in the River Irwell, Roch and Croal catchments recording their highest ever levels. Heavy rainfall began on Christmas Day and lasted about 36 hours, falling on saturated ground. This was focussed on the River Irwell catchment particularly the upland areas of it and catchments to the North. Catchments across South Manchester, Cheshire, Merseyside and elsewhere saw far less rain, though there was flooding around Wigan, St Helens and Warrington.

Around 2,250 properties flooded internally, over 80% of which was from main rivers. Approximately 2,450 properties were protected from flooding by raised defences along main rivers, culvert clearance and pumping station operation. Surface water and ordinary watercourse flood alleviation assets also protected properties e.g. the Calder Brook flood basin which prevented significant further property flooding in Littleborough. Internal sewer flooding was reported at 25 properties. An unknown number of additional properties experienced external flooding from sewers.

The flooding caused numerous problems to important infrastructure and widespread travel disruption. Over 31,200 properties were initially left without power due to damage at electricity sub-stations and thousands of people were affected by widespread travel disruption. Several small bridges collapsed or were damaged during the flood and many more were damaged. Effluent discharged to the river from Bury Wastewater Treatment Works after the flood did not meet full treatment standards for several weeks due to damage sustained to the plant. The high river levels and flooding caused damage to many river channel retaining walls and some culverts and transported substantial volumes of gravel down the river network.

The most heavily affected areas were Salford (750 properties), Radcliffe/Redvales (670 properties), Littleborough (175 properties) and Rochdale Town Centre and vicinity (54 properties). Investigations or works to manage flood risk in these areas are already underway and include the following schemes:

- **Littleborough and Rochdale** – Work was already underway to develop proposals for a flood defence scheme. The Environment Agency and Rochdale Council are committed to working in partnership to reduce flood risk in Littleborough and Rochdale.
- **Radcliffe and Redvales, Bury** - Work was already underway to develop proposals for a flood defence scheme. The Environment Agency and Bury Council are committed to working in partnership to reduce flood risk in Radcliffe and Redvales. Consultants are being appointed in August 2016 to commence a study which will assess flood defence options.
- **Salford Flood Alleviation Improvements** - Construction of a second flood storage area at Castle Irwell will finish in autumn 2016 and this will reduce flood risk to approximately 1,900 homes and businesses in Lower Kersal, Lower Broughton and Cheetham.

6.2 Incident response and recovery

In the aftermath of the flooding RMAs have worked together to support affected communities and understand what happened. The Environment Agency's flood warning service provided approximately 5,700 properties with a direct warning of possible flooding from rivers. Homes were evacuated by emergency services in several locations including: Salford, Radcliffe, Prestolee, Littleborough, Rochdale, Summerseat, Leigh and Wigan.

Field staff from the Environment Agency, Local Authorities and United Utilities have carried out maintenance and repair works following the event. Inspections have been carried out on approximately 4,000 assets/structures along rivers since the flood – including flood walls, embankments, river channel retaining walls, culverts, bridges etc. Nearly £2 million has been

allocated to repairing structures on main rivers and removing gravel.

Local Authorities and the Environment Agency have carried out extensive engagement with affected communities. Within three days of the flood 36 of the communities affected flooded were visited by Local Authority and Environment Agency staff and many more in the weeks following. Local Authorities have been meeting many hundreds of people affected by flooding in order to administer grant payments to householders and businesses for community recovery and property resilience, and to provide ongoing support to vulnerable residents. This has also provided information on flood mechanisms and extent/ severity.

6.3 Conclusions

The extreme rainfall and widespread flooding on Boxing Day caused devastation to many communities across Greater Manchester. The flooding mechanisms were complex involving multiple sources of flooding. The majority of the flooding was caused by main rivers, but hundreds more properties were affected by flooding from other sources such as surface water, ordinary watercourses, sewers and ground water.

A number of RMAs and responders worked together in the incident response and recovery phase to support affected communities. The RMAs have continued to work together and share information to produce this flood investigation report covering the whole of Greater Manchester, and they remain committed to working together to reduce flood risk across local communities. Please see the 'Recommendations' and 'Next Steps' section for more information about what happens next.

7. Recommended and ongoing actions

The purpose of this report is for the relevant RMAs to jointly record and explain the extent of flooding in their area and to consider and prioritise those actions relevant to each authority. In this way, communities affected by the flooding can be clear what has happened since the flood, what is proposed and which organisation is leading in their area. This investigation report contains recommendations to manage flood risk across Greater Manchester. There are general recommendations which apply across the whole of Greater Manchester and where available ongoing or planned actions to be taken in specific locations. Due to the widespread nature of the flooding it has not been possible to produce detailed actions for each location affected. The RMAs involved in this report will continue to work together, engaging with communities to identify all potential options for each location. Recommendations will be prioritised in line with other commitments and subject to bidding and securing funding and resources.

Table 5 Recommended and ongoing actions for Greater Manchester

Action by	Recommended action	Where
Actions recommended across areas		
Greater Manchester RMAs	Risk Management Authorities will continue to meet at a Greater Manchester level, working through the GM Flood and Water Management Board, Local Resilience Forum and the GMCA. Flood Recovery and future resilience will form an important part of these discussions and how organisations work together. This partnership working will guide and help to co-ordinate resources which will seek to enhance preparedness, mitigate flood risk and inform incident management.	Across Greater Manchester
Greater Manchester RMAs	Continue to support each other in completing any remaining data collection and evidence recording activities associated with the Boxing Day Flood, working through the GM Flood and Water Management Board and the Local Resilience Forum.	Across Greater Manchester
Greater Manchester RMAs	Engagement with affected communities and businesses is a key part of understanding the issues and developing and choosing appropriate options. RMAs will work together to identify how to engage and support communities through local flood action groups, promoting Flood Re, warning sign up and alternative approaches to flood risk management. This will be co-ordinated by the GM Flood and Water Management Board.	Across Greater Manchester
Greater Manchester RMAs	Local Authorities that experienced damage to infrastructure from December flooding are bidding for government funding to carry out repairs.	Across Greater Manchester
Environment Agency	Bring all relevant evidence together to produce one or more 'historic flood outlines' of river flooding. This will ultimately be used to update its suite of Flood Maps to better inform all RMAs.	Across Greater Manchester

Action by	Recommended action	Where
Environment Agency	Review Flood Warning Areas; where necessary investigate provision of new Flood Warning Areas. Threshold levels will be altered if necessary. These improvements are ongoing and local communities will be involved in the process where appropriate.	Prestolee & Stoneclough, Radcliffe & Redvales, Pioneer Mill, Ramsbottom, Cheetham, Delph, Uppermill, Rochdale centre, Hey Brook at Rochdale, Lower Broughton, Lilford Park Brook, Hindley
Environment Agency	Assessments will be done to see if any areas which flooded from 'main rivers' should be offered a direct Flood Warning service in future, if this is not currently available. Local communities will be involved as opportunities to improve or extend the Flood Warning service are explored.	Lostock, Smithhills, Horwich, Darcy Lever, Bury Centre, Tottington, J2 Bury Business Park, Hendham Vale, Shaw, Grasscroft, Heap Bridge; Heywood Hooley Bridge; Heywood, Milnrow, Belfield, Platt Bridge, Worsley Mesnes
Environment Agency	The Environment Agency will apply its 'Communities at Risk' approach in developing any future proposals to mitigate flood risk. Communities at Risk uses a risk based approach to identify hotspots of flood risk. It allows risk to be identified across whole catchments and assessment of all potential options, including natural flood management, engineered solutions and community resilience. The Environment Agency plans to share this programme with LLFAs in the coming months so that RMAs can work together to identify additional opportunities for funding. This will ensure that places most at risk (higher number of properties, or more frequent flooding, or combinations of these) anywhere in Greater Manchester and beyond are considered as the higher priorities.	Across Greater Manchester
Greater Manchester LLFAs and Environment Agency	As investigations of possible solutions develop, these will be followed by bids for any necessary funding. The Regional Flood and Coastal Committee may be asked for funding contributions to priority projects from its Local Flood Defence Levy Fund.	Across Greater Manchester
Manchester Ship Canal Flood Risk Partnership Group	Hold a joint workshop on incident response arrangements for flooding from the MSC for MSCCo staff and incident response staff from public authorities.	Across Group stakeholders and relevant areas
Manchester Ship Canal Flood Risk Partnership Group	Establish a task group to examine the possibility of sharing data and real-time information between all parties, eg water levels. This is particularly key to establishing a system for providing flood warnings to communities, businesses and residence at risk from the MSC.	Across Group stakeholders and relevant areas

Action by	Recommended action	Where
Manchester Ship Canal Flood Risk Partnership Group	Establish a task group to build an understanding of the ownership, operation, maintenance and repair/replacement of assets that affect flood risk and by so doing improve awareness of issues and identify opportunities to improve how they are addressed.	Across Group stakeholders and relevant areas
Actions for specific locations		
Bolton		
LLFA	Forest Road, Smithills. Undertake repair of collapsed culvert and land slip.	Bolton
LLFA	Undertake river training wall repairs on the Rivers Tonge and Irwell.	Bolton
LLFA	Ongoing repair of flood damaged footbridges and public right of way footpaths.	Bolton
LLFA	Continuing to pursue riparian landowners to fulfil their statutory responsibilities.	Bolton
Environment Agency	Sand on the river bank upstream and downstream of Ringley Old Bridge will be moved to smooth the flow through the arched bridge openings. Gravel from the island downstream of Ringley Old Bridge will be used to fill in scour to the right bank (looking downstream) of the river.	Prestolee & Stoneclough
Environment Agency	Computer modelling is programmed for 2016/17 to provide flood levels for a range of simulated flood flows and sediment build-up. These will guide the need for any gravel removal, such as around bridges and to inform possible defence/improvement options.	Prestolee & Stoneclough
Environment Agency	Consultants have been engaged since Boxing Day to investigate possible improvements to the design of the Bessy Brook debris screen.	Lostock
Environment Agency	Woodlands Trust own the land uphill of the area affected and have large scale tree planting proposals. The Environment Agency are beginning to work with Woodlands Trust to see whether these and additional measures could reduce flood risk locally.	Smithills
Bury		
Environment Agency	The Environment Agency is investigating ways of repairing/replacing river channel walls at Nuttall Park which were damaged in the flood.	Ramsbottom
Environment Agency & LLFA	Proposals are being drawn up by the Environment Agency to develop a flood defence scheme for Radcliffe and Redvales. The Environment Agency and Bury Council have committed to working together to develop a business case and funding strategy for the scheme which will consider the options for flood defences and flood storage throughout the Borough.	Radcliffe and Redvales

Action by	Recommended action	Where
Environment Agency & LLFA	Environment Agency and Bury Council will jointly explore possible flood resistance and resilience measures to properties at Chamberhall most at risk and possible non-return (flap) valves where surface water drains outfall to the river.	Bury Centre
Environment Agency & LLFA	The Environment Agency, Bury Council and United Utilities will work together to look at possible measures to reduce flood risk in the centre of Ramsbottom, but this could be a long term process.	Ramsbottom
United Utilities & LLFA	United Utilities and Bury Council will work together to look at possible measures to reduce flood risk in Tottington, but this could be a long term process.	Tottington
Manchester		
LLFA	Carry out repairs to collapsed river retaining wall.	Hendham Vale
Environment Agency	Local Environment Agency teams have made bids for additional funding from central government which is to be made available after the Winter floods. Funding for Hendham Vale, if available, would be used to review defences and possible improvements.	Hendham Vale
Oldham		
LLFA	Progress future flood defence schemes and studies already submitted for funding.	Oldham
Environment Agency	Progress ongoing strategic assessment of flood risk issues and options across the River Tame catchment around Saddleworth which is expected to complete in late 2016. The strategic assessment will provide possible options for improvements. Further work by the Environment Agency, in collaboration with Oldham Council, is likely to follow, but this will be subject to justification and available funding.	Delph, Uppermill
Rochdale		
LLFA	Flood alleviation project in construction – Second flood storage basin, Calder Brook, near Littleborough – completion Autumn 2016.	Littleborough
LLFA	Implement recommendations from post event debrief to improve future flood response. Continue dialogue with volunteer groups that assisted council staff during the event. Work with existing and emerging local flood action groups to support increased community resilience.	Rochdale
Environment Agency	Repair of collapsed length of flood defence behind Riverside Care Home will finish in August 2016 and drainage is being improved to reduce surface water ponding behind the flood wall.	Littleborough

Action by	Recommended action	Where
Environment Agency	Computer modelling to simulate flood flows and levels from the River Roch in this area is to be improved/updated and is out to tender Summer 2016. Data from this would be used in any future investigations if these can be justified based on priority of this location compared to others.	Heap Bridge, Heywood
Environment Agency & LLFA	<p>Work was already underway, prior to Boxing Day, to develop a flood defence scheme and funding strategy for Littleborough – the scope of this project has been extended to Rochdale to consider all areas affected by the Boxing Day floods.</p> <p>Any solution is likely to be a combination (some or all) of:</p> <ul style="list-style-type: none"> o raising the level of existing defence walls o building one or more flood storage basins o operating the reservoirs at Blackstone Edge differently o using natural flood management techniques to slow run-off from land 	Littleborough and Rochdale (Including town centre and Wardleworth)
Environment Agency & LLFA	The Environment Agency and Rochdale Council have jointly visited the area and will investigate the potential for simple measures such as infilling gaps between some garden walls. Although not designed as flood defences, some walls provide some flood protection.	Milnrow
Environment Agency & LLFA	The Environment Agency and Rochdale Council will work together to better understand the flood risk at this location and consider the types of measures that may reduce it.	Hooley Bridge, Heywood
Salford		
LLFA	Salford City Council is producing a separate, more detailed report of the flooding at Lower Broughton, with further details of investigations and possible next steps.	Salford
Environment Agency	Construction of a second flood storage area at Castle Irwell will finish in autumn 2016 and this will reduce flood risk to approximately 1,900 homes and businesses in Lower Kersal, Lower Broughton and Cheetham.	Salford
Wigan		
LLFA	Council have obtained funding to improve road drainage on Elmridge. Work will include lowering the footpath and constructing a speed table in the road. This will encourage initial surface water run-off / flood basin spills back into Lilford Park Brook immediately downstream of the culvert under Elmridge.	Lilford
Environment Agency	Improvements to the standard of flood protection at Abram/Bickershaw are to be investigated. Options will have been considered by the end of 2018 and a preferred solution recommended.	Abram
Environment Agency	Improvements to the standard of flood protection at Platt Bridge are to be investigated. Options will have been considered by the end of 2018 and a preferred solution recommended.	Platt Bridge

Action by	Recommended action	Where
Environment Agency	Improvements to the standard of flood protection at Hindley are to be investigated. Options will have been considered by the end of 2018 and a preferred solution recommended. Natural measures to slow the flow into Borsdane Brook upstream of Hindley will be considered.	Hindley

8. Next Steps

The recommendations and ongoing actions within this report will be taken forward by the identified responsible Risk Management Authority. Recommendations and actions will be prioritised in line with other commitments and subject to available funding and resources. Any major works requiring capital investment will be considered through the Defra funding programme.

All authorities involved in this report will continue to cooperate and work together to reduce flood risk across Greater Manchester. Due to the widespread nature of the flooding it has not been possible to produce detailed recommendations for each location affected. RMAs will continue to work together and with affected communities to understand and assess the full range of options for each location. In many cases a range of options may be required to manage flood risk in that location.

9. Acknowledgements

The following organisations have contributed to the production of this report:

- Greater Manchester Combined Authority.
- The 10 Lead Local Flood Authorities within Greater Manchester – Bolton, Bury, Manchester, Oldham, Rochdale, Salford, Stockport and Wigan (Tameside and Trafford confirmed they had no significant flooding).
- Environment Agency.
- United Utilities.
- AGMAs Civil Contingencies Resilience Unit.
- Manchester Ship Canal Company
- Transport for Greater Manchester.
- Electricity North West.
- Highways England.

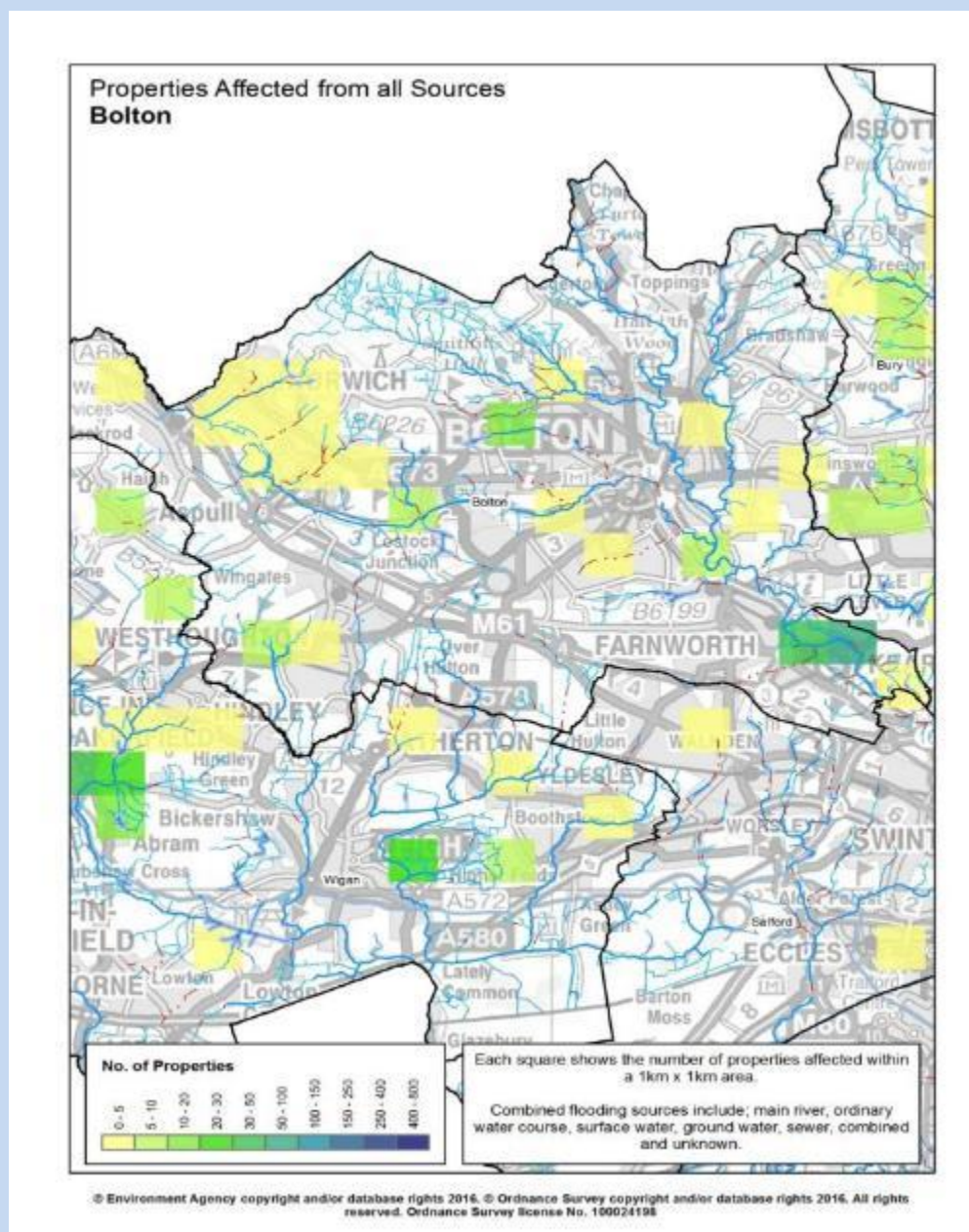
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Appendix 1.1 – Bolton Local Flood Information

Bolton borough summary

A total of 116 properties in the Bolton borough, were affected by internal flooding of property. Worst affected was Prestolee, near Kearsley where 57 homes were flooded from the River Irwell, some to as much as 1.5 metres in depth (all statistics exclude cellars unless they are habitable accommodation). Other flooding clusters were at Lostock (Bessy Brook), Horwich (Pearl Brook and other sources), Darcy Lever (River Croal) and Smithills (ordinary watercourse).



Representative raingauges and readings are:

- Ringley - 52mm/24hrs
- Worthington, near Standish – 66mm/24 hrs
- Holden Wood, Haslingden - 109mm/24hrs
- Sweetloves, Darwen – 73mm/24hrs

River levels:

- 6.33m at Kearsley (46.660m AOD), which is 1.6m higher than any other reading in its 13 years of records

- 1.44m at Bessy Brook, Lostock, which is higher than any other reading in its 5.5 years of records

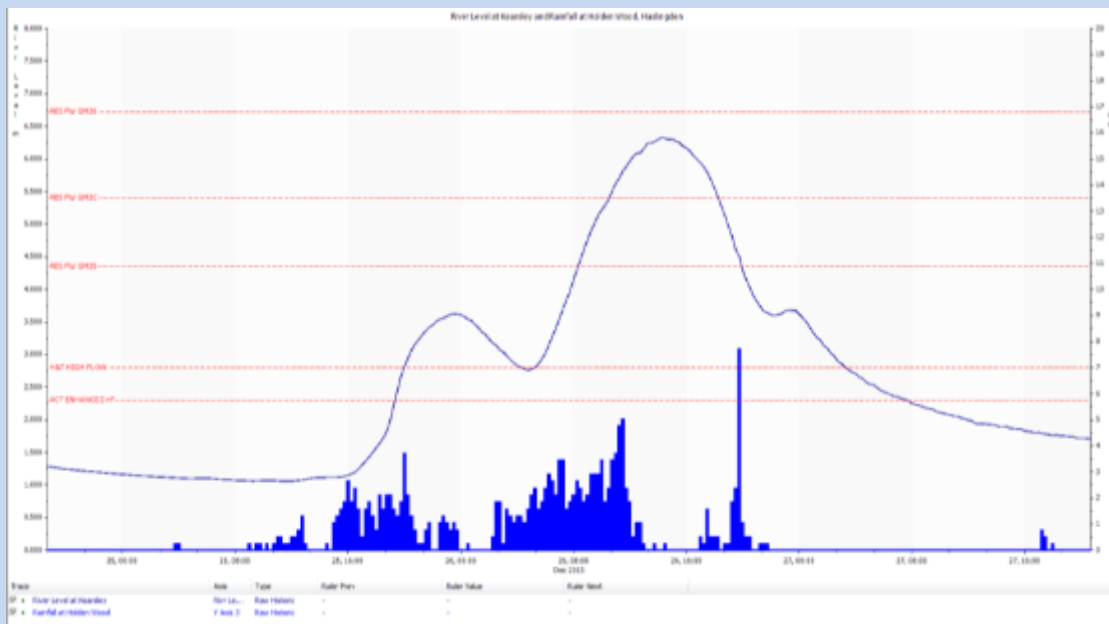


Figure 6 River Irwell level at Kearsley and the corresponding rainfall in the Upper Irwell catchment

United Utilities pipe bridge collapsed at Kearsley pumping station. A temporary pipe route has been installed while the bridge is replaced. Damage was also sustained to Prestolee pumping station.

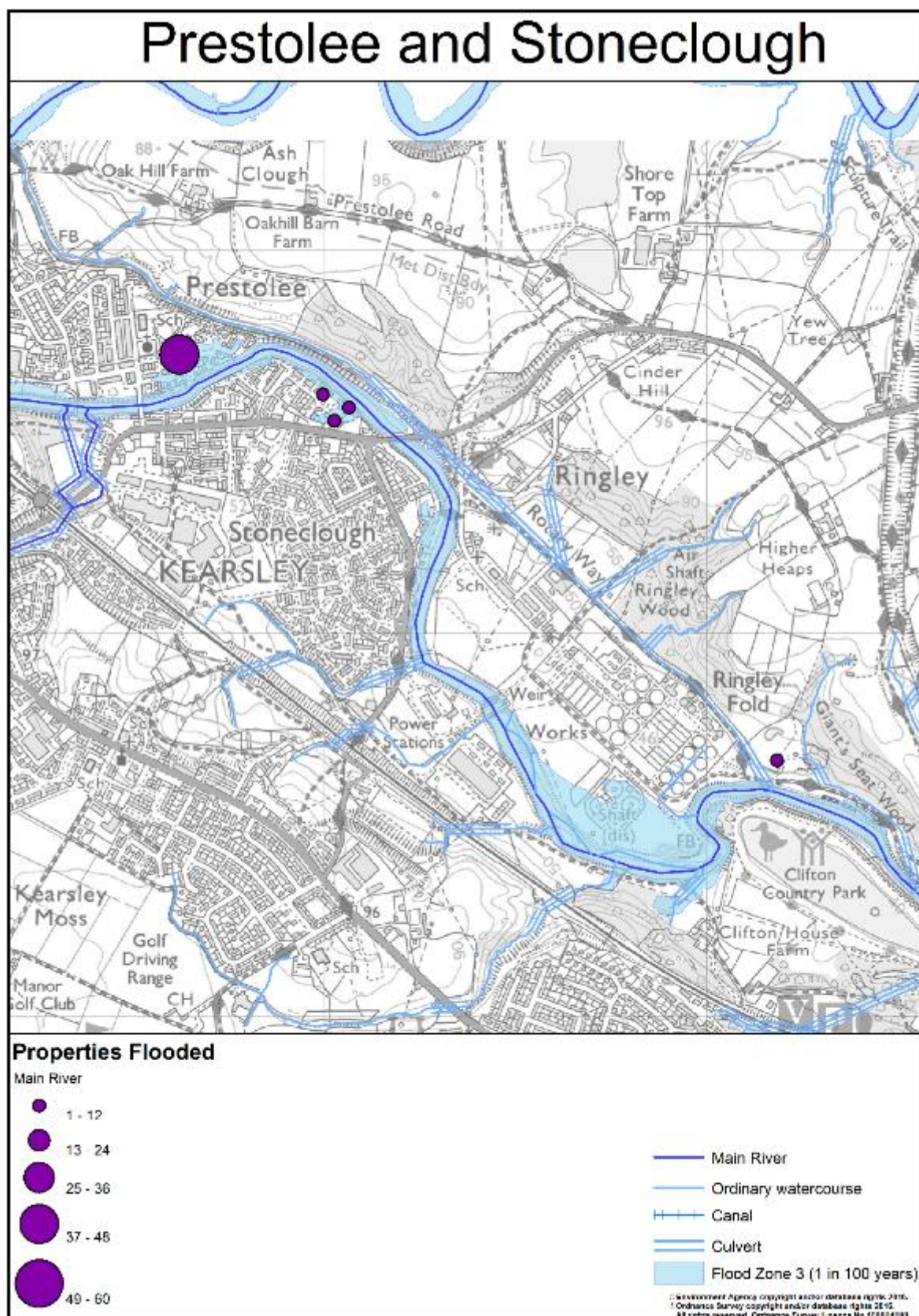
Bolton Metropolitan Borough Council undertook street cleaning, litter picking and debris removal. Communal skips were also provided to residents for free disposal of flood damaged house contents.

Bolton Metropolitan Borough Council identified 4 blocked and / or collapsed culverts as a result of the flooding that posed significant flood risks or land drainage problems. Emergency civil engineering works undertaken by Bolton Council to resolve two of these. Two culverts require a more planned approach and are lengthy on-going projects.

34 distinct locations required detailed investigations at request of residents to identify the cause of flooding, required repair works and possible actions to reduce future flood risk. Work to resolve many of the issues where they relate to private land owners are on-going.

Damage to some of the 13 bridges and 300m of riverside footpaths across Bolton have been repaired, but some areas still remain closed for health and safety reasons. Inspections and surveys of slips/erosion, training wall damage and highway damage have been commenced and are still underway

Additional staff resources have been brought in to support the above work.



Points shown above indicated clusters of reported flooding and do not represent the exact properties or extents that experienced flooding

Description/Main Issues

- The Environment Agency are leading investigations at this location as flooding was from main river
- The River Irwell (main river) flooded 57 properties internally, including 1 business
- Floodwaters overtopped natural bank levels
- Properties on Riverside Drive flooded to a depth of up to 1.5m
- Apartments on Stoneclough Rise flooded up to 200mm in depth
- Residents are in the process of forming a Flood Action Group to promote self-help and to communicate effectively with the Risk Management Authorities, principally the Environment Agency and Bolton Council.
- Detrimental social impacts are still being felt by people in the borough, due to ongoing temporary accommodation, flood damage to homes, road collapses and closures, stress, community breakdown and substantial damage to recreational open spaces and facilities.

Photos



Picture 4 Photo indicating flood level at Langcliffe Place, Stoneclough Rise



Picture 5 Localised bank slip

Environment Agency

- A flood warning was issued for the River Irwell at Prestolee and Ringley Bridges
- Rainfall in the upper Irwell is the main influence on river levels at Prestolee/Stoneclough. On Boxing Day this is estimated to have had a likelihood of occurring once in up to 50 years. This was made more extreme by the saturation of the catchment before any of this rain fell
- The level measured by the Environment Agency's gauge in the River Irwell at Kearsley was the highest in 13 years of records – 1.6m higher than the previous highest levels in

January 2008 and June 2012

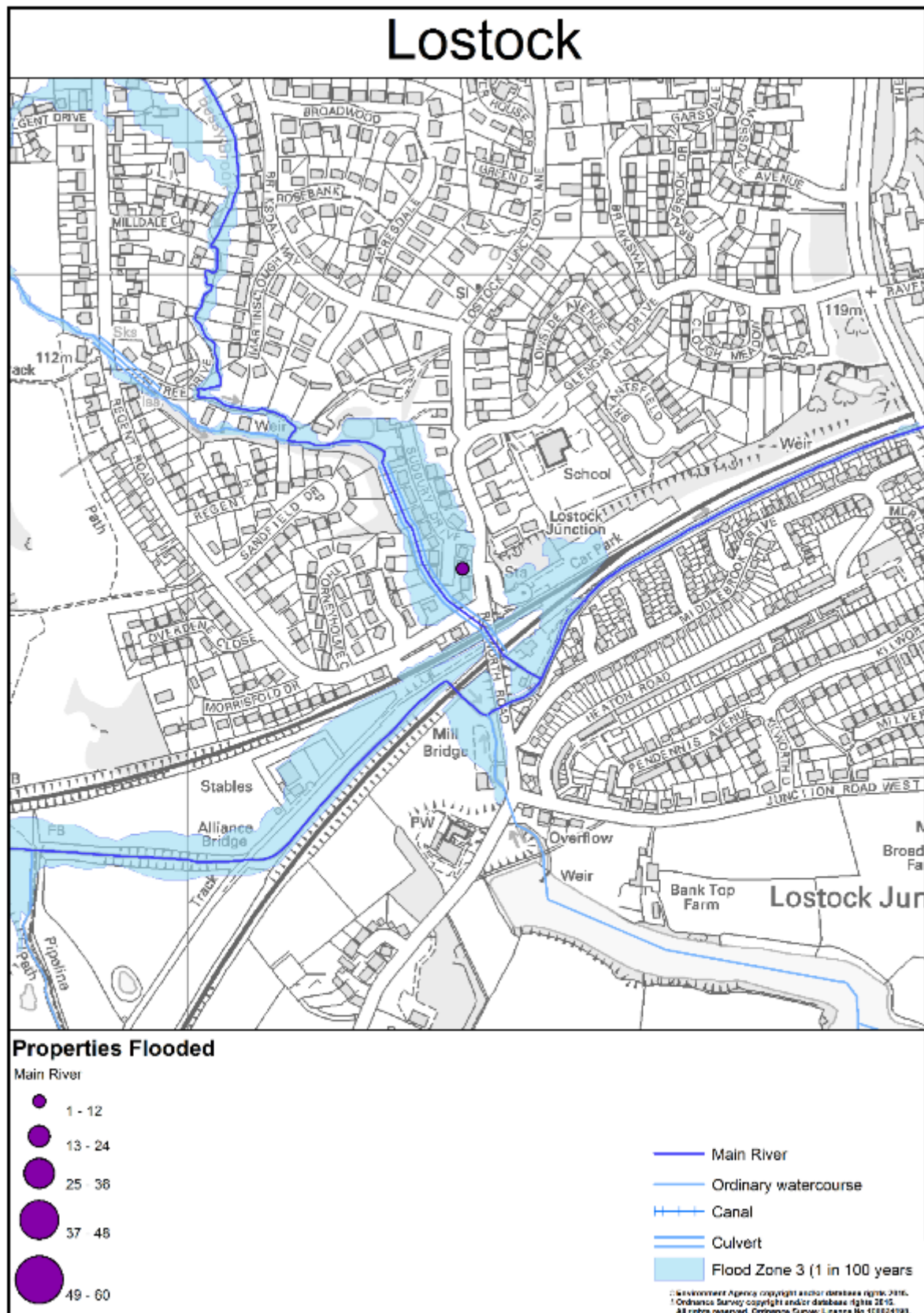
- This river level is estimated to have a likelihood of occurring only once in 100 to 150 years
- Properties flooded above ground floor are in Flood Zone 2 (up to a 1 in 1000 chance of flooding in any given year) and Flood Zone 3 (a 1 in 100 or greater chance of flooding in any given year)
- Localised slip of river bank (shown above) West of Prestolee New Bridge
- Sand on the river bank upstream and downstream of Ringley Old Bridge will be moved to smooth the flow through the arched bridge openings
- Gravel from the island downstream of Ringley Old Bridge will be used to fill in scour to the right bank (looking downstream) of the river
- Computer modelling is programmed for 2016/17 to provide flood levels for a range of simulated flood flows and sediment build-up
- Computer model outputs will guide the need for any gravel removal, such as around bridges and to inform possible defence/improvement options
- This location is included within a proposed strategic assessment of flood risk issues and options across the Croal catchment around Bolton
- The River Irwell at Prestolee and Ringley Bridges (GM25) Flood Warning Area is currently being reviewed. Threshold levels will be altered if necessary. These improvements are ongoing and local communities will be involved in the process where appropriate
- As part of the Environment Agency Recovery Programme gravel removal upstream of Bridge Street, Prestolee is scheduled.

Bolton Metropolitan Borough Council

- Council found that occupiers of 67 properties, although not flooded, were temporarily trapped in by floodwater – Riverside Drive is a cul-de-sac road
- Provided sandbags to residents on request
- Needs-based provision of white goods and other house contents to families

United Utilities

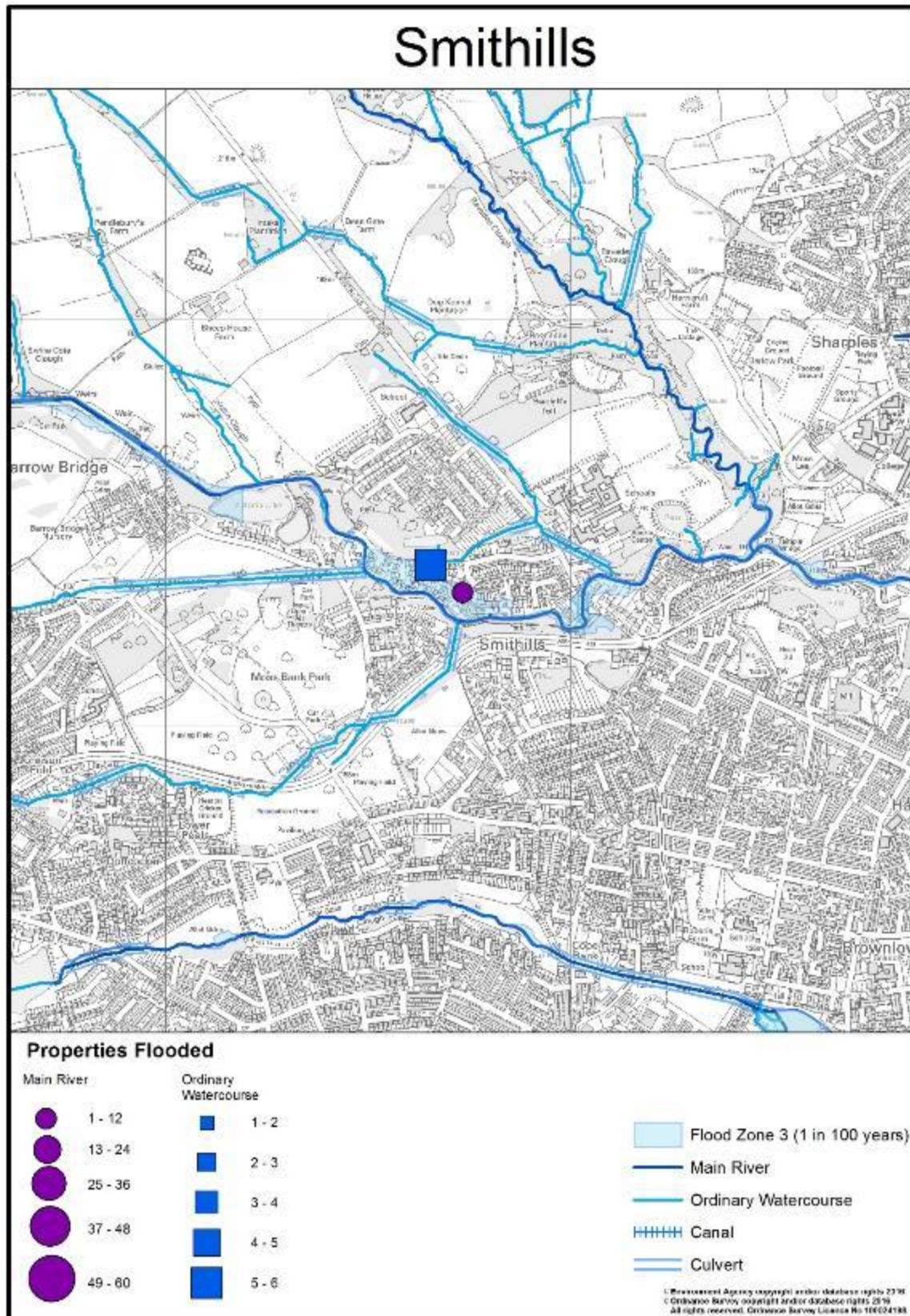
- There was no sewer flooding reported to United Utilities on Boxing Day 2015 in this area
- United Utilities attended the local community meetings/drop-in sessions



Points shown above indicated clusters of reported flooding and do not represent the exact properties or extents that experienced flooding

Description/Main Issues
<ul style="list-style-type: none"> • The Environment Agency are leading investigations at this location as flooding was from Bessy Brook which is main river • 7 properties flooded at this location • Flooding occurred when the long culvert beneath Sudbury Drive/Ashridge Close gardens, Regent Road and the railway embankment was overwhelmed. Debris at the inlet also exacerbates flooding • This area has flooded from main river before - in 2002 (16 properties), 2003 and 2007 (1 property)
Environment Agency
<ul style="list-style-type: none"> • Lostock is mid-way between two rain gauges – Worthington near Standish and Ringley near Bury. Recorded rainfall is estimated to have a likelihood of occurring once in up to 20 to 25 years at Worthington and once in 5 years at Ringley. The catchment was also fairly saturated before the onset of rainfall • The level measured by the Environment Agency's gauge in Bessy Brook was the highest in 5.5 years of records • All culverts are susceptible to a build-up of debris, so it isn't always possible to prevent flooding in their vicinity • Properties flooded above ground level are within Flood Zone 3 (a 1 in 100 or greater chance of flooding in any given year) • The debris screen on the upstream end of the culvert was improved at this location after previous flooding. Instrumentation was also added to it so that the Environment Agency can monitor its level remotely and respond during incidents. • Consultants have been engaged since Boxing Day to investigate possible improvements to the design of this debris screen • Alternatively, residents have asked whether a second screen can be installed upstream of the existing one, to catch some additional debris and so reduce blockages near the culvert. This will be investigated if the existing screen cannot be improved, but access to clear any second screen would be problematic • The potential for a new Flood Warning Area is being considered. A Flood Warning, if appropriate, will be triggered by high river levels and issued to local residents alongside contact with Environment Agency Field staff • Residents may form a Flood Action Group to promote self-help and to communicate effectively with the Risk Management Authorities, principally the Environment Agency and Bolton Council.
Bolton Metropolitan Borough Council
<ul style="list-style-type: none"> • Residents have asked, since Boxing Day, whether additional road drainage can be installed to cope with some floodwater in the event of culvert/screen blockage. This will be investigated.
United Utilities
<ul style="list-style-type: none"> • There was no sewer flooding reported to United Utilities on Boxing Day 2015 in this area

Appendix 1.1.3 - Smithills, Bolton



Points shown above indicated clusters of reported flooding and do not represent the exact properties or extents that experienced flooding

Description/Main Issues

- Bolton Metropolitan Borough Council are leading investigations at this location as flooding was from an ordinary watercourse and surface water
- 8 properties flooded:
 - 6 properties had habitable cellars flooded due to collapse of a culverted watercourse (ordinary watercourse)
 - 2 properties flooded on Whitsters Hollow, likely to be as a result of debris from a land slip in a field channelling water towards them
- Culvert collapse was initiated by, or caused, a large land slip to embankment east of Forest Road
- Surface water flooding previously occurred in June and November 2002

Photos



Picture 6 Landslip debris and damage to footbridge



Picture 7 Highway embankment collapse



Picture 8 Land Slip showing land eroded by culvert collapse

Environment Agency

- This location is roughly equidistant to 3 rain gauges: Worthington near Standish, Ringley near Bury and Sweetloves near Darwen. Of these, Sweetloves may better represent rainfall over higher ground – that was estimated to have a likelihood of occurring once in 10 to 15 years and the catchment was fairly saturated before any of this rain fell
- Woodlands Trust own the land uphill of the area affected and have large scale tree planting proposals. The Environment Agency are beginning to work with Woodlands Trust to see whether these and additional measures could reduce flood risk locally
- Assessments will be done to see if any areas which flooded from 'main rivers' should be offered a direct Flood Warning service in future, if this is not currently available. Local communities will be involved as opportunities to improve or extend the Flood Warning service are explored
- Properties flooded above ground floor are in Flood Zone 3 (a 1 in 100 or greater chance of flooding in any given year)

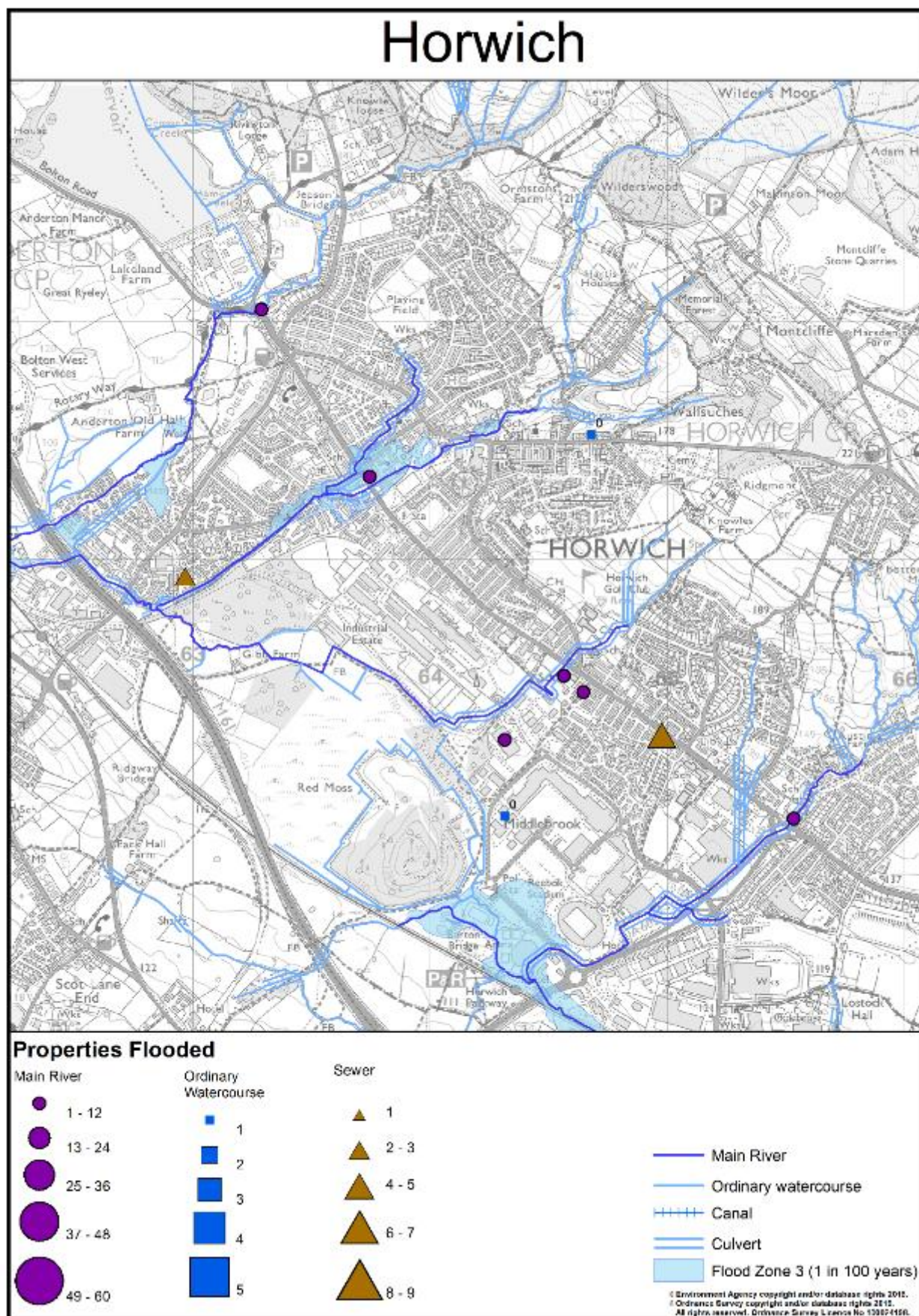
Bolton Metropolitan Borough Council

- Land slip undermined a public road leading to its closure
- Minor impact on electricity supply network
- Temporary closure of a public right of way footpath
- Repair of collapsed culvert, reinstatement of highway embankment, repair to damaged carriageway, footway footpaths and bridges estimated at £650k

United Utilities

- There was no sewer flooding reported to United Utilities on Boxing Day 2015 in this area

Appendix 1.1.4 - Horwich, Bolton



Points shown above indicated clusters of reported flooding and do not represent the exact properties or extents that experienced flooding

Description/Main Issues

- The Environment Agency are leading investigations at this location, as flooding was from 3 main rivers, but also an ordinary watercourse and possibly a sewer
- Flooding of 20 properties occurred in several locations and from different sources:
 - 12 flooded from main river
 - 2 flooded from ordinary watercourse
 - 6 flooded from sewer
- Horwich previously experienced localised flooding from Pearl Brook in 1992

Photos



Picture 9 Flooding to Back Emmet Street and Back Chorley New Road

Environment Agency

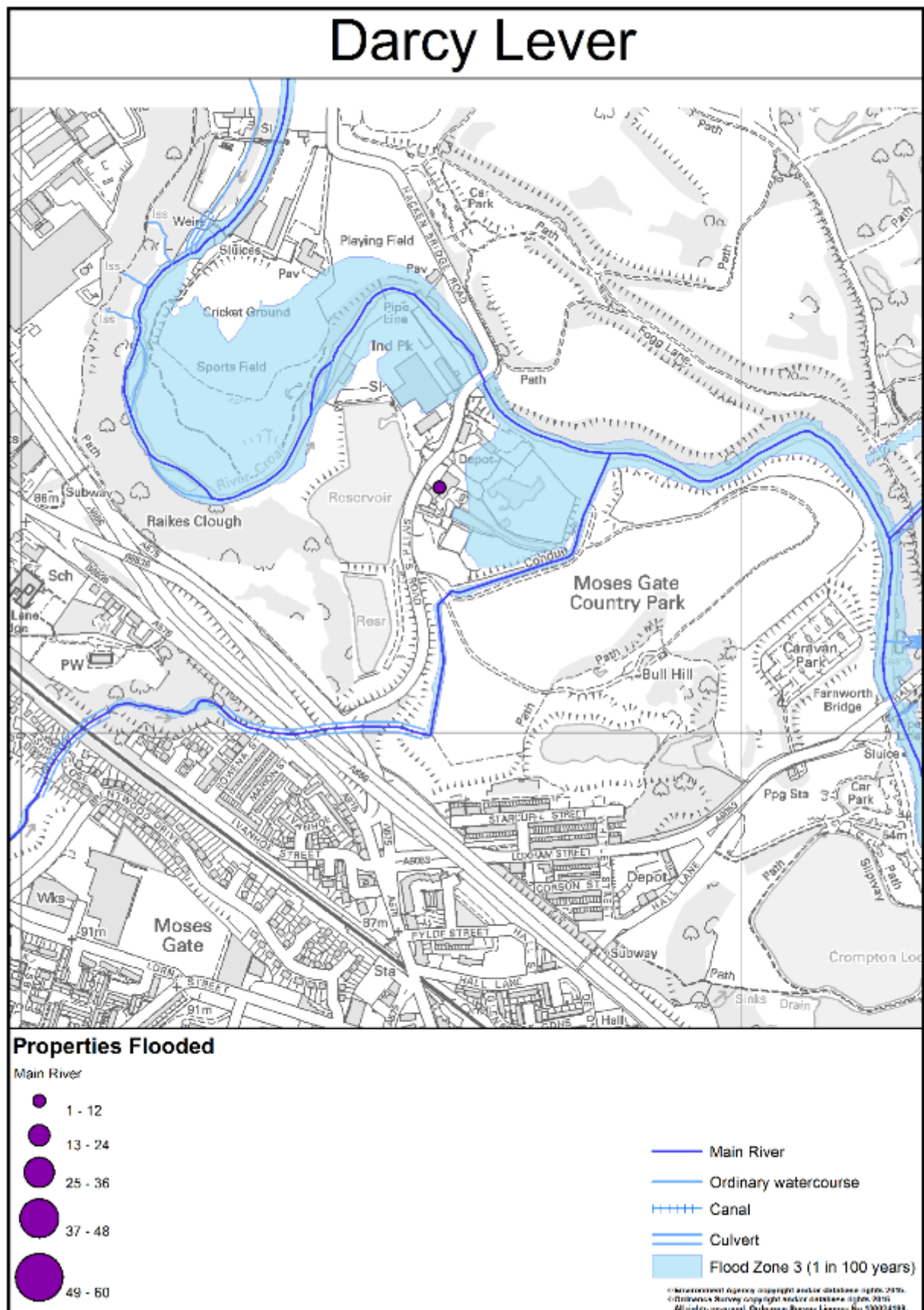
- There are 3 raingauges relevant to this location: Worthington near Standish, Ringley near Bury and Sweetloves near Darwen. Of these, Worthington is nearest, so may better represent rainfall locally – that was estimated to have a likelihood of occurring once in 20 to 25 years and the catchment was fairly saturated before any of this rain fell
- Part of Chorley New Road Primary School is built over an under-sized, culverted main river called Nellies Clough. The school flooded when the manhole in the school car park blew its cover
- Three newly built properties on Napier Drive were flooded, either due to the upstream school flooding, or due to the unconsented and under-sized culvert of Nellie's Clough (main river) installed by the developer. Enforcement action is being considered.
- A Public House suffered flooding believed to have been due to blockage of a main river debris screen on Moor Platt Clough
- Assessments will be done to see if any areas which flooded from 'main rivers' should be offered a direct Flood Warning service in future, if this is not currently available. Local communities will be involved as opportunities to improve or extend the Flood Warning service are explored
- Properties flooded above ground level are within Flood Zone 2 (up to a 1 in 1000 chance of flooding in any given year) and Flood Zone 3 (a 1 in 100 or greater chance of flooding in any given year)

Bolton Metropolitan Borough Council

- A Flood Defence Grant in Aid funded project is being undertaken by Bolton Council to study the mechanism of flooding within Horwich Town Centre, and to examine flood risk reduction solutions. The project is currently gathering culvert flow data to use in the verification of hydraulic computer models.
- Repair and refurbishment work to Chorley New Road Primary School completed. Re-building of Chorley New Road primary School, possibly within two years, will address its flood risk
- A property at Scholes Bank suffered internal flooding from Jepson's Clough
- Flooding of cellars to 5 homes on Chorley New Rd is likely to be from a surface water sewer

United Utilities

- Data collected by Bolton Metropolitan Borough Council indicates likely sewer flooding to 2 properties
- United Utilities attended the local community meetings/drop-in sessions



Points shown above indicated clusters of reported flooding and do not represent the exact properties or extents that experienced flooding

Description/Main Issues
<ul style="list-style-type: none"> • The Environment Agency are leading investigations at this location as flooding was from main river • 8 flooded properties: 2 residential and 6 businesses, flooded from the River Croal • Flooding previously occurred in 2002 when main river capacity exceeded
Environment Agency
<ul style="list-style-type: none"> • The Ringley rain gauge is a short distance downstream of this location, but the gauge at Sweetloves near Darwen, whilst further away, may be more indicative of catchment flows reaching Darcy Lever. Rainfall at Sweetloves was estimated to have a likelihood of occurring once in 10 to 15 years and for Ringley this is once in 5 years. The catchment was fairly saturated before any of this rain fell • The flooded properties are within Flood zone 2 (up to a 1 in 1000 chance of flooding in any given year) • The area has flooded previously • This location is included within a proposed strategic assessment of flood risk issues and options across the Croal catchment around Bolton • Assessments will be done to see if any areas which flooded from 'main rivers' should be offered a direct Flood Warning service in future, if this is not currently available. Local communities will be involved as opportunities to improve or extend the Flood Warning service are explored
Bolton Metropolitan Borough Council
All Risk Management Authorities are working together to share available information about flood risk from all sources and engage with communities, so the flood risk can be better understood and appropriately managed.
United Utilities
<ul style="list-style-type: none"> • There was no sewer flooding reported to United Utilities on Boxing Day 2015 in this area • United Utilities attended the local community meetings/drop-in sessions.

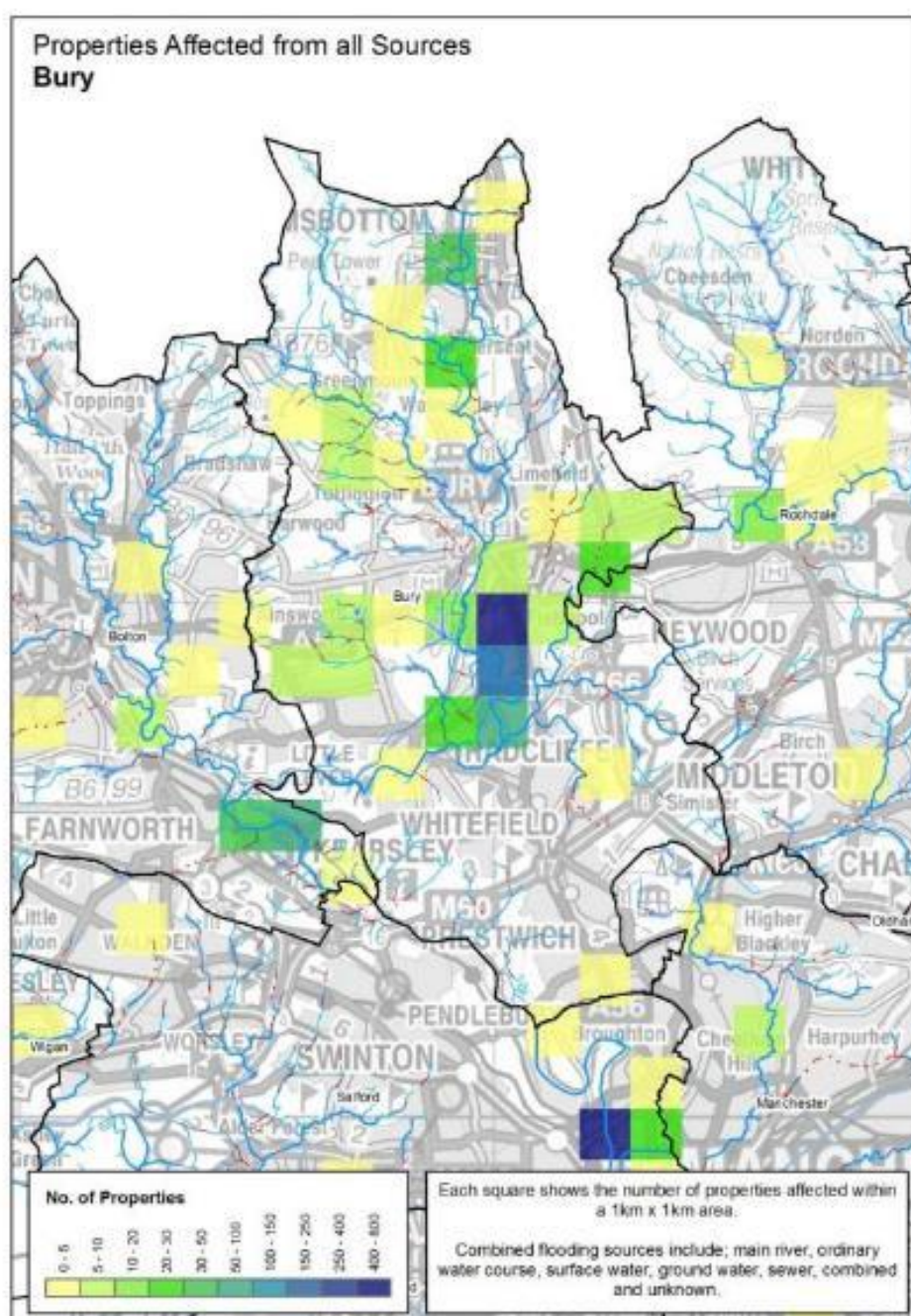
Appendix 1.2 – Bury Local Flood Information

Bury borough summary

A total of 808 properties were affected by the 2015 Boxing Day flood event (all statistics exclude cellars unless they are habitable accommodation).

The extent of the damage is still being assessed. The communities and businesses most severely affected were; Radcliffe and Redvales where about 671 properties were flooded from the River Irwell. Maximum flood depth above ground level was 1.4m and 0.6 to 0.8m was typical.

Other affected areas include: Pioneer Mill at Radcliffe, industrial properties close to Bury town centre, Tottington, Summerseat, Ramsbottom and Breightmet, on the Borough boundary.



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Representative raingauges and readings are:

- Holden Wood, Haslingden - 109mm/24hrs
- Ringley - 52mm/24hrs
- Heaton Park, Manchester – 50mm/24hrs

River levels:

- 3.39m (127.42m AOD) at Ramsbottom, which is 1.0m higher than any other reading in its 10 years of records
- 2.18m (81.90m AOD) at Bury Ground, which is 0.4m higher than any other reading in its 37 years of records
- 5.33m (62.97m AOD) at Pioneer Mills, Radcliffe, which is 0.9m higher than any other reading in 5 years of records
- 3.36m (66.28m AOD) at Blackford Bridge, which is 1.1m higher than any other reading in its 64 years of records

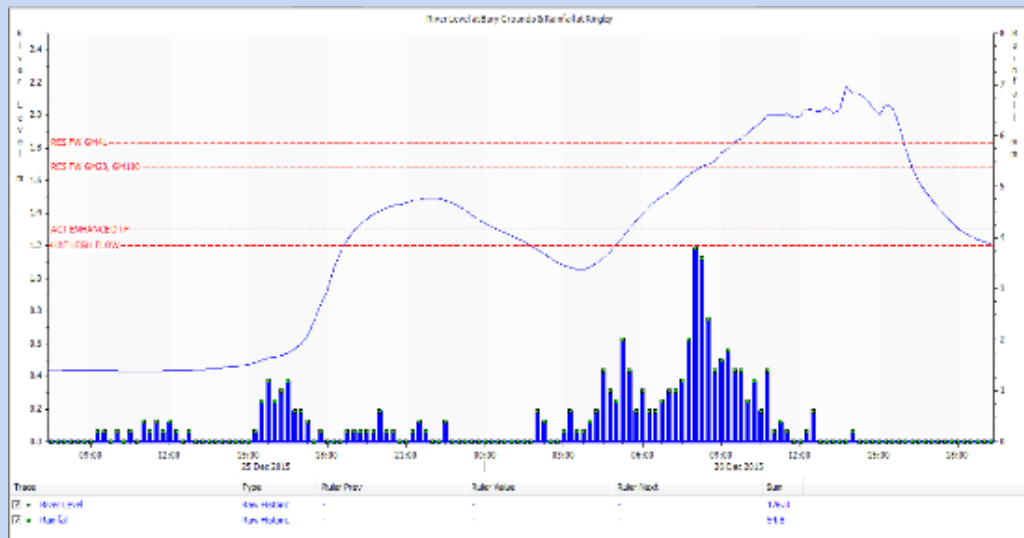


Figure 7 River Irwell level at Bury and the corresponding rainfall at the nearest rain gauge (note though that rain in the Upper Irwell was far higher)

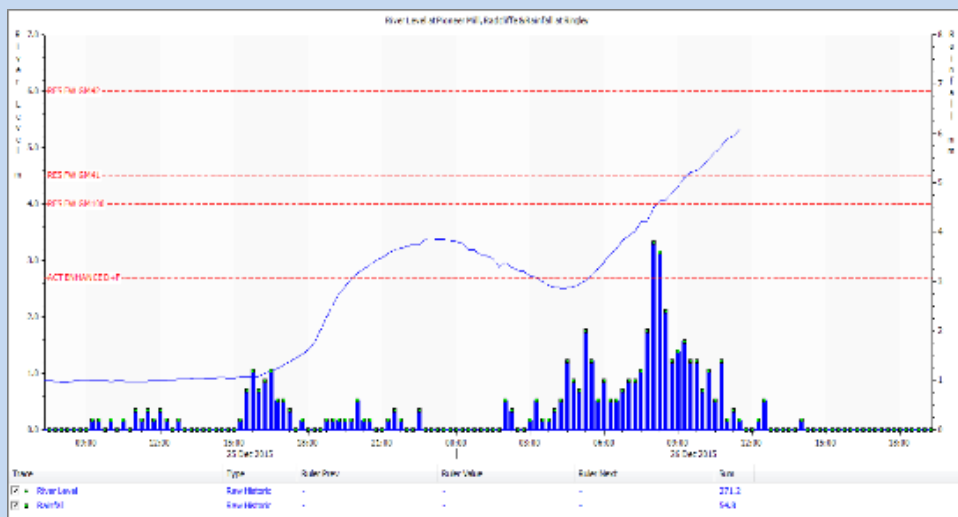


Figure 8 River Irwell at Pioneer Mill, Radcliffe (where the gauge was washed away at midday on Boxing Day) and the corresponding rainfall at the nearest rain gauge (again, note that rain in the Upper Irwell was far higher)

In addition to residential and commercial property flooding, the Waterside Restaurant in Summerseat, collapsed into the River Irwell. This also caused the partial collapse and subsequent closure of the associated masonry arch bridge. No-one was in this building at the time, however the event made national TV coverage. The bridge remains closed to traffic.

A footbridge carrying a sewer and gas main collapsed at Lomax Street in Radcliffe, rupturing the gas main which caused a fire and explosion and discharging sewage into the river. The footbridge was washed away and is still missing therefore there is no pedestrian access or use.

A further footbridge at Milltown Street in Radcliffe, was damaged beyond repair and is scheduled for demolition.

Hundreds of residential and commercial properties were affected by flooding to highways, disrupting access. Damage to existing drainage systems has also resulted in further flooding since December, in locations that have never previously flooded. Surveys have been commissioned to assess the damage caused to drainage systems.

Treated sewage discharged into the River Irwell from Bury Wastewater Treatment Works which flooded during the Boxing Day event. The discharge water did not meet full treatment standards for several weeks due to damage sustained on Boxing Day.

3,200 properties at Radcliffe were without power on Boxing Day due to flood damage at electricity sub-stations.

Metrolink services between Bury and Whitefield were suspended during the flood.

The flooding had severe impacts on recreational grounds across Bury, including two Green Flag parks which have been supported by 'Friends of' groups for many years. Several other communal recreation facilities were affected; the parks in particular will take a long time to fully recover from the impacts. Volunteer groups have helped Council staff to clear flood debris and restore facilities as much as possible.

Bury Council carried out the following action during and after the flood event:

The Council utilised its Emergency Control Room and contact facilities to coordinate its responses and the Chief Executive of Bury Council chaired a range of coordination and response groups with staff and partners. A rest centre was also set up at Castle Leisure Centre, where affected residents could receive support from various services within the Council and multiagency partners. This support is ongoing. Volunteer groups set up temporary rest centres in Ramsbottom and Radcliffe supported by the Council.

In the immediate aftermath, Council teams removed debris and flood damaged items. Infrastructure, gully and asset inspections have been carried out, resulting in maintenance and repair works. Additional waste collections and a free skip service was made available for residents to dispose of flood damaged items. Close Park and Nuttall Park were surveyed and made safe. A programme of repairs has been drawn up. A structural assessment of the affected bridges was undertaken to ensure that the high river levels hadn't caused structural damage.

£500 Community Recovery payments to help affected householders and businesses with the immediate aftermath and associated costs were provided. Payments started on 5 January 2016. The Council is now receiving applications for Property Resilience Grants of up to £5000 per property. Submission of applications for the Business Recovery Grant closed on the 31st March 2016 and it is proposed to close applications for the Property Level Flood Resilience Grant on 30th September 2016.

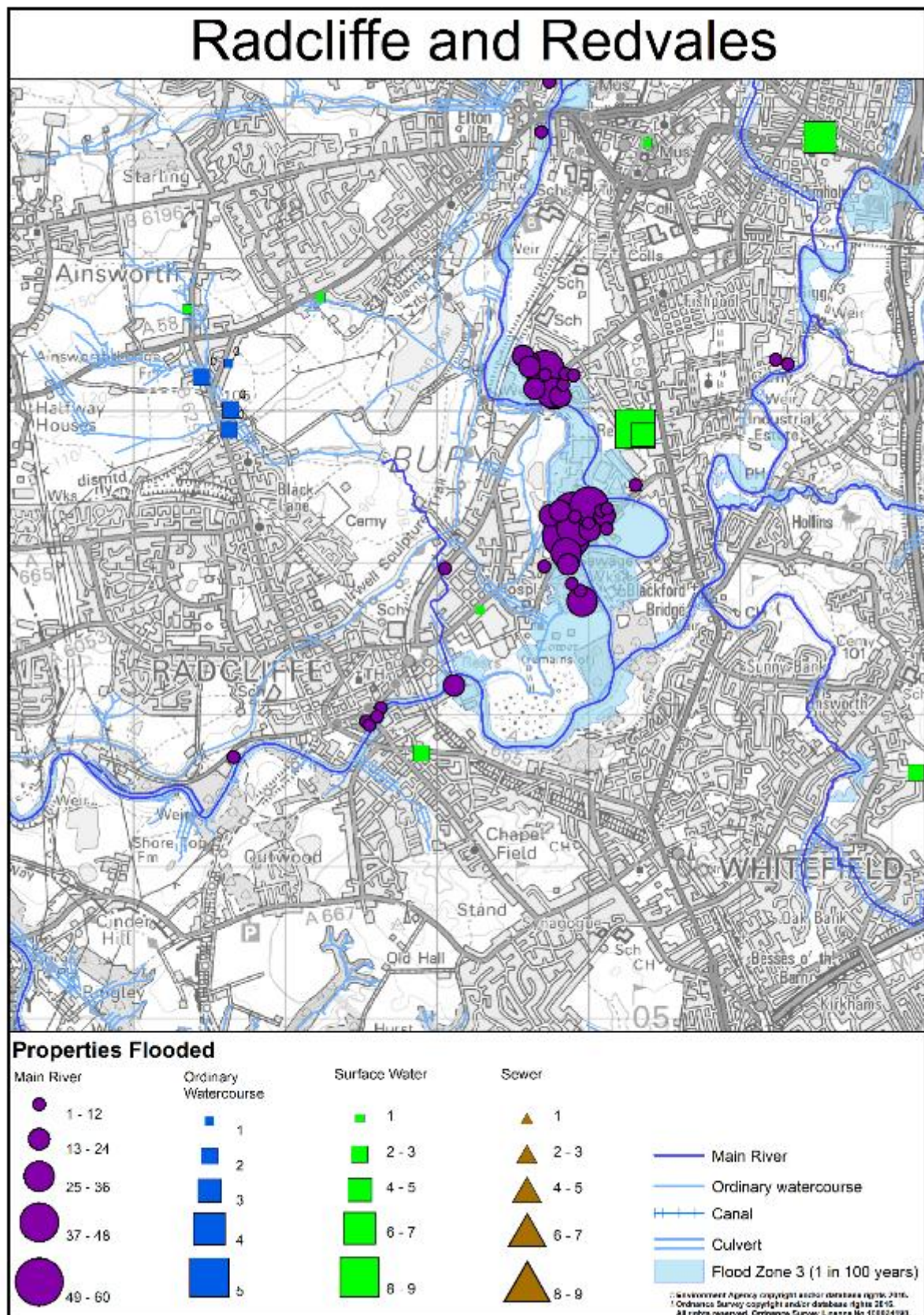
Council officers visited businesses immediately after the event to provide advice on continuity and a Business Adviser is continuing to offer practical support.

Multi-agency partners attended a community drop in event and public meeting in February and a further drop in event in June 2016 to provide advice and guidance to affected residents and businesses groups. A multiagency flood working group has been established, which brings together partners from the Council, Environment Agency and United Utilities, to address queries raised at the event and ensure co-ordination of flood risk issues in the future.

All bridge repair work is anticipated to be complete before the end of the year. Work to date has included complete removal of Lomax Street Bridge, partial removal of Milltown Street Bridge and temporary re-instatement of utilities.

Proposals are being drawn up by the Environment Agency to develop a flood defence scheme for Bury South and Radcliffe. The Environment Agency and Bury Council have committed to working together to develop a business case for the scheme which will consider the options for flood defences and flood storage throughout the Borough.

A flood extent outline has been mapped.



Points shown above indicated clusters of reported flooding and do not represent the exact properties or extents that experienced flooding

Description/ Main issues

- The Environment Agency are leading the investigations at this location as most flooding was from the River Irwell
- 671 properties were flooded
- These properties were mainly located along Warth Road/Radcliffe Road, where water flowed from under the Metrolink, along York Street/Dumers Lane, where water flowed over the cleared site on York Street and along Morris Street, and Parkside Close/Riverside Drive, where water came directly from the river
- Saturated ground over the 165 km² catchment area upstream of Radcliffe was a major factor in the severity of the flooding
- A footbridge carrying a sewer and gas main collapsed at Lomax Street in Radcliffe, rupturing the gas main which caused a fire and explosion and discharging sewage into the river. As a result 900 domestic properties *were* affected by low pressure but did not experience a loss of supply
- A further footbridge at Milltown Street in Radcliffe, was damaged beyond repair has already been partially removed
- A number of properties in the Higher Ainsworth Road area, were flooded due to the combined effects of a culverted ordinary watercourse and surface water run-off
- A significant number of businesses were affected in this area, both in the immediate aftermath of the event and longer term. A number of companies were unable to relocate locally due to the lack of suitable business sites and land and have since relocated to new premises outside the Borough
- Residents with the support of the National Flood Forum have set up a Radcliffe Flood Action group to promote self-help and to communicate effectively with the Risk Management Authorities, principally the Environment Agency, Bury Council and United Utilities
- There was sewage contamination in the Riverside Road area in Parkside Close

Photos



Picture 10 Warth Road



Picture 11 Radcliffe Road



Picture 12 Flames from ignited gas following collapse of Lomax Street footbridge which carried a sewer and gas main

Environment Agency

- Rainfall over the Upper Irwell catchment contributed to the flooding. At Haslingden this is estimated to have a likelihood of occurring only once in 50 to once in 160 years. To compound this, the ground was saturated before this rain started to fall
- The level in the River Irwell at Bury is estimated to occur only once in 120 to 180 years and similar at Pioneer Mill (downstream of Radcliffe and Redvales)
- Maximum flood depth (above ground level) at Parkside Close was 1.45m and 0.6 to 0.8m was the general flood depth for Radcliffe and Redvales
- Properties flooded are in Flood Zone 2 (up to a 1 in 1000 chance of flooding in any given year) and Flood Zone 3 (a 1 in 100 or greater chance of flooding in any given year)
- There are some raised walls and embankments along the river in some of the areas which flooded but these have not been built to flood defence standards and may need improving
- Survey has been carried out in and around the Rivers Irwell and Roch in this area. This data, which shows sediment build-up and other changes due to the flood, has been used in computer simulations of flood flows and levels which will be complete in August 2016
- The Environment Agency are working with Bury Council to develop proposals for a flood defence scheme for the area
- Funding has been approved and consultants are being appointed to investigate options then proceed to design of any proposed works
- Building new flood walls or embankments appear the most likely ways of reducing flood risk at this location

- River Irwell at Redvales (GM41) Flood Warning Area is currently being reviewed. Threshold levels will be altered if necessary. These improvements are ongoing and local communities will be involved in the process where appropriate
- The River Irwell at Radcliffe and Redvales (GM42) Flood Warning Area is currently being reviewed and, if necessary, improvements will be made to its coverage and the numbers of properties warned, as well as the threshold levels. These improvements are ongoing and local communities will be involved in the process where appropriate
- As part of the Environment Agency Recovery Programme gravel removal at several locations and repairs to equipment at the Pioneer Mills gauging station is scheduled.

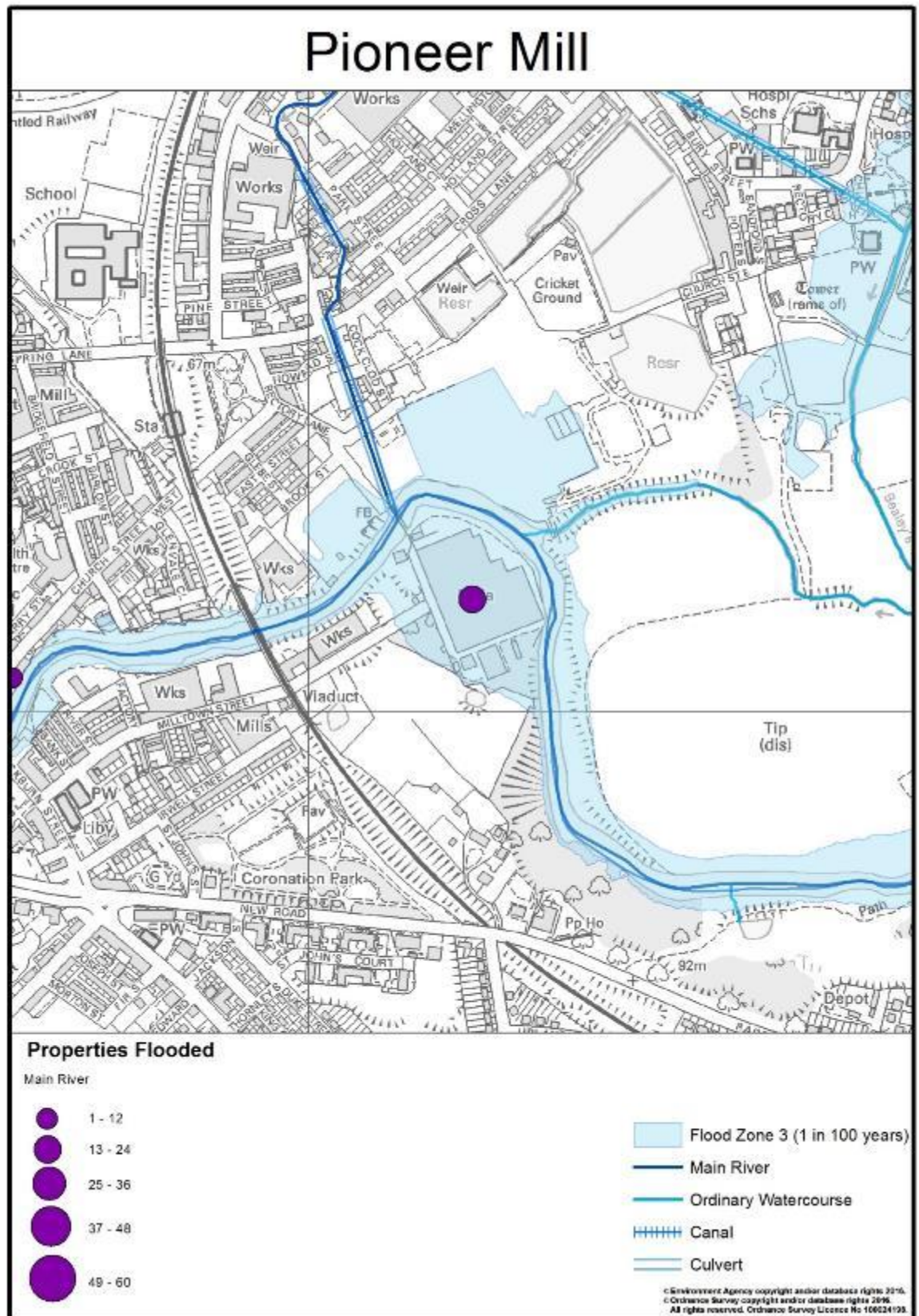
Bury Council

- Road closures were temporarily enforced to protect a number of significant bridges over the river
- A small supply of sandbags were utilised to assist defence and recovery and to redirect minor flows mainly in highway incidents
- A rest centre was established at Castle Leisure Centre
- A clean up operation was carried out over several weeks after the event, which included free skips for severely affected areas/residents until early in the new year.
- Bridges were subsequently inspected and re-opened when river levels fell
- The Council are working with the Environment Agency to develop proposals for a flood defence scheme for the area

United Utilities

- 19 properties flooded from sewers in this area
- Bury wastewater treatment works was flooded and a number of the treatment processes were affected. A recovery plan was agreed with the Environment Agency to bring the works back to normal operation as soon as possible.
- A temporary pipe route has been installed while the pipe bridge in Radcliffe is replaced

Appendix 1.2.2 Pioneer Mill, Radcliffe



Points shown above indicated clusters of reported flooding and do not represent the exact properties or extents that experienced flooding

Description/Main Issues

- The Environment Agency are leading investigations at this location, as flooding was from main river
- Pioneer Mill is on the inside of a meander in the River Irwell which overtopped, flooding it from 3 sides. Pioneer Mill has flooded several times before, the most recent in June 2012
- Maximum flood depth above ground level was 1.76m. Water this deep presents a danger to people
- 19 units flooded (Pioneer Mill is divided into small industrial units)
- Businesses lost power for several weeks
- Milltown Street footbridge, which provides direct access to the Mill, was damaged beyond repair
- Security has become a particular issue since the event, with a number of break-ins occurring
- There have been a number of serious environment health issues concerning waste and fly-tipping
- There are also serious concerns about the structure of the building
- Adjacent to Pioneer Mills on the opposite riverbank, a large section of riverside wall was washed away and extensive flooding occurred on Council owned land

Photos



Picture 13 Flood damaged goods at Pioneer Mill



Picture 14 Flood damage at Pioneer Mill



Picture 15 Structural damage at Pioneer Mill



Picture 16 Milltown Street footbridge damaged beyond repair

Environment Agency

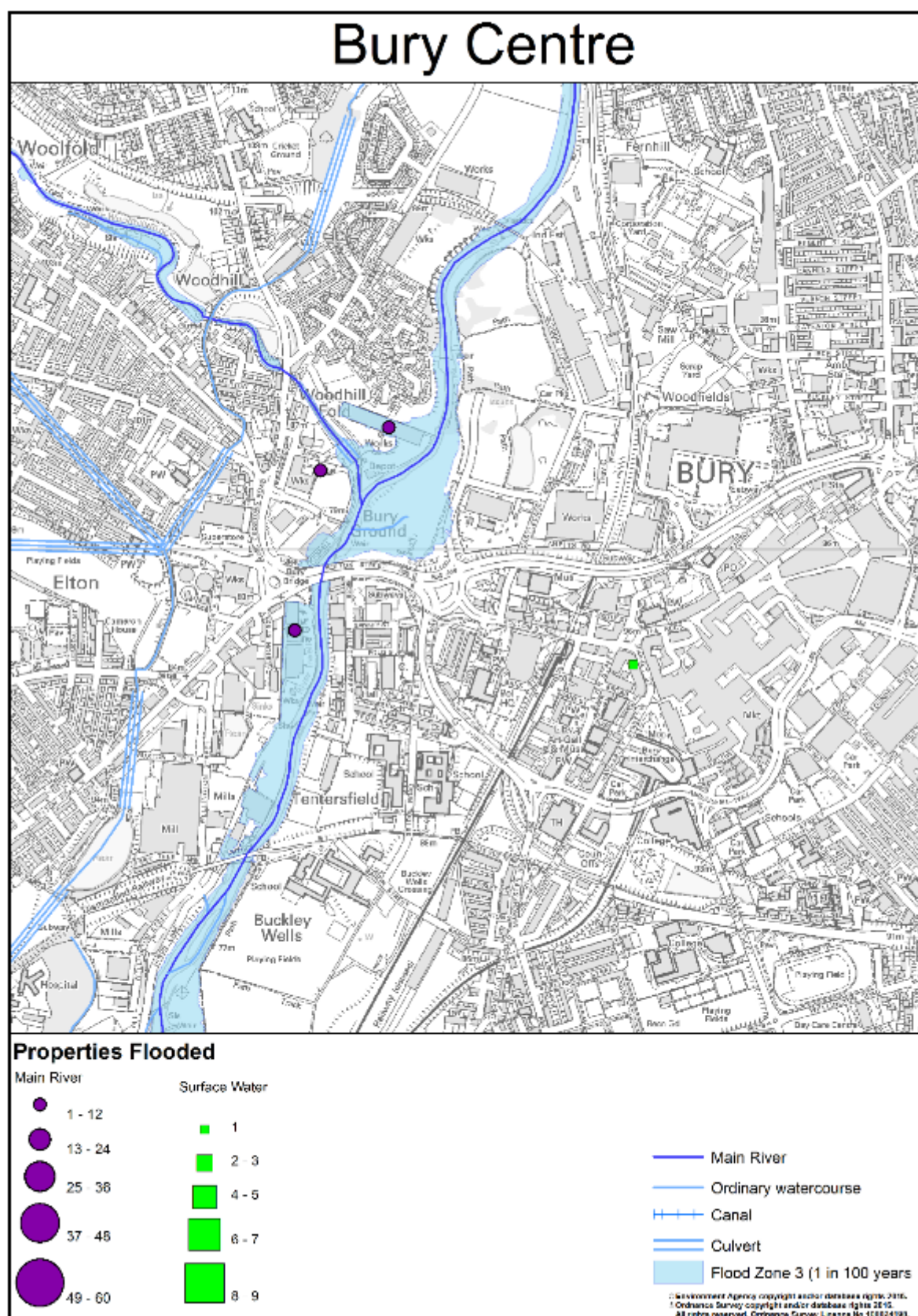
- Rainfall over the Upper Irwell catchment contributed to the flooding. At Haslingden this is estimated to have a likelihood of occurring only once in 50 to once in 160 years. To compound this, the ground was saturated before this rain started to fall
- The level in the River Irwell at Bury is estimated to occur only once in 120 to 180 years and similar at Pioneer Mill
- Properties flooded are in Flood Zone 2 (up to a 1 in 1000 chance of flooding in any given year) and Flood Zone 3 (a 1 in 100 or greater chance of flooding in any given year)
- There is a privately built wall next to Pioneer Mill which may slightly reduce flood frequency here, but this hasn't been built to flood defence standards
- The gauging station at Pioneer Mill recorded the peak river flow but was badly damaged by high flows shortly after this
- The Environment Agency are working with Bury Council to develop proposals for a flood defence scheme for the Radcliffe and Redvales area. However, flood defence improvements are hard to justify at this location due to the poor condition of the building and would require financial contributions
- River Irwell at Pioneer Mills and Parkside Close (GM100) Flood Warning Area is currently being reviewed. Threshold levels will be altered if necessary. These improvements are ongoing and local communities will be involved in the process where appropriate
- As part of the Environment Agency Recovery Programme gravel removal at several locations and repairs to equipment at the Pioneer Mills gauging station is scheduled

Bury Council

- All businesses within Pioneer Mill were visited by Environmental Health and Trading Standards offering hygiene and safety advice and facilitating access to flood relief funding assistance
- Building Control and Environmental Health engaged with the owners of Pioneer Mill to ensure they addressed structural conditions and the accumulations of flood damaged waste dumped on the site
- Slurry, mud and waste deemed to be a potential health risk in the common parts was removed by the Council's highways engineers
- Environmental Health teams helped to clear out rubbish and gave advice to businesses
- Economic Development officers provided advice on business continuity and available grants
- Immediately following the flooding some outlying parts of the structure presented an immediate danger and Building Control required the owners to demolish those sections
- The approved occupation of the main mill building is dependent upon the outcome of a full structural survey of the fabric and the receipt of a satisfactory condition report for the electrical installation and the fire alarm system. This building is divided into three ownerships and as a result some areas are now being repaired faster than others
- The owners have commissioned a full survey of the mill and this has been received by the Council's Building Control. Repair works are currently being carried out

United Utilities

- There was no sewer flooding reported to United Utilities on Boxing Day 2015 in this area



Points shown above indicated clusters of reported flooding and do not represent the exact properties or extents that experienced flooding

Description/ Main Issues

- Bury Council are assisting the Environment Agency in their investigations at a number of locations within Bury Town Centre.
- 6 industrial properties at Bridge Trading Estate were flooded from surface water drains initially and then by the River Irwell seeping through the embankment and river boundary wall. Surface water drainage from the industrial properties outfalls to the river. It is likely that the outfall was ineffective due to river flow levels.
- Occupiers of the industrial units report that there have been previous problems with drains within the area, but there have been no recorded incidents or complaints.
- All units flooded to a depth of 0.6m to 1.0m
- One property had flood proofing measures, including gates, but flooded when water backed up through drains and seeped through walls.
- Flooding also occurred at residential properties in Redvales, close to Bury Town Centre and in the Fairfield area. This flooding was primarily due to surface water and culverted water course issues. Investigations into flooding in the Lakeland Crescent area have so far been inconclusive, but it is likely that a culverted watercourse to the south of the area played a part in the flooding.
- In the wider Bury area, there have been some historical issues with Bealey's and Hutchinsons Goit which the Environment Agency are investigating as part of the Radcliffe and Redvales Flood Management Scheme. There are a small number of properties affected by a culverted watercourse which flows under the Metrolink line and along Warth Fold Road. The culvert is prone to blockage, resulting in flooding of the carriageway which then flows across Radcliffe Road onto farmland. The main flooded area on Boxing Day was north of this area and came from the River Irwell underneath both the Metrolink Bridge at Warth Business Park and behind Derby High School.
- Flooding previously occurred in 2002 when main river capacity exceeded

Photos



Picture 17 River Irwell at Chamberhall



Picture 18 River Irwell at Chamberhall



Picture 19 Debris left at Chamberhall

Environment Agency

- Rainfall over the Upper Irwell catchment contributed to the flooding. At Haslingden this is estimated to have a likelihood of occurring only once in 50 to once in 160 years. To compound this, the ground was saturated before this rain started to fall
- The level in the River Irwell at Bury is estimated to occur only once in 120 to 180 years and similar at the Pioneer Mill river level gauge.
- Properties flooded are in Flood Zone 2 (up to a 1 in 1000 chance of flooding in any given year) and Flood Zone 3 (a 1 in 100 or greater chance of flooding in any given year)
- The raised wall that delayed the onset of flooding from the River Irwell is not a formal flood defence
- Water from the River Irwell also seeped under the boundary wall and emerged from the ground behind it
- A possible future scheme for areas to the South of Bury does not extend this far North
- Environment Agency and Bury Council will jointly explore possible flood resistance and resilience measures to properties at Chamberhall most at risk and possible non-return (flap) valves where surface water drains outfall to the river
- Assessments will be done to see if any areas which flooded from 'main rivers' should be offered a direct Flood Warning service in future, if this is not currently available. Local communities will be involved as opportunities to improve or extend the Flood Warning service are explored
- Part of the riverside wall and public footpath was washed away by the river on the west side of the riverbank, north of Bury Bridge. This footpath has been closed by the Council and repair work will be required.

- A major development is currently underway south of Bury Bridge for Greater Manchester Fire and Rescue Service. The implications downstream of new defences on this site will need to be assessed.

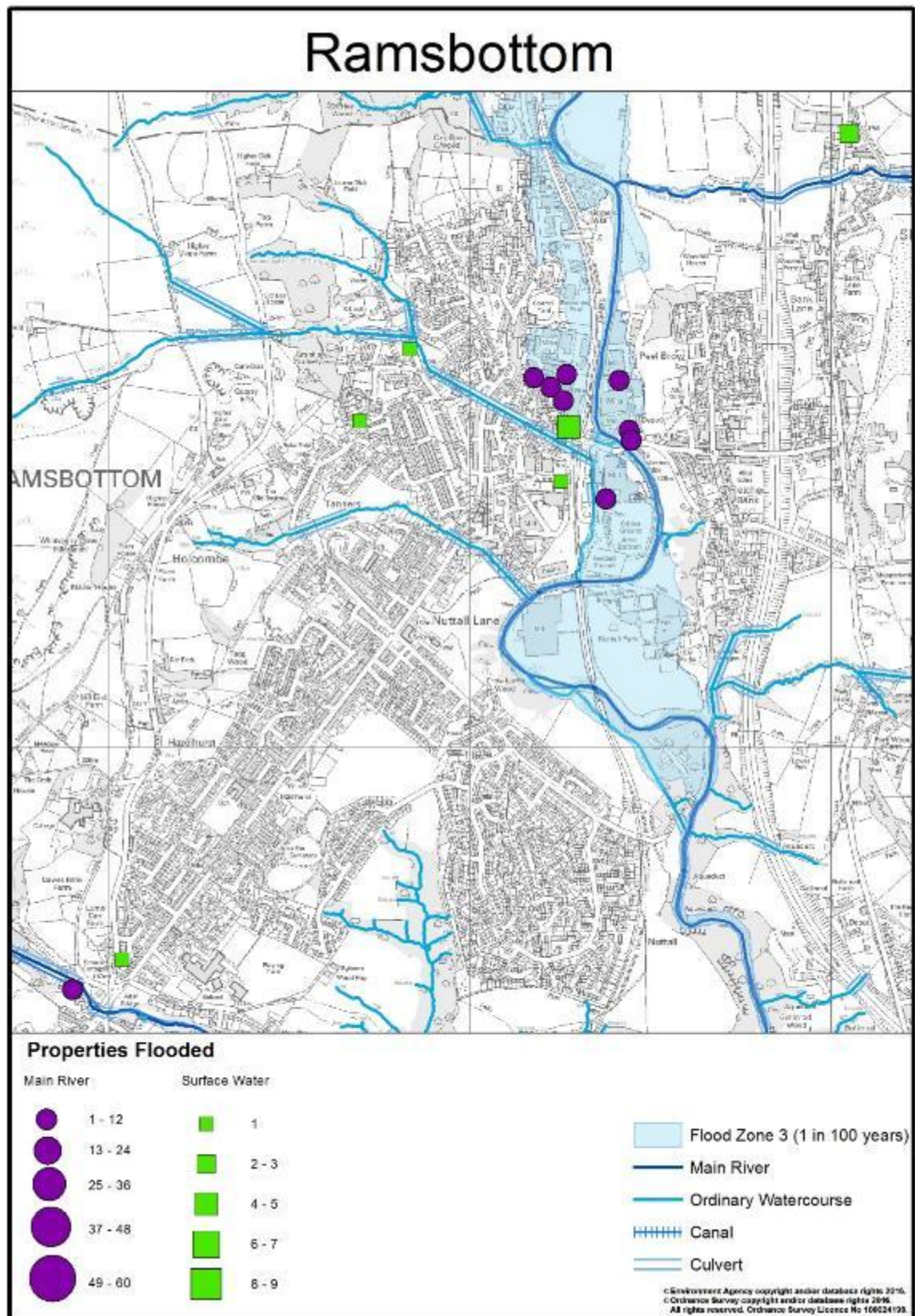
Bury Council

- Residents were given the opportunity to evacuate to the rest centre at Castle Leisure Centre
- Safety inspections were undertaken on the day to all key structures, a number of which were closed until more detailed inspections were possible after water levels subsided
- A number of locations were affected by surface water run-off and/or culvert related flooding, particularly in the Lakeland Crescent area. Investigations are ongoing into these issues with a view to assessing the viability of any improvement works.

United Utilities

- There was no sewer flooding reported to United Utilities on Boxing Day 2015 in this area

Appendix 1.2.4 Ramsbottom



Points shown above indicated clusters of reported flooding and do not represent the exact properties or extents that experienced flooding

Description/Main Issues

- The Environment Agency and Bury Council are working together to carry out investigations at this location as flooding was from main river and surface water:
 - 43 properties flooded from main river
 - 11 properties flooded from surface water
- A raised flood defence wall protects 26 properties in the Kenyon Street area from flooding from the River Irwell. There was visible evidence of seepage through the wall however the wall was not overtopped.
- Ramsbottom suffered flooding from combined sources. The topography of the town is such that surface water is dealt with primarily by culverts which flow from higher ground into the River Irwell. The inundation of culverts and highway drainage led to overland flows along roads meeting river flooding in lower lying areas. Anecdotal evidence from local residents to Environment Agency staff suggest water flowed down roads and ponded behind the Kenyon Street flood defence. Residents also claimed that there are culverts which might have been considered redundant, but suspected to be still outfalling to the river - these would have backed up due to high river levels and contributed to problems at Crow Lane
- Flooding was probably from a complex combination of surface water and the River Irwell later. As surface water drainage relies on outfalls to the river it is likely that the exceptionally high river levels prevented flows from outfalling, adding to the capacity issues. One culvert in particular was damaged at the junction of Crow Lane and Bridge Street, leading to large additional volumes of water flowing down Crow Lane. This damaged was repaired in the days immediately following the Boxing Day event
- Businesses located in the Kenyon Street/Bridge Street area were affected by a combination of river and surface water flooding. Residential properties more remote from the river were largely affected by a combination of surface water run-off and inundated culverts
- The East Lancashire Railway line was closed

Photos



Picture 20 Ramsbottom Level Crossing



Picture 21 Ramsbottom Football club



Picture 22 Damage to canoe by-pass of Bridge Street weir



Picture 23 Kenyon Street basement

Environment Agency

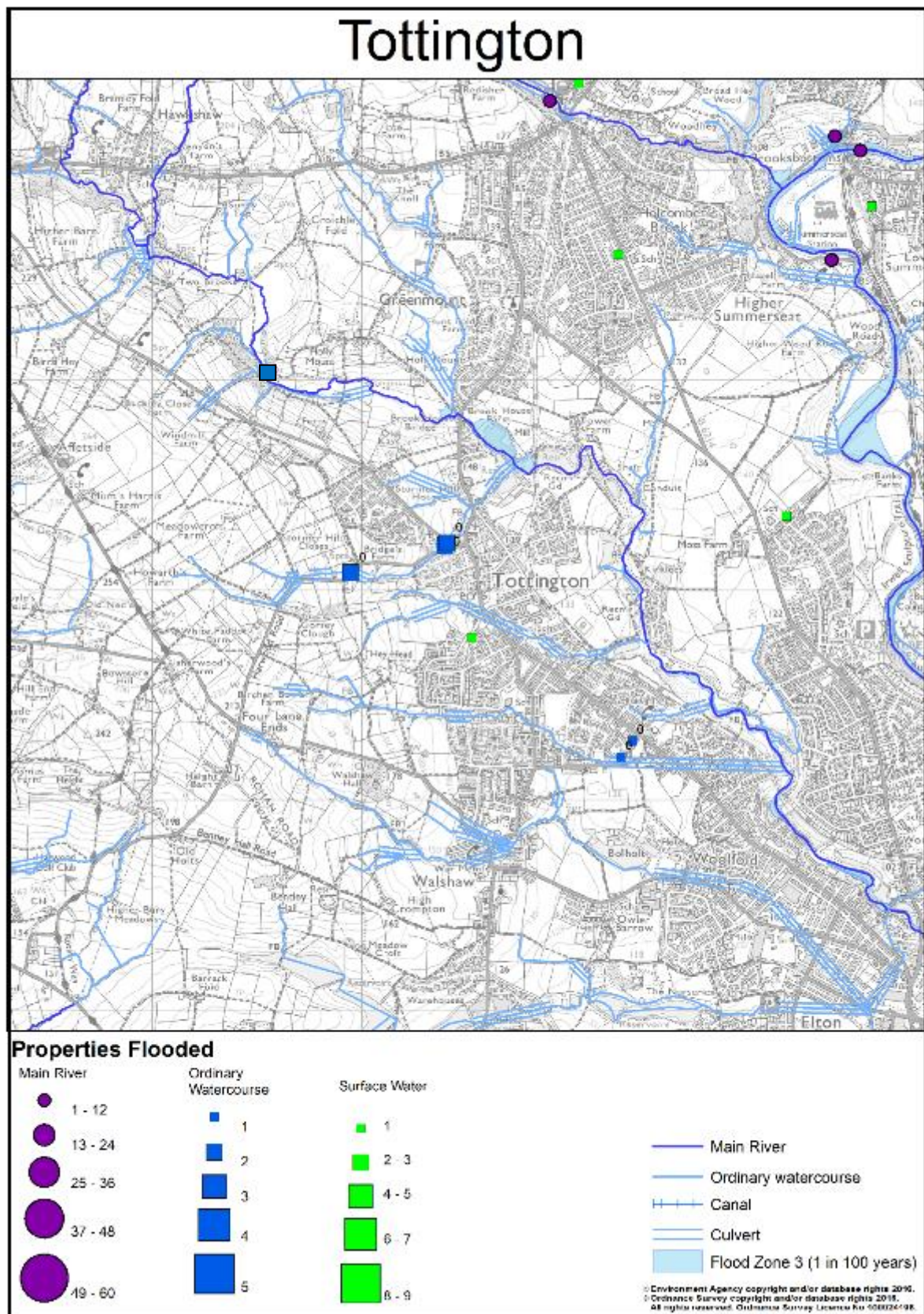
- Rainfall over the Upper Irwell catchment at Haslingden is estimated to have a likelihood of occurring only once in 50 to once in 160 years. To compound this, the ground was saturated before this rain started to fall
- The level at Ramsbottom is estimated to occur only once in 100 to 200 years
- Just upstream of Peel Brow there is a weir in the River Irwell and a flood defence wall between the river and properties on Kenyon Street. Similar defences continue further upstream and some buildings along this reach have been altered to act as flood defences and resist flooding of the buildings themselves
- Raised defences, which protect 26 properties from fluvial flooding, were designed to protect against a flood which may happen about once in 100 years
- The peak river level recorded at a gauging station 270m upstream of Peel Brow was 200mm higher than the defence for Kenyon Street, which starts 200m downstream of the gauging station. It seems possible that the river was briefly just brimming around the crest level of the defence
- The cricket and football grounds flooded from main river
- Properties flooded are in Flood Zone 2 (up to a 1 in 1000 chance of flooding in any given year) and Flood Zone 3 (a 1 in 100 or greater chance of flooding in any given year)
- The Environment Agency is investigating ways of repairing/replacing river channel walls at Nuttall Park which were damaged in the flood
- River Irwell at Ramsbottom (GM7) Flood Warning Area is currently being reviewed and, if necessary, improvements will be made to its coverage and the numbers of properties warned, as well as the threshold levels. These improvements are ongoing and local communities will be involved in the process where appropriate
- As part of the Environment Agency Recovery Programme gravel removal at several locations is scheduled.
- The Environment Agency and Bury Council will work together to look at possible measures to reduce flood risk in the centre of Ramsbottom, but this could be a long-term process
- The Environment Agency are currently in the process of supporting local businesses and residents to form a Flood Action Group to promote self-help and to communicate effectively with the Risk Management Authorities, principally the Environment Agency, Bury Council and United Utilities

Bury Council

- Many road gullies were found to be blocked. There were claims from residents that blocked highway gullies were a factor in the flooding, but many of these were cleared only shortly before the floods and it is more likely that these were blocked by flood debris carried from higher ground
- The Local Authority is seeking quotes for repairs to the canoe pass which bypasses the weir in the River Irwell just upstream of Peel Brow
- Ongoing investigations into a number of culverts
- Road closures were temporarily enforced to protect a number of significant bridges over the river
- A small supply of sandbags were utilised to assist defence and recovery and to redirect minor flows mainly in highway incidents
- A clean up operation was carried out over several weeks after the event, which included free skips for severely affected areas/residents until early in the new year.
- Bridges were subsequently inspected and re-opened when river levels fell
- Nuttall Park was surveyed and made safe

United Utilities

- There was no sewer flooding reported to United Utilities on Boxing Day 2015 in this area



Points shown above indicated clusters of reported flooding and do not represent the exact properties or extents that experienced flooding

Description/Main Issues

- Bury Council are leading investigations at this location, as flooding was from an ordinary watercourse and surface water but there was also flooding to a cellar from groundwater
 - 8 properties flooded from ordinary watercourse
 - 1 property flooded from surface water
- A number of properties lost power
- A riparian culvert at Harwood Road, which was already under investigation due to an ongoing flooding problem again flooded on Boxing Day, leading to substantial flows running down Harwood Road and flooding a number of properties further downstream via overland flows along the carriageway
- The same culvert outfalls to recreational land near Turton Road. This section is prone to silting up during heavy rainfall, although it is unlikely this was a major contributing factor due to the steep gradient at this point
- A culvert at Scobell Street flooded just before the Boxing Day event, in November and December, so was already subject to an investigation. This problem appears to be related to blockage of the inlet to a culverted watercourse by debris on the trash screen. Debris is transported by overland flows over the adjacent land. Water then over topped the bank and flooded the carriageway and ultimately down a public footpath, flooding low lying properties. Subsequent flooding following an improved maintenance regime for the culvert trash screen has identified an issue with the main sewer at this location. It appears that suspected alterations to the sewer have led to hydraulic issues which prevents the length of road from draining correctly, so the over-topping culvert has exacerbated an existing problem.
- Further flooding occurred at Bottoms Hall Cottages

Photos



Picture 24 Scobel Street



Picture 25 Harwood Road

Environment Agency

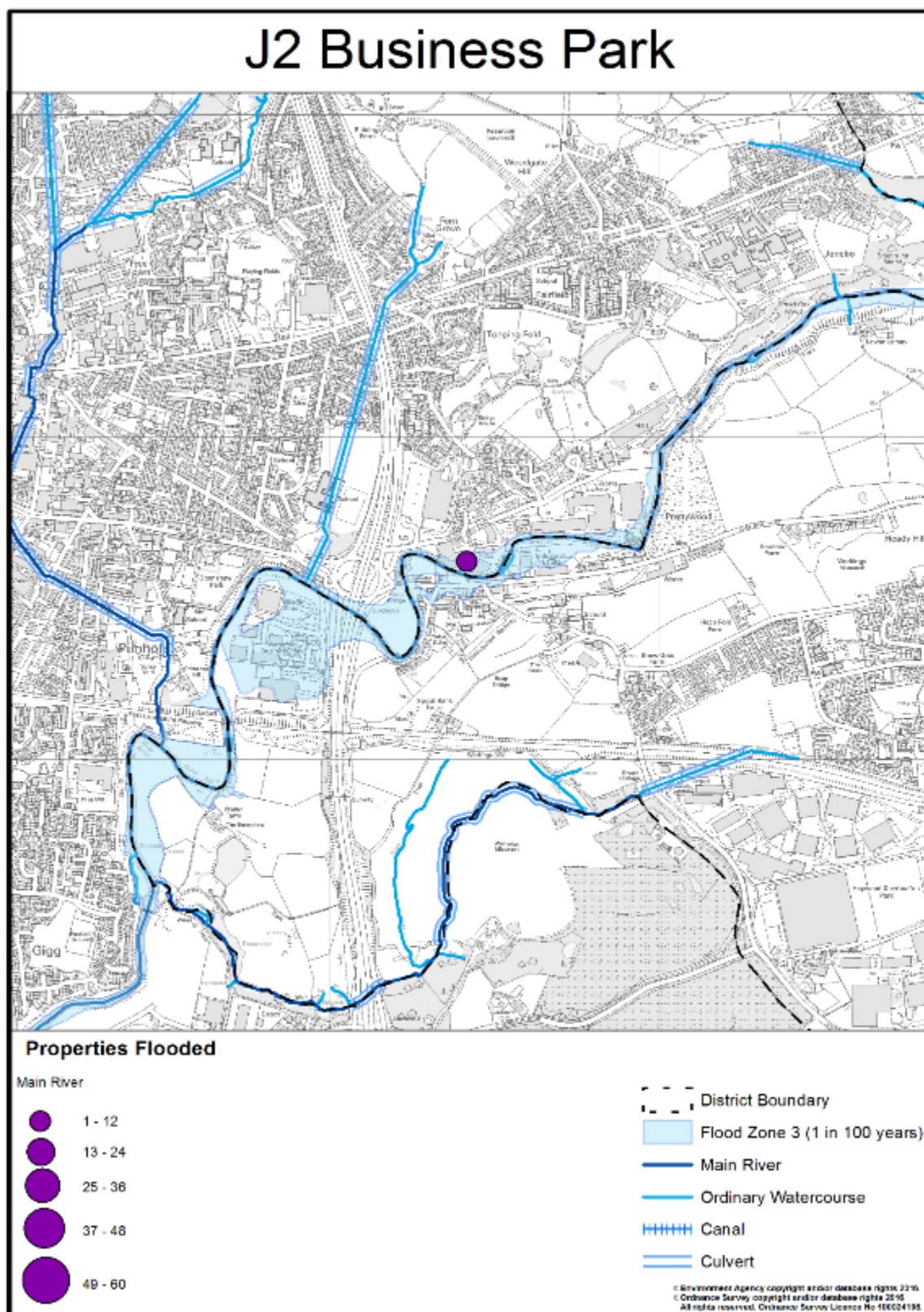
- All Risk Management Authorities are working together to share available information about flood risk from all sources, so it can be better understood and appropriately managed
- Assessments will be done to see if any areas which flooded from 'main rivers' should be offered a direct Flood Warning service in future, if this is not currently available. Local communities will be involved as opportunities to improve or extend the Flood Warning service are explored

Bury Council

- Investigations are ongoing into both sections of the culvert on Harwood Road, as well as a further possible culvert from Cann Street, which may form a branch into it
- The culvert inlet at Scobell Street is on land owned by the Council and is maintained by Grounds Maintenance. Inspection and maintenance regimes have been significantly increased in an attempt to allow early intervention, but it is clear that the speed at which debris is transported will make it difficult to guarantee this alone as a preventative measure. Alternative works are being considered to try and manage the problem more effectively
- A joint investigation involving Bury Council and United Utilities is on-going to determine the degree to which the sewer has been altered and how to deal with the associated hydraulic issues.

United Utilities

There was no sewer flooding reported to United Utilities on Boxing Day 2015 in this area



Points shown above indicated clusters of reported flooding and do not represent the exact properties or extents that experienced flooding

Description/Main Issues

- The Environment Agency are leading investigations at this location as flooding was from the River Roch which is main river
- 10 business properties flooded at this location
- Depths of flooding within commercial properties varied between 0.3 and 1.5m, with 0.5m being fairly typical. Flooding was enough to float cars at one industrial unit
- Some businesses are large and flood damage was very disruptive for those affected. One business leased several units and suffered losses estimated at several £million
- Some businesses may opt to relocate after the flood
- The River Roch overtopped its right bank above a hydropower unit at the weir and flowed down into the units on the industrial park, flooding the businesses and all accesses to them via the shutters and doors
- Water was fast and flooding was sudden, muddy and polluted
- Riparian landowners cleared some debris from the river channel (see photo below) and a disused footbridge following the flood and will consider possible bridge removal (3rd arch was blocked)
- Previous flooding occurred in 1998

Photos



Picture 26 Debris, River Roch



Picture 27 Flooding of commercial properties

Environment Agency

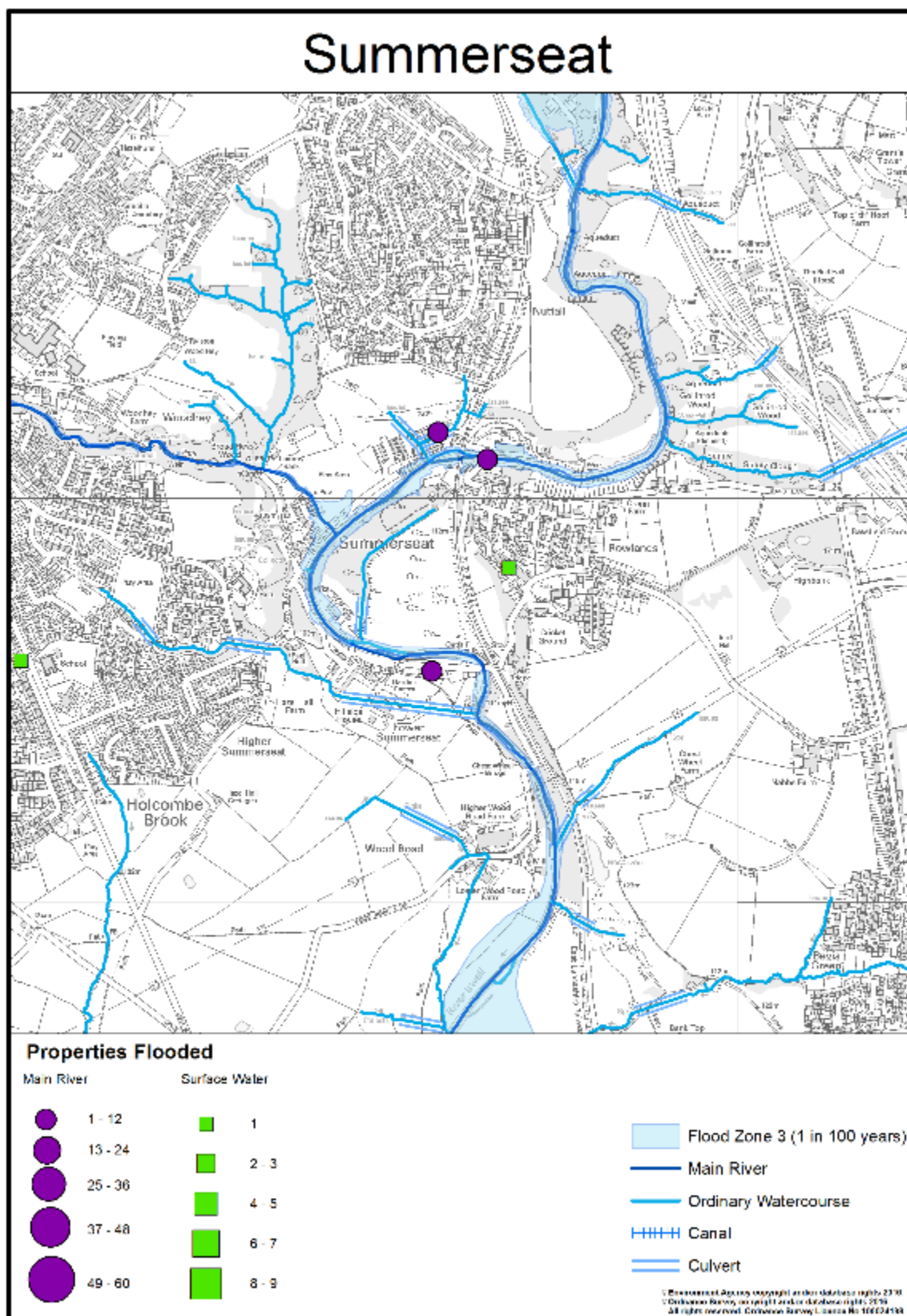
- Recorded rainfall in the River Roch catchment upstream of the J2 Business Park varied according to location. It had an estimated likelihood of occurring between once in 5 years and once in 50 years. Saturated ground will have exacerbated amount and rate of run-off
- The Environment Agency does not have a river level gauge at this location. The nearest is at Rochdale Wastewater Treatment Works about 7km upstream. That gauge recorded the highest level in 22 years of records - 400mm higher than the previous highest recorded in January 2008 and 600mm higher than in 1995
- This river level is estimated to have a likelihood of occurring only once in 50 to 100 years and the flood extent is similar to Flood Zone 3 (a 1 in 100 or greater chance of flooding in any given year)
- There is no direct flood warning service available to this location
- Computer modelling to simulate flood flows and levels from the River Roch in this area is to be improved/updated and is out to tender Summer 2016. Data from this would be used in any future investigations if these can be justified based on priority of this location compared to others
- Some business owners cited alterations to the level of a wall when the hydropower plant was installed as a contributory factor to the flooding. However, Environment Agency staff have looked at this and consider the impact to have been minor - flooding would have occurred with or without these alterations
- Assessments will be done to see if any areas which flooded from 'main rivers' should be offered a direct Flood Warning service in future, if this is not currently available. Local communities will be involved as opportunities to improve or extend the Flood Warning service are explored

Bury Council

- Commercial properties are within Bury Council's area and residential properties (also affected by flooding) are within Rochdale Council's area – see also Heap Bridge Appendix 1.5.4. A Heap Bridge Residents Committee now meets regularly
- Bury's Business Growth Advisor offered information, advice and guidance to businesses in relation to continuity and access to grant funding

United Utilities

- There was no sewer flooding reported to United Utilities on Boxing Day 2015 in this area



Description/Main Issues

- The Environment Agency are leading investigations at this location.
- 11 residential properties were flooded from the River Irwell
- 2 residential properties were flooded from surface water
- The Waterside Restaurant collapsed into the River Irwell. This also caused the partial collapse and subsequent closure of the associated masonry arch bridge. No-one was in the building at the time.
- Traffic continues to be affected as the bridge remains closed to traffic. Traffic has been re-routed through the village with temporary traffic lights in use.

Photos



Picture 28 Debris from the collapse of the Waterside restaurant, Summerseat



Picture 29 Debris from the collapse of the Waterside restaurant, Summerseat



Picture 30 Debris from the collapse of the Waterside restaurant, Summerseat

Environment Agency

- All Risk Management Authorities are working together to share available information about flood risk from all sources and engage with communities, so the flood risk can be better understood and appropriately managed

Bury Council

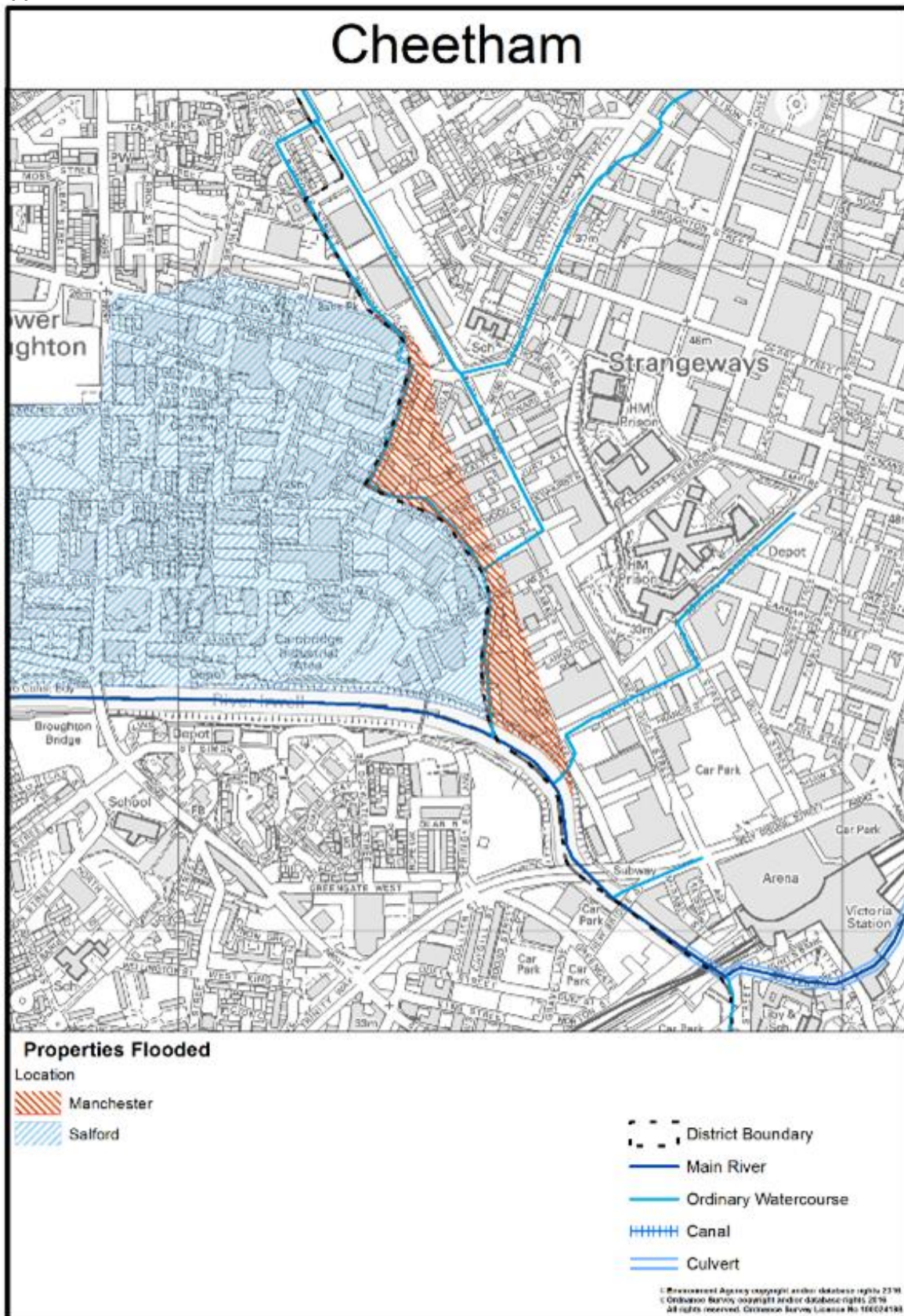
- The remaining parts of the building were demolished and removed from site, but the bridge has been rendered unsafe for vehicle use as the building originally served as the parapet to one side. The bridge is now open to pedestrians only. Plans are on-going to provide a long-term repair solution, which may include betterment, subject to land ownership and other physical constraints. All vehicular traffic has been re-routed, but the alternative route around the village is not acceptable as a long term solution

United Utilities

- There was no sewer flooding reported to United Utilities on Boxing Day 2015 in this area.

Appendix 1.3 – Manchester Local Flood Information

Appendix 1.3.1 - Cheetham



Points shown above indicated clusters of reported flooding and do not represent the exact properties or extents that experienced flooding

Description/Main Issues

- The Environment Agency are leading investigations at this location as flooding was from the River Irwell which is main river
- Flooding occurred when high levels of rainfall caused the River Irwell to overtop raised defences and natural bank levels and exceed the capacity of the surface water network
- Up to 47 non-residential properties are within the overall area affected by flooding - 27 are known to have flooded internally

Environment Agency

- The closest rain gauges to Cheetham is at Heaton Park, Prestwich. The gauge at Holden Wood, near Haslingden is also relevant in giving an indication for the upper Irwell catchment. Recorded rainfall is estimated to have a likelihood of occurring once in up to 50-120 years at Holden Wood and up to 5 years at Heaton Park. This was made more extreme by the saturation of the catchment before any of this rain fell

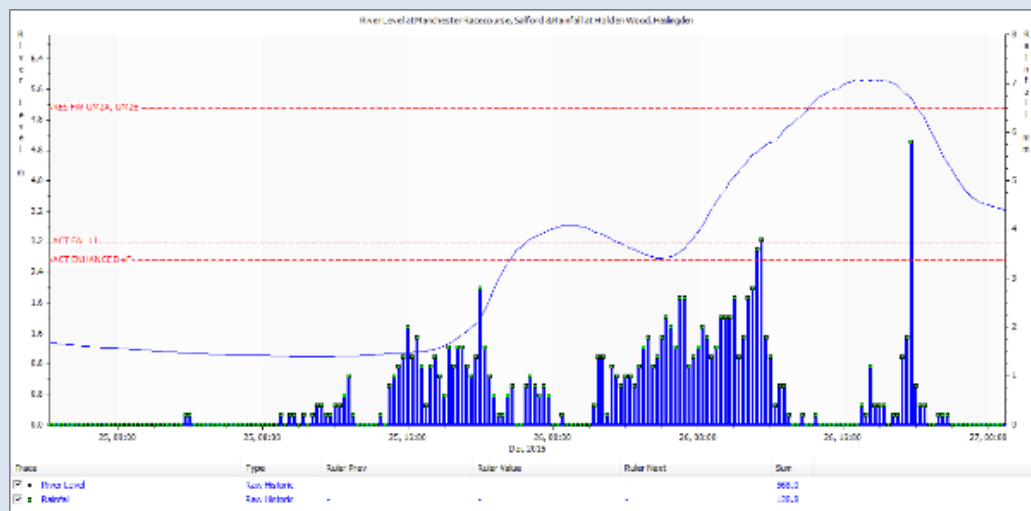


Figure 9 River Irwell levels at Salford (near to Cheetham) and the corresponding rainfall in the upper catchment

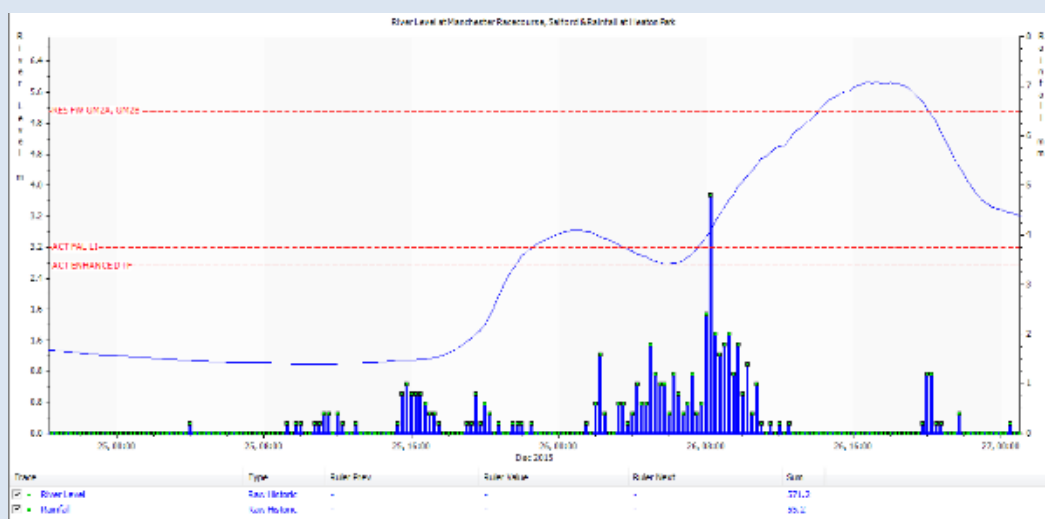


Figure 10 River Irwell at Salford (near to Cheetham) and the corresponding rainfall in the lower catchment

- The Environment Agency's gauge in the River Irwell at Manchester Racecourse recorded a river level of 5.67m (29.83 AOD), which is 1.3m higher than any other reading in its 75 years of recording
- This river level is estimated to have a likelihood of occurring only once in 100 to 150 years
- Properties flooded above ground floor are in Flood Zone 2 (up to a 1 in 1000 chance of flooding in any given year) and Flood Zone 3 (a 1 in 100 or greater chance of flooding in any given year)

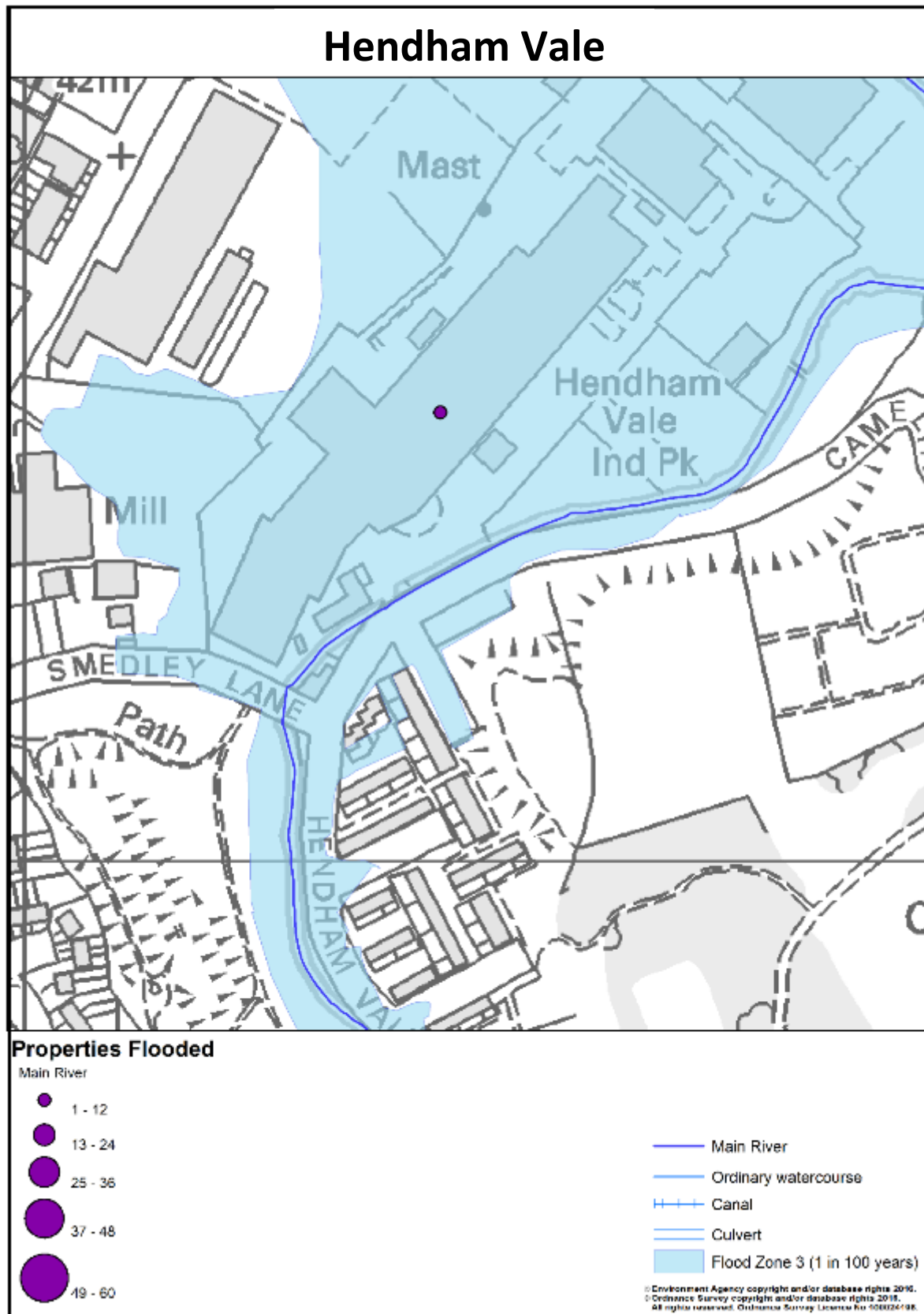
- A Flood Warning was issued for the River Irwell at Salford – area B Flood Warning Area
- The Environment Agency is nearing completion of a second flood storage basin at Castle Irwell. This, combined with the existing basin at Lower Kersal, will reduce flood risk to properties at Cheetham – for more details see Appendix 1.6.1 for Lower Broughton
- River Irwell at Salford Area B (GM2B) Flood Warning Area is currently being reviewed. Threshold levels will be altered if necessary. These improvements are ongoing and local communities will be involved in the process where appropriate

Manchester City Council

- All Risk Management Authorities are working together to share available information about flood risk from all sources and engage with communities, so the flood risk can be better understood and appropriately managed

United Utilities

- There was no sewer flooding reported to United Utilities on Boxing Day 2015 in this area



Points shown above indicated clusters of reported flooding and do not represent the exact properties or extents that experienced flooding

Description/Main Issues

- The Environment Agency are leading investigations at this location as flooding was from the River Irk which is main river
- Flooding occurred when high levels of rainfall caused the River Irk to overtop natural bank levels
- Internal property flooding to 10 businesses, plus external damage to a further 3. Principal damage was to furniture, carpets, equipment, machinery and stock
- Internal flood depths of greater than 600 mm were recorded
- Flood waters caused damage to a river retaining wall adjacent to footpath at Hendham Vale which has now partially collapsed
- Flooding previous occurred in 2000

Photo



Picture 31 Damage to the footpath along the River Irk at Hendham Vale

Environment Agency

- Rain gauges relevant to Hendham Vale include Heaton Park and Royton. The rainfall recorded during this event is estimated to have a likelihood of occurring once in up to 6 years. This was made more extreme by the saturation of the catchment before any of this rain fell
- The Environment Agency's gauge in the River Irk at Collyhurst Weir recorded a river level of 1.15m (30.35 AOD), the highest reading in its 20 years of recording.
- This river level is estimated to have a likelihood of occurring only once in 15 to 40 years
- Properties flooded above ground floor are in Flood Zone 3 (a 1 in 100 or greater chance of flooding in any given year)
- A Flood Warning was issued for the River Irk at Cheetham Flood Warning Area
- Assessments will be done to see if any areas which flooded from 'main rivers' should be offered a direct Flood Warning service in future, if this is not currently available. Local communities will be involved as opportunities to improve or extend the Flood Warning service are explored
- Local Environment Agency teams have made bids for additional funding from central government which is to be made available after the winter floods. Funding for Hendham Vale, if available, would be used to review defences and possible improvements.

Manchester City Council

- Repairs/reconstruction of a collapsed river retaining wall and footpath have been organised for August to October 2016
- All Risk Management Authorities are working together to share available information about flood risk from all sources and engage with communities, so the flood risk can be better understood and appropriately managed

United Utilities

- There was no sewer flooding reported to United Utilities on Boxing Day 2015 in this area.

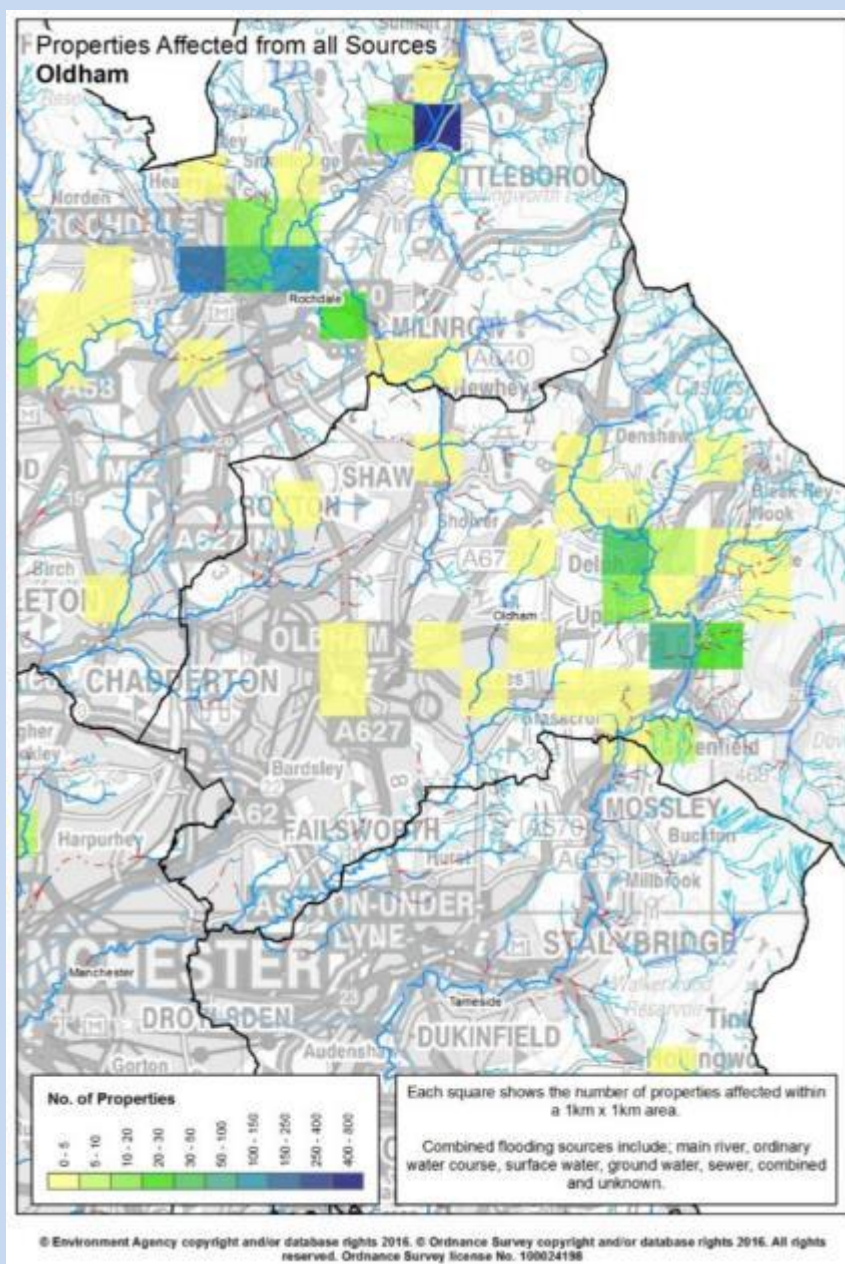
Appendix 1.4 – Oldham Local Flood Information

Oldham borough summary

A total of 123 properties were internally flooded in the Oldham Borough. Worst affected were Delph where 42 properties were flooded. At Uppermill, 35 properties flooded.

Other clusters of flooding were seen at Shaw, a total of 11 (surface water), Grasscroft (7 surface water and 2 ordinary water course), Diggle 4 (surface water and ordinary watercourse), Greenfield 3 (surface water), Lees 3 (surface water), Austerlands 1 (surface water), Royton 2 (ordinary watercourse) and many other areas in Oldham (all statistics exclude cellars unless they are habitable accommodation).

A United Utilities received reports of 3 properties flooding from sewers in Oldham.



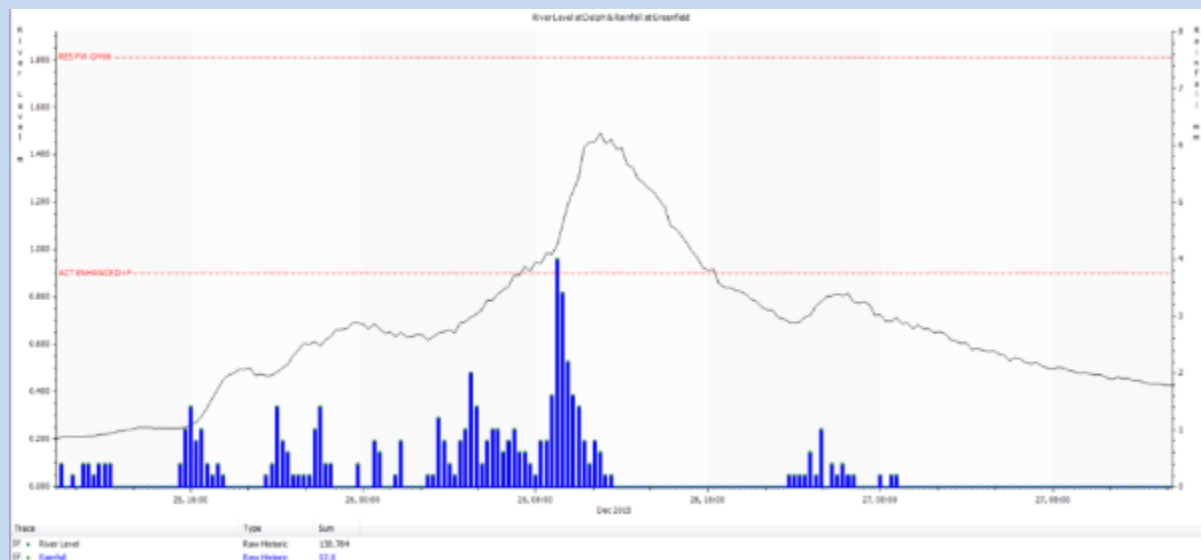


Figure 11 River Tame levels at Delph and the corresponding rainfall

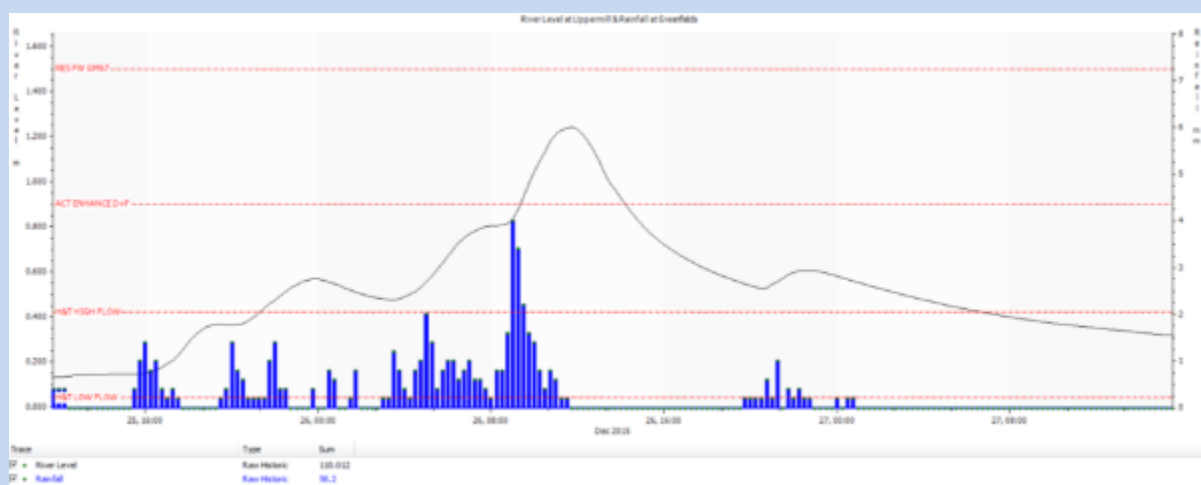


Figure 12 River Tame levels at Uppermill and the corresponding rainfall

The graphs above showed how the River Tame at Delph and Uppermill rose and responded in response to rainfall.

Representative rain gauge readings are:

- Greenfield – 51.8mm/24hrs

River levels:

- 1.242m at Uppermill (156.79m AOD), which is higher than any other reading in its 17 years of records

Oldham Metropolitan Borough Council provided sandbags to affected residents, undertook gully clearance and blockage removal, vegetation clearance, culvert clearance and carried out post event investigations to identify the source of the flooding. They also worked in partnership with other risk management authorities and responders during the event.

Grants or funding

That Oldham Council has received an award of £750,000 from the Department for Transport's 2015/16 Local Highway Flood Damage Funding for urgent capital and maintenance works to reduce the effects of flooding

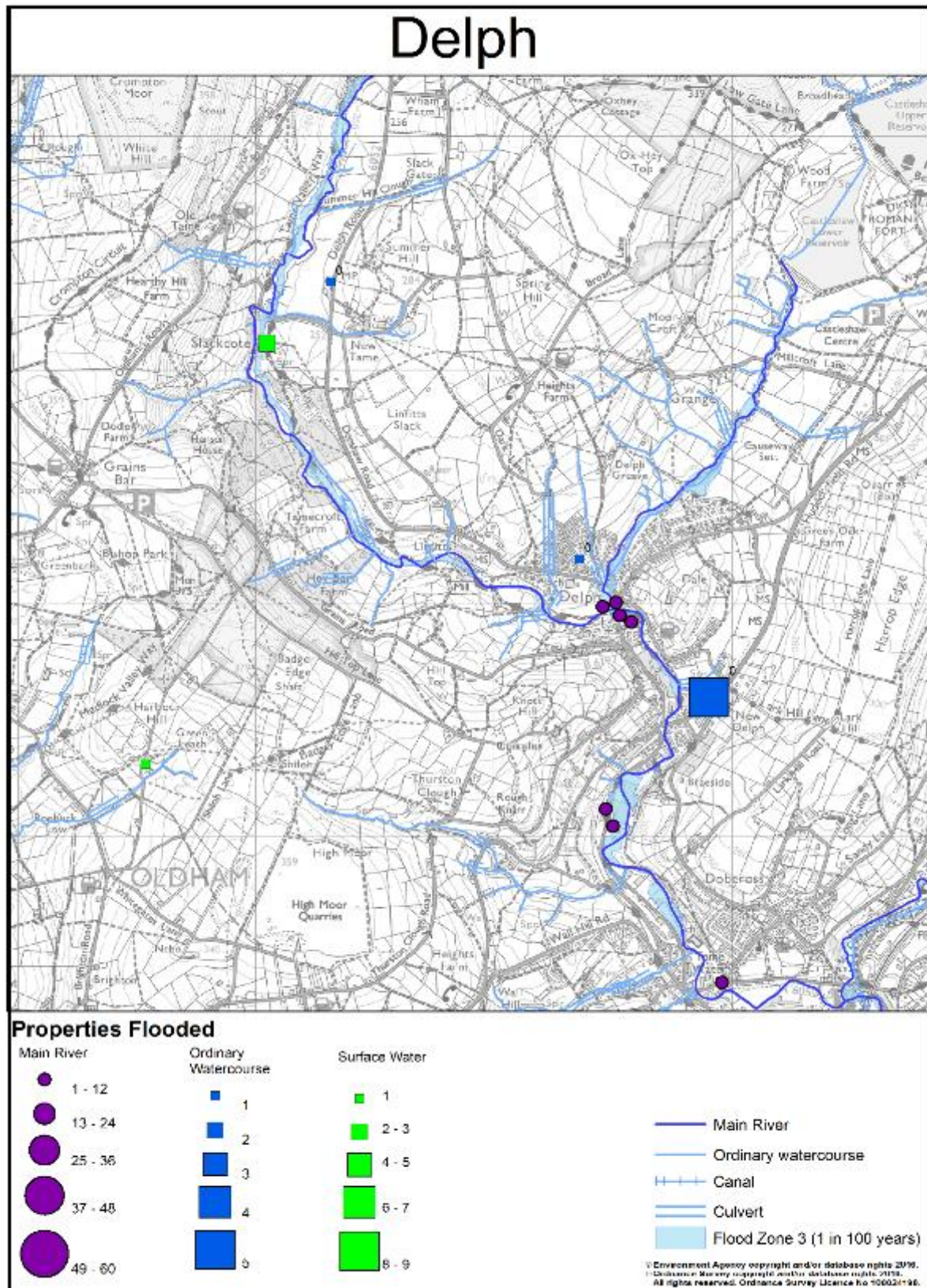
Future flood defence schemes

Future schemes which have been confirmed include the following:

- Delph New Road, Delph - Flood Mitigation Scheme
- Pencil Brook at Duchess Street, Shaw - Surface Water Flood Mitigation
- Broomes Park Flood Alleviation Scheme, Chadderton - Surface Water Flood Mitigation
- Stoneleigh Park - Flood Mitigation Scheme
- Borough-wide Trash Screens Cleaning and Replacement
- Uppermill Culvert - Desilting works and culvert repairs / improvement
- Burnedge Lane, Grasscroft - Flood Mitigation Scheme

3 of the above schemes are currently undergoing EA's project approval process.

Appendix 1.4.1 Delph



Points shown above indicated clusters of reported flooding and do not represent the exact properties or extents that experienced flooding

Description/Main Issues

- The Environment Agency and Oldham Council are working in partnership to lead investigations at this location as flooding was from multiple sources.
- **Internal** property flooding to 42 properties where, 7 were businesses and 35 were residential properties
 - 16 properties flooded from the River Tame.
 - 9 properties flooded from ordinary water courses
 - 17 properties flooded due to surface water
- Flooding occurred when high levels of rainfall caused the River Tame to overtop natural bank levels
- Flooding was exacerbated at the location of the bridge at High Street, where flow was restricted by the bridge causing water levels to rise and come out of bank
- At the location of Delph New Road the restriction of the culvert under adjacent industrial units caused water to back up and flow on to the road, where it follows the topography of the land back toward the river. Flooding at this location was also exacerbated by surface water
- Hull Brook also came out of bank causing flooding to adjacent gardens
- Surface water flooding also affected the area
- Surface water flooding was mainly due existing road gullies surcharging as they were over capacity
- Numerous ordinary watercourses also contributed to flooding in this area
- Saddleworth Parish Council are currently working with residents with support from the Environment Agency to develop a flood action plan and to promote self-help and to communicate effectively with the Risk Management Authorities, principally the Environment Agency and Oldham Council

Photo



Picture 32 Properties flooded in Delph (Courtesy of Saddleworth News)



Picture 33 Industrial units flooded on Delph New Road from the River Tame



Picture 34 Industrial units flooded from the River Tame



Picture 35 Debris showing the extent of the water that came out of channel at the location of the bridge on High Street, Delph



Picture 36 The bridge at High Street, Delph – Where Hull Brook meets the Tame (Hull Brook coming in from the right)



Picture 37 Green Ash, Denshaw Road, Delph



Picture 38 Property at Green Ash, Delph



Picture 39 High Street/King Street, Delph looking from the bridge toward Brookside Terrace

Environment Agency

- The closest rain gauge to Delph is Greenfield which recorded a rainfall level of 51.8mm/24hrs . The rainfall recorded during this event is estimated to have a likelihood of occurring once in up to 2 years. This was made more extreme by the saturation of the catchment before any of this rain fell
- The Environment Agency's gauge at Uppermill (downstream of Delph) at recorded a river level of 1.24m (156.79AOD), the highest reading in its 17 years of recording
- This river level is estimated to have a likelihood of occurring only once in 50 to 100 years
- Properties flooded from main river are in FZ3 (a 1 in 100 or greater chance of flooding in any given year)
- The Environment Agency carried out site visits and community engagement following the event
- Computer simulations of flood flows and levels are being produced and will include the Boxing Day conditions
- This location is included within a proposed strategic assessment of flood risk issues and options across the River Tame catchment around Saddleworth which is expected to complete in late 2016
- The strategic assessment will provide possible options for improvements. Further work by the Environment Agency, in collaboration with Oldham Council, is likely to follow, but this will be subject to justification and available funding
- River Tame at Delph (GM66) Flood Warning Area is currently being reviewed and, if necessary, improvements will be made to its coverage and the numbers of properties warned, as well as the threshold levels. These improvements are ongoing and local communities will be involved in the process where appropriate

Oldham Metropolitan Borough council

Oldham MBC carried out the following action during and after the flood event:

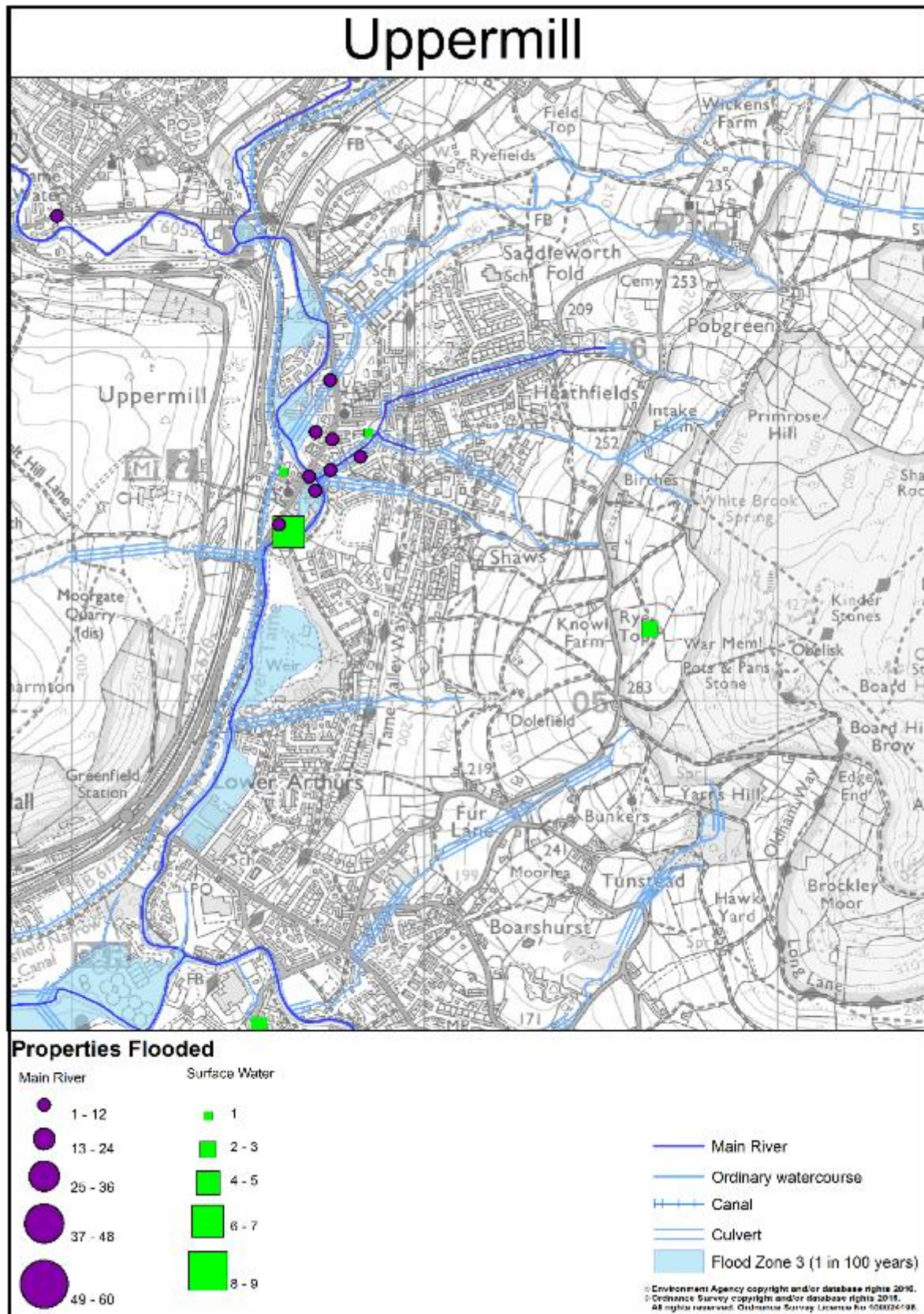
- Sandbags were made available to residents who required them, but residents were made aware that the supply of sand bags would not be repeated in the future as Oldham Council has a policy that it will not usually supply sandbags to property owners, occupants or businesses
- Carried out gully clearance at identified hotspots
- Cleared a blocked culvert which was causing flooding to properties on Bleak Hey Nook Lane

- Notified the Environment Agency during the event and carried out post event investigations into the causes of the flooding

United Utilities

- There were 3 incidents of sewer flooding reported to United Utilities on Boxing Day 2015 in this area

Appendix 1.4.2 Uppermill



Points shown above indicated clusters of reported flooding and do not represent the exact properties or extents that experienced flooding

Description/Main Issues

The Environment Agency are leading investigations at this location as flooding was from the River Tame which is main river

- Internal property flooding to 35 properties where 12 were businesses and 23 were residential properties
 - 12 properties flooded from the River Tame
 - 21 properties flooded due to surface water
 - 2 residential properties flooded from ordinary watercourses
- Post event investigation has identified that there was water seepage through the channel wall at the site of the cafe on the bridge at High Street. The channel banks were not overtopped at School Street
- Mechanism for flooding to property on Moorgate Street is unclear. RMAs will continue to work together to understand the flooding mechanism in this location
- Surface water and ordinary watercourse flooding also affected the area. Although in some cases the incidence or extent of such flooding was masked by the fluvial flood water event
- Surface water flooding was mainly due existing road gullies surcharging as their capacity was exceeded. Post-flooding investigations identified that high levels of silt in surface water culvert contributed to surcharging of gullies
- Saddleworth Parish Council are currently working with residents with support from the Environment Agency to develop a flood action plan and to promote self-help and to communicate effectively with the Risk Management Authorities, principally the Environment Agency and Oldham Council
- The level recorded by the gauge in the River Tame on Boxing Day was actually several metres below the recorded high of 13th July 1872, but the High Street bridge has been rebuilt since it was blocked by a tree in the 1872 flood.

Photo



Picture 41 Debris in channel – Uppermill



Picture 40 Uppermill Park



Picture 42 High Street



Picture 43 Station Road/ Back of Lee Street



Picture 44 River Tame, Uppermill



Picture 45 School Street, Uppermill



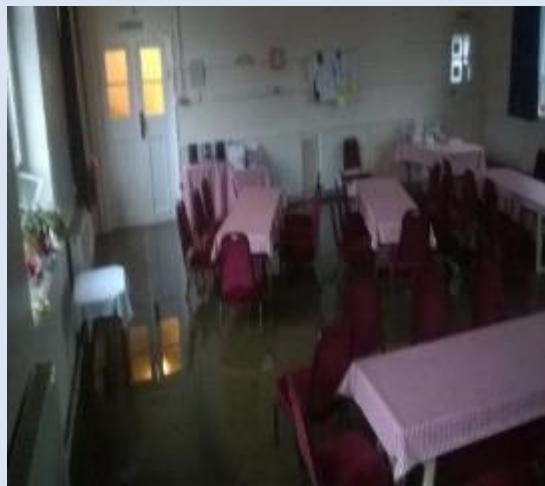
Picture 46 School Street, Uppermill



Picture 47 Church, High Street, Uppermill



Picture 48 High Street, Uppermill



Picture 49 Inside of Church, High Street

Environment Agency

- The rainfall recorded during this event is estimated to have a likelihood of occurring once in up to 2 years. This was made more extreme by the saturation of the catchment before any of this rain fell
- The Environment Agency's gauge at Uppermill recorded a river level of 1.24m (156.79AOD), the highest reading in its 18 years of recording
- This river level is estimated to have a likelihood of occurring only once in 50 to 100 years
- Properties flooded are in Flood Zone 3 (a 1 in 100 or greater chance of flooding in any given year)
- The Environment Agency carried out site visits and community engagement following the event
- Repairs were commenced following the collapse of a culvert on Pickhill Brook. However, there have then be further collapses on other lengths, so construction of a replacement culvert which follows a diversion route is ongoing (July 2016)
- Computer simulations of flood flows and levels are being produced and will include the Boxing Day conditions
- This location is included within a proposed strategic assessment of flood risk issues and options across the River Tame catchment around Saddleworth which is expected to complete in late 2016
- The strategic assessment will provide possible options for improvements. Further work by the

Environment Agency, in collaboration with Oldham Council, is likely to follow, but this will be subject to justification and available funding

- River Tame at Uppermill (GM67) Flood Warning Area is currently being reviewed and, if necessary, improvements will be made to its coverage and the numbers of properties warned, as well as the threshold levels. These improvements are ongoing and local communities will be involved in the process where appropriate

Oldham Metropolitan Borough council

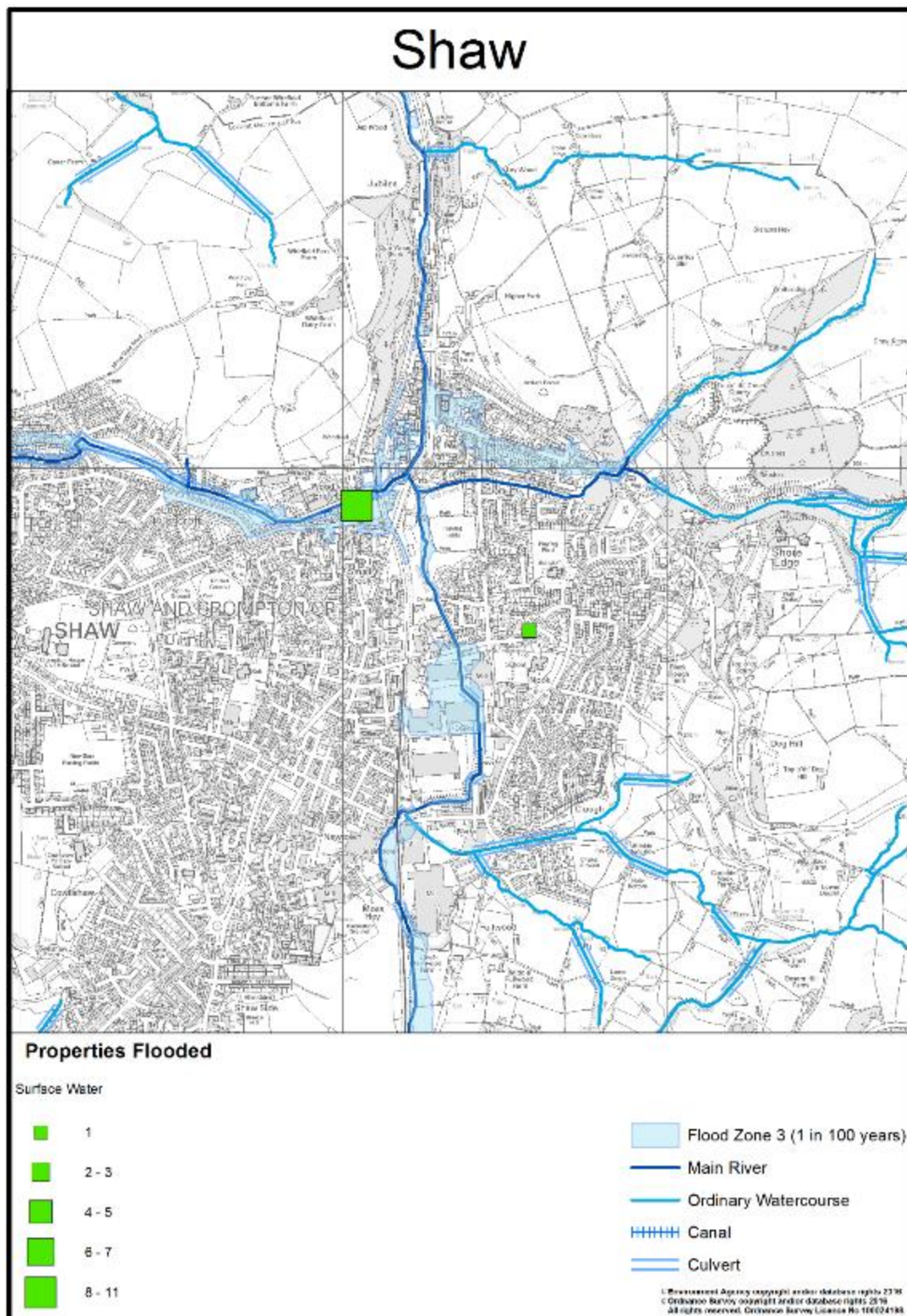
Oldham MBC carried out the following action during and after the flood event:

- Sandbags were made available to residents who required them, but they were made aware that the supply of sand bags would not be repeated in the future as Oldham Council has a policy that it will not usually supply sandbags to property owners, occupants or businesses
- Carried out gully clearance on identified hotspots
- Notified the Environment Agency during the event and carried out post event investigations into the causes of the flooding

United Utilities

- There were no incidences of sewer flooding reported to United Utilities on Boxing Day 2015 in this area

Appendix 1.4.3 Shaw



Points shown above indicated clusters of reported flooding and do not represent the exact properties or extents that experienced flooding

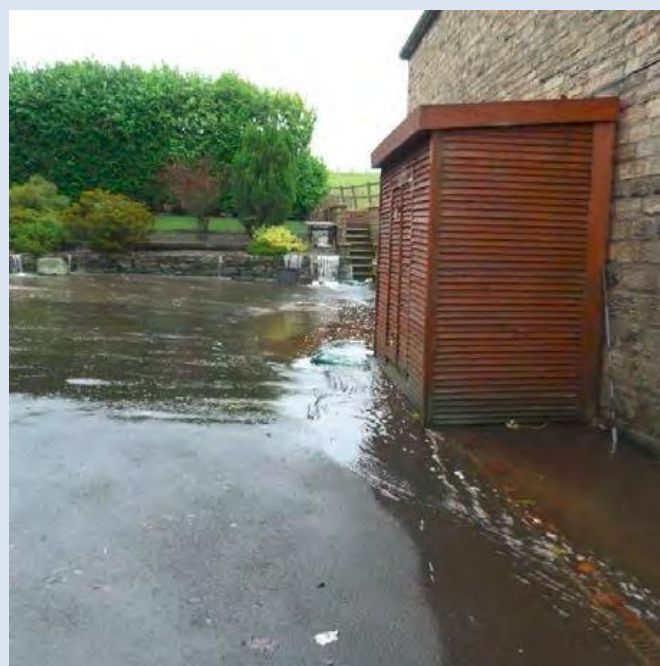
Description/Main Issues

- Oldham MBC are leading investigations at this location
- Internal property flooding to 11 properties
- All 11 properties were flooded from surface water
- Surface water flooding was mainly due to lack of capacity of surface water culverts and existing road gullies surcharging

Photo



Picture 50 Jubilee Road



Picture 51 Ripponden Road



Picture 52 Smallbrook RoagRoad



Picture 53 Dunwood Park

Environment Agency

- Flooding at this location was caused by surface water, therefore Oldham MBC are leading investigations.
- Flooded properties are within Flood Zones 1 (less than a 1 in 1000 chance of flooding in any given year) and Flood Zone 3 (a 1 in 100 or greater chance of flooding in any given year)
- Assessments will be done to see if any areas which flooded from 'main rivers' should be offered a direct Flood Warning service in future, if this is not currently available. Local communities will be involved as opportunities to improve or extend the Flood Warning service are explored

Oldham Metropolitan Borough council

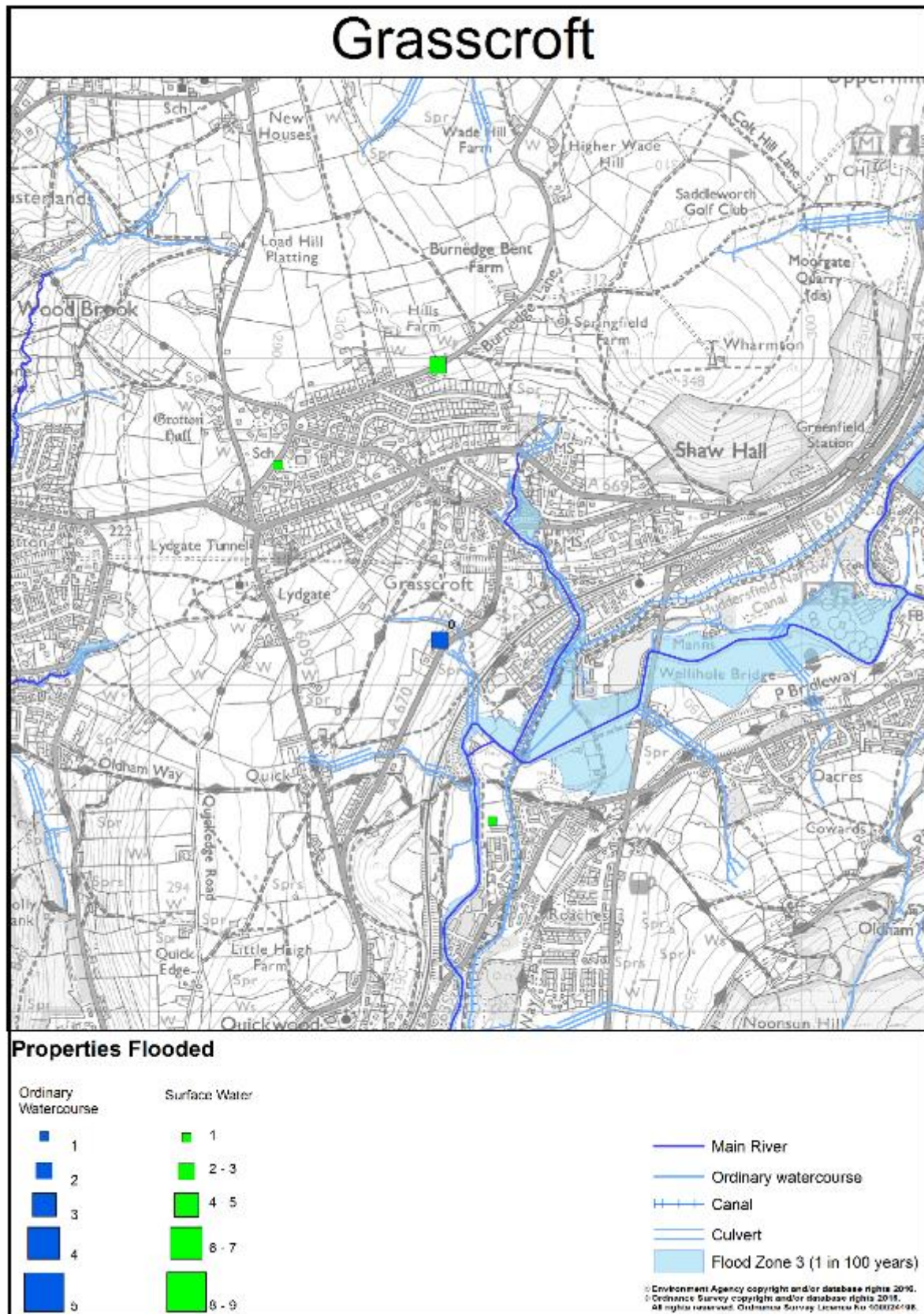
Oldham MBC carried out the following action during and after the flood event:

- Cause of flooding was investigated
- Vegetation adjacent to highway was cleared

- Blocked gullies were cleared

United Utilities

- There were no incidences of sewer flooding reported to United Utilities on Boxing Day 2015 in this area



Points shown above indicated clusters of reported flooding and do not represent the exact properties or extents that experienced flooding

Description/Main Issues

- Oldham MBC are leading investigations at this location as flooding resulted from surface water
- Internal property flooding to 2 properties:
 - 2 properties flooded from ordinary water courses
 - 7 properties flooded from surface water
- Surface water flooding was mainly due to existing road gullies surcharging as their capacity was exceeded
- Saddleworth Parish Council are currently working with residents with support from the Environment Agency to develop a flood action plan and to promote self-help and to communicate effectively with the Risk Management Authorities, principally the Environment Agency and Oldham Council

Photos



Picture 54 Coverhill Road



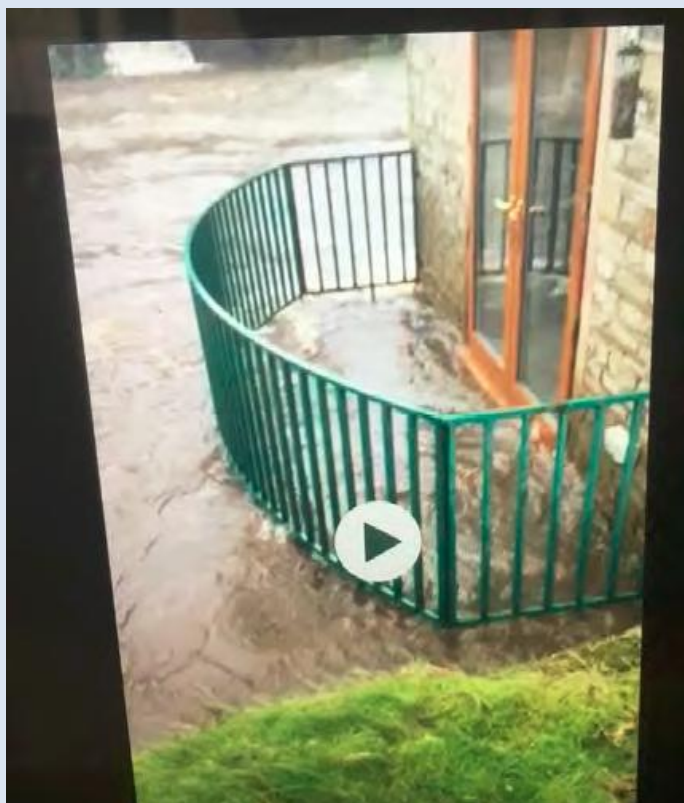
Picture 55 Chew Valley Road (Courtesy of Saddleworth) [Newsham Chronicle]



Picture 56 Mossley Road



Picture 57 Mossley Road Flooding On Road



Picture 58 Balcony and house flooding at Wright Mill adjacent to River Tame



Picture 59 House flooded close by to Wright Mill Just off Calf Lane

Environment Agency

- Flooding at this location was caused by surface water, therefore Oldham MBC are leading investigations
- Computer simulations of river flood flows and levels are being produced and will include the Boxing Day conditions
- This location is included within a proposed strategic assessment of flood risk issues and options across the River Tame catchment around Saddleworth which is expected to complete in late 2016
- Assessments will be done to see if any areas which flooded from 'main rivers' should be offered a direct Flood Warning service in future, if this is not currently available. Local communities will be involved as opportunities to improve or extend the Flood Warning service are explored

Oldham Metropolitan Borough council

Oldham MBC carried out the following action during and after the flood event:

- Cause of flooding was investigated
- Vegetation adjacent to highway was cleared
- Blocked gullies were cleared

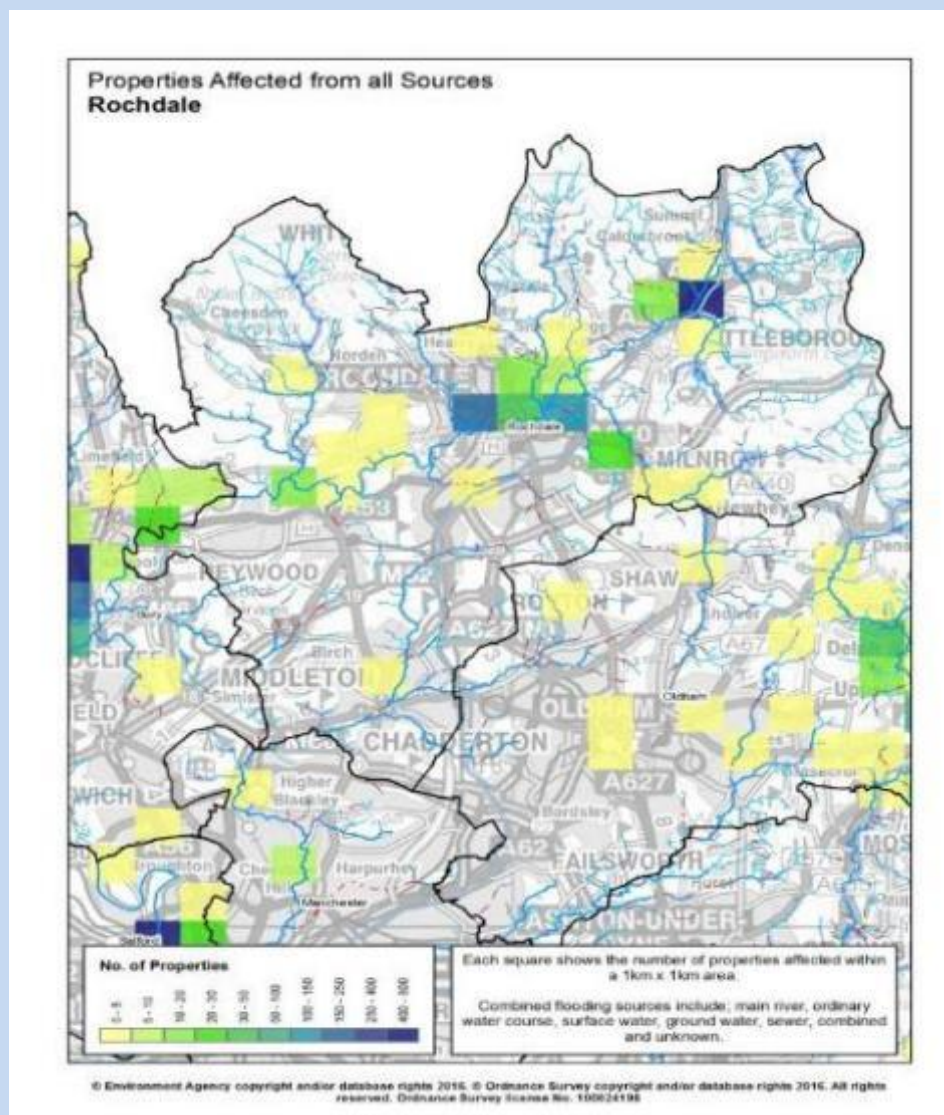
United Utilities

- There were no incidences of sewer flooding reported to United Utilities on Boxing Day 2015 in this area

Appendix 1.5 – Rochdale Local Flood Information

Rochdale borough summary

A total of 324 properties in the Rochdale borough, flooded internally. The extent of damage to properties is in some cases still being assessed regarding habitable spaces and businesses. The worst affected areas were: Littleborough; 174 properties (up to 1.2m deep), Wardleworth and Hey Brook; 36 properties, Rochdale town centre; including Mitchell Hey and Sparth Bottoms; 54 properties (up to 1.5m deep) and Hooley Bridge; 20 properties. All statistics exclude cellars unless they are habitable accommodation. This was primarily from the River Roch, Greenvale Brook, Hey Brook/Buckley Brook and the River Spodden. Some flooding was from surface water, groundwater and sewers. These areas are detailed on the following pages. There were many tens of properties in Littleborough, Wardleworth and other parts of Rochdale Borough where cellars flooded. This was sometimes from rivers or surface water and in some cases it was due to groundwater - when high groundwater levels caused seepage through cellar walls. In addition, many other areas in Rochdale experienced flooding, but in clusters of less than 5 properties so details are not included in this report.



Rainfall:

- Blackstone Edge, Littleborough – 74mm/24hrs
- Cowm Reservoir, Whitworth – 107mm/24hrs
 - Bacup – 103mm/24hrs
 - Royton – 56mm/24hrs

River levels:

- Littleborough - 2.003m = 144.681 mAOD
- Station Rd, Milnrow – 1.861m = 145.046 mAOD
- Albert Royds St (upstream of Wardleworth and town centre) - 2.425m = 125.101 mAOD
- Rochdale Wastewater Treatment Works (downstream of town) - 2.222m = 112.476 mAOD
- Blackford Bridge (on R Roch near its confluence with R Irwell) - 3.362m = 66.282m AOD
- The recorded level at Blackford Bridge was 1.1m higher than any other reading in its 64 years of records

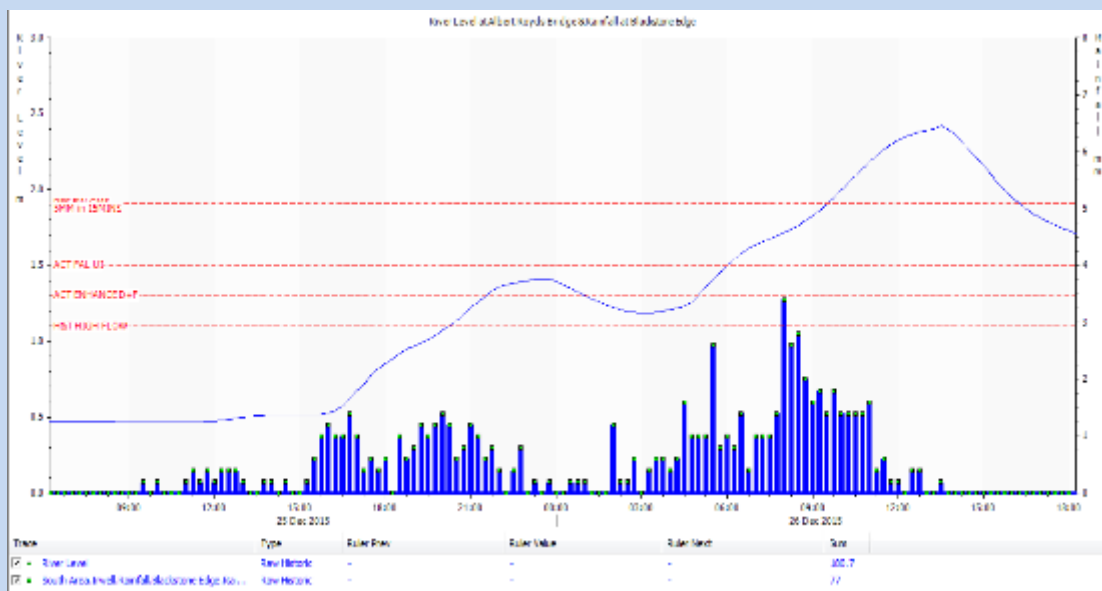


Figure 13 River levels on the River Roch upstream of Wardleworth and corresponding rainfall

The last major flooding in the Rochdale area was to 36 properties in 1995, 81 in 1991 and an unknown number in 1965. The town centre came very close to flooding in 2008. Several cellars of houses in Wardleworth flooded in 2012.

A 2004 scheme by the Environment Agency improved protection of flooding from rivers to areas of Rochdale and Littleborough. Rochdale BC have now completed works to 'Reveal the Roch' in Rochdale town centre. Opening up the Esplanade culvert is likely to have reduced the Boxing Day flood extent and limited flood depths. Water was able to re-enter the river near the bottom of Yorkshire Street and this also reduced town centre flood duration.

The flooding caused extensive power loss (20,000 properties initially, reducing to 5,500 later on Boxing Day, but some properties were without power for up to 4 days) and impacts on telephone and other services beyond immediate flood affected areas. Flooding to Rochdale Wastewater Treatment Works caused some impacts to treatment. Flooding prevented trams from reaching the town centre. The new bus station sustained flood damage and power loss. A Strategic Command and Control Centre was established at Rochdale Town Hall with rest centres being established in key areas around the borough.

Council staff were assisted by volunteers in manning rest centres and assisting community outreach work for those affected both directly and indirectly. Volunteers were critical in helping Council staff open rest centres, distribute supplies and clear debris and waste.

Updates from Rochdale Council twitter feed were viewed ten times more than the daily average on 27th December. The Council received praise from the Chartered Institute of Public Relations for its communication during the recovery operation.

Rochdale Metropolitan Borough Council made available £500 Community Recovery payments to

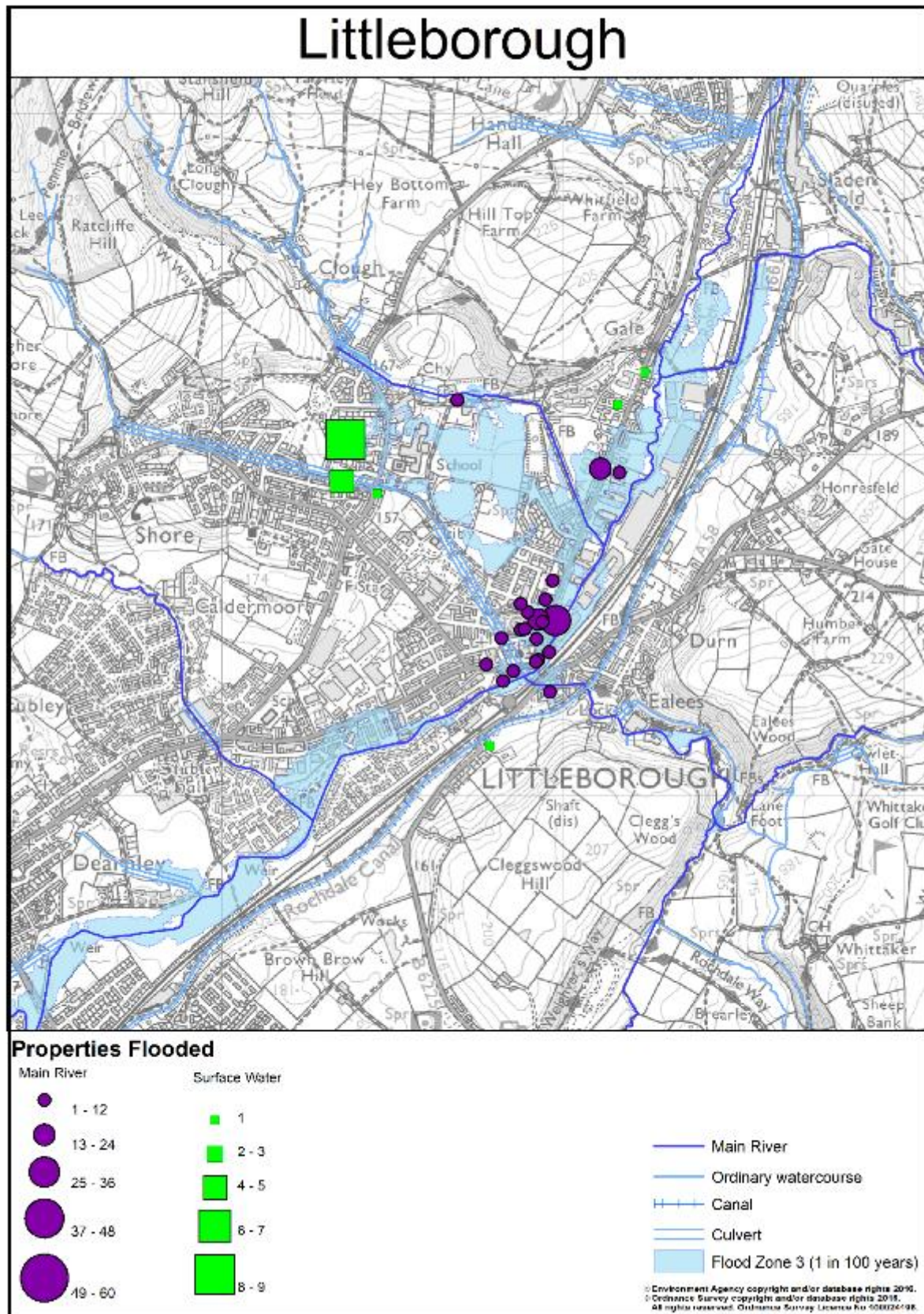
help affected householders and businesses with the immediate aftermath and associated costs. Applications for payments started on 29th December 2015 and ran until July 2016. The Local Authority also administered applications for Property Resilience Grants and Business Recovery Grant of up to £5,000 per property. The application window for Business Recovery Grant closed on the 31st July 2016.

Hardship and vulnerable residents support services have been provided by Council and multiagency partners. These support services are ongoing. Prior to the Boxing Day floods, a community resilience programme in Wardleworth and Littleborough was established through the Defra funded Flood Resilience Community Pathfinder programme which ended in 2015. The Council's partnership with the National Flood Forum in these communities has continued post-Pathfinder and has provided support after the Boxing day floods. All Risk Management Authorities attended community drop-in sessions to offer advice, gather more information from those affected and explain what was known so far and is ongoing managed by the Council. Subsequent events to promote and answer questions about the resilience grants programme have also been held and more are being set up.

Infrastructure and asset inspections have been carried out, resulting in maintenance and repair works, including de-silting of rivers and gully cleaning etc.

Proposals are being developed by the Environment Agency for further work to alleviate flood risk from the River Roch working with the Council. These focus on the Roch and its key tributaries between Littleborough and Rochdale town centre. Revealing the Roch de-culverting project has now been completed.

Key officers from Rochdale Council held a debrief to capture learning points and best practise from the event. The Council will seek to implement recommendations from this debrief, and also continue dialogue with volunteer groups whose help was invaluable, considering how their input may be planned and supported for the future based on capabilities and availability.



Points shown above indicated clusters of reported flooding and do not represent the exact properties or extents that experienced flooding

Description/Main Issues

- The Environment Agency are leading investigations at this location as most flooding was from main river
- 158 properties flooded above ground floor level from River Roch and Greenvale Brook (both main river)
- 17 properties flooded from surface water
- Floodwaters overtopped raised defences and natural bank levels to reach depths of up to 1.2m (at Garden Mews)
- Flood depths were exacerbated by surface water and water from Rochdale Canal
- Saturated ground of the Littleborough catchment was a major factor in the severity of the flooding
- Most of the flooding was to properties on or near Todmorden Road. Some of these have flooded more than once before
- Greenvale Business Park flooded due to overtopping of the flood relief channel which flows under the railway and from overtopping of the River Roch
- Infrastructure damage included culvert damage at Calderbrook Rd, Todmorden Road and Halifax Road, gully blockage and damage throughout the area, including to various rural paths. There was also a landslip at Whitfield Brow which caused the evacuation of properties. This is subject to further investigation of the detailed cause of the landslip and how much was attributable to Storm Eva
- The local community have formed a Flood Action Group to promote self-help and to communicate effectively with the Risk Management Authorities, principally the Environment Agency and Rochdale Borough Council.

Photos



Picture 60 Examples of responders in Rochdale



Picture 61 Riverside Nursing Home Flood Wall Collapse



Picture 62 Littleborough Flood Wall Temporary Sandbagging



Picture 63 Footbridge Blockage

Environment Agency

- A flood warning was issued to over 690 properties for the for the River Roch at Littleborough
- Recorded rainfall is estimated to have a likelihood of occurring once in up to 7 years. This was made more extreme by the complete saturation of the catchment before any of this rain fell. Videos on Youtube show dramatic footage of overland flows off Blackstone Edge and around Calderbrook and other areas
- The level measured by the Environment Agency's gauge in the River Roch at Littleborough was the highest in 19 years of records - 300mm higher than the previous highest recorded in June 2012
- This river flow is estimated to have a likelihood of occurring only once in 25 to 50 years
- High river levels prevented surface water from being able to drain away
- Properties flooded above ground floor are typically in Flood Zone 3 (a 1 in 100 or greater chance of flooding in any given year)
- A flood warning was issued for Littleborough
- Surface water ponded against a flood defence wall to the River Roch behind Riverside Care Home. This wall, which protects about 20 properties, then collapsed into the river. Large numbers of properties had flooded by this time, so no property flooding occurred as a result of this collapse
- A sandbag wall was built by EA Field staff immediately after the flood where the defence behind Riverside Care Home had failed. Construction of a replacement length of flood defence will finish in August 2016 and drainage is being improved to reduce surface water ponding behind the flood wall
- A future scheme is being developed to improve flood protection to Littleborough. Options being considered include: whether any defences between Littleborough and Rochdale town centre can be raised, constructing flood storage areas and operating Blackstone Edge reservoir differently. Opportunities for using natural flood management techniques in this area will also be explored
- River Roch at Littleborough (GM11) Flood Warning Area is currently being reviewed and, if necessary, improvements will be made to its coverage and the numbers of properties warned, as well as the threshold levels. These improvements are ongoing and local communities will be involved in the process where appropriate.

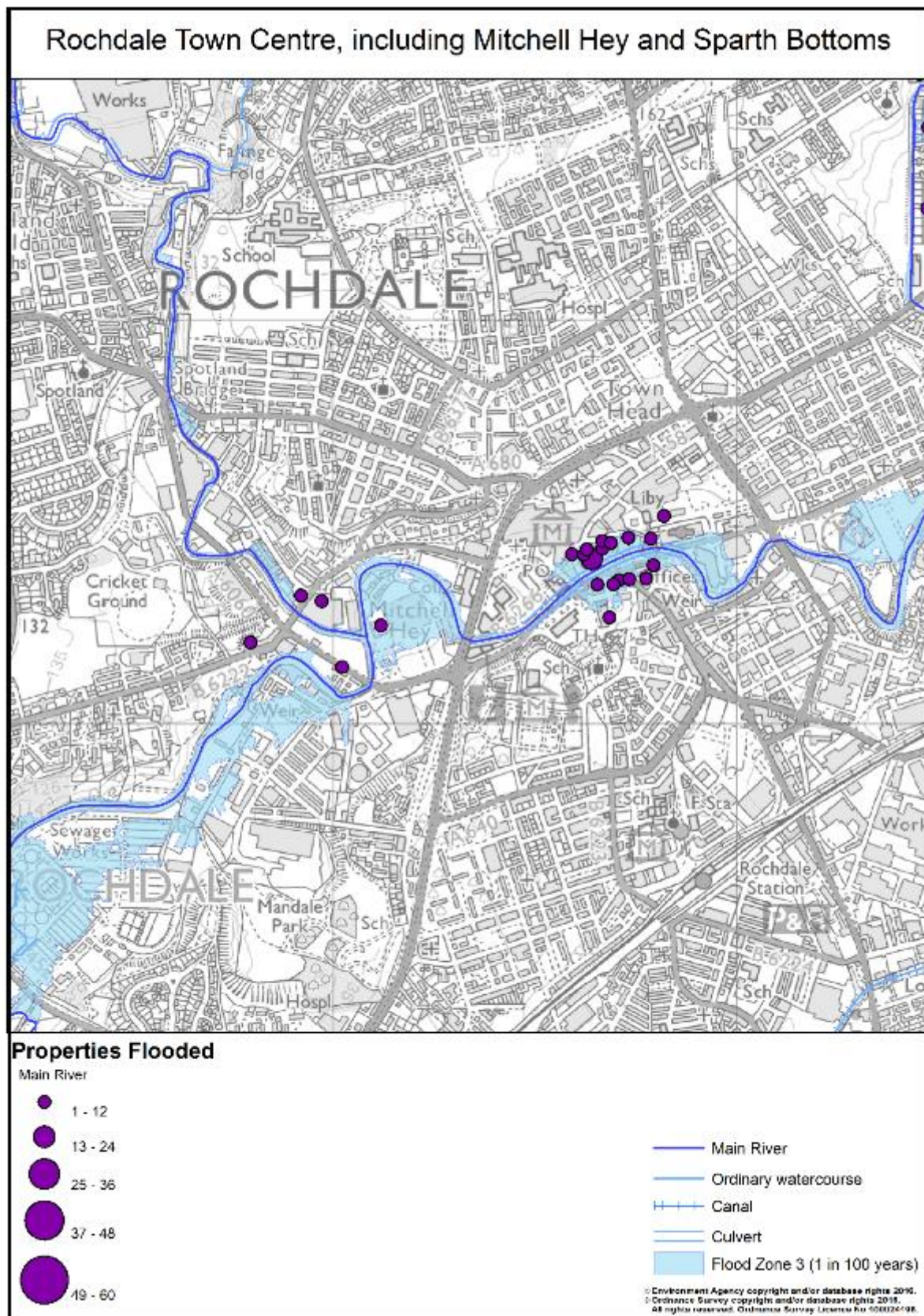
Rochdale Borough Council

- Rest centres established at Littleborough Conservative Club and St Barnabas' Church
- Sand collection points/empty sand bags provided at Littleborough Conservative Club
- Ongoing community resilience programme in Littleborough through Flood Pathfinder legacy programme
- Flood alleviation project in construction – Second flood storage basin, Calder Brook, near Littleborough – completion Autumn 2016

United Utilities

- There was no sewer flooding reported to United Utilities on Boxing Day 2015 in this area
- United Utilities attended the local community drop-in session on 16 February

Appendix 1.5.2 Rochdale Town Centre, including Mitchell Hey and Sparth Bottoms



Points shown above indicated clusters of reported flooding and do not represent the exact properties or extents that experienced flooding

Description/Main Issues

- The Environment Agency are leading investigations at this location as all flooding was from main river - 54 properties flooded
- Flooding occurred when flows in the River Roch through the town centre exceeded the capacity of the entrance to a culvert next to the new bus station. Photos from 2008 show the level was nearly as high then but did not flood
- Floodwater flowed along Smith Street and South Parade and re-entered the river where Rochdale Council has opened up a culvert and exposed a historic bridge. Most businesses on Smith Street, South Parade, The Butts and The Walk were flooded, as was the new Council office at Number One Riverside. Number One Riverside was largely operational by the time of reopening to the public at New Year, however the ground floor library is still partially closed
- The town centre bus station and tram terminus sustained flood damage. Bus services were running again the next day but many of the services and shops in the bus station took some time to recover
- Power loss affected many homes and businesses
- The Town Hall narrowly escaped flooding – the ‘Revealing the Roch’ works being carried out by Rochdale Council and the Environment Agency to open up a town centre culvert may have contributed to reducing the risk here
- Some properties flooded to as much as 1.5 metres deep (measured at The Butts), with substantial cellar flooding affecting business operations on South Parade and Yorkshire Street.
- Two cellars and the yard at a piling contractor’s depot flooded from the River Spodden near its confluence with the River Roch
- Just downstream of the town centre, the Asda superstore, adjacent Curry’s PC World and Sixth Form College all suffered internal damage. Asda was flooded up to 50mm deep. Damage was caused to St Mary's Gate subway
- No serious surface water flooding was noted
- The town centre came close to flooding in January 2008 and autumn/winter 2015

Photos



Picture 64 Looking towards Regal Moon



Picture 65 South Parade



Picture 66 Water re-enters river where culvert is being opened up



Picture 67 Council office and library



Picture 68 The Walk, Rochdale



Picture 69 Smith Street



Picture 70 Smith Street looking towards the Wheatsheaf Centre

Environment Agency

- A flood warning was issued to 541 properties for the River Roch in Rochdale
- Recorded rainfall in the River Spodden catchment (Shawforth and Whitworth) was quite extreme (estimated to have a likelihood of occurring once in 30 to 50 years). However, the ground was saturated and videos show dramatic footage of significant surface flows down moorland above Littleborough and some other areas
- The level measured by the Environment Agency's gauge in the River Roch at Albert Royds Street (upstream of town centre) was the highest in 22 years of records - 400mm higher than the previous highest recorded in January 2008 and 500mm higher than June 2012
- This river flow is estimated to have a likelihood of occurring only once in 25 to 50 years
- The flood extent was broadly similar, or in some case perhaps slightly beyond, Flood Zone 3 (a 1 in 100 or greater chance of flooding in any given year)
- Proposals are being developed to alleviate flood risk from the River Roch from Littleborough to Rochdale town centre
- River Roch in Rochdale (GM5) Flood Warning Area is currently being reviewed and, if necessary, improvements will be made to its coverage and the numbers of properties warned, as well as the threshold levels. These improvements are ongoing and local communities will be involved in the process where appropriate

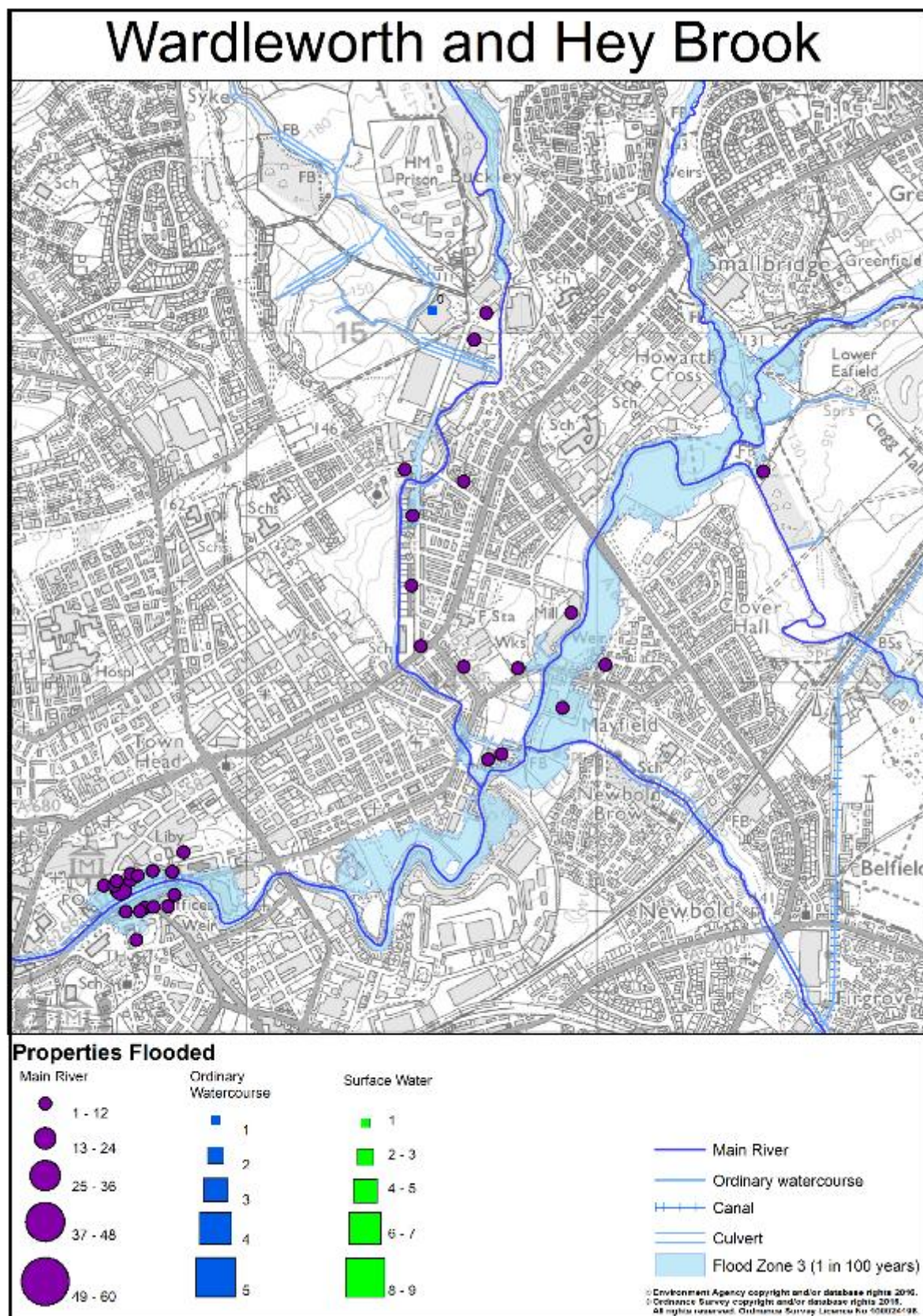
Rochdale Metropolitan Borough Council

- The recently built Council Offices at Number One Riverside flooded. This affected the ground floor library and computer servers in the cellar, adding to the challenge of co-ordinating flood recovery. Repairs are well advanced and the building was substantially operational from 4 January 2016 (library on the ground floor is still partially closed)
- Sand collection points/empty sand bags provided
- A Central Rochdale rest centre was established after the flood
- The Council are supporting the Environment Agency in developing proposals to reduce fluvial flood risk

United Utilities

- There was no sewer flooding reported to United Utilities on Boxing Day 2015 in this area
- United Utilities attended the local community drop-in session on 10 February

Appendix 1.5.3 Wardleworth and Hey Brook



Points shown above indicated clusters of reported flooding and do not represent the exact properties or extents that experienced flooding

Description/Main Issues

- The Environment Agency are leading investigations at this location as most flooding was from main river
- 36 flooded properties flooded:
 - 35 from main river (River Roch and Hey Brook/ Buckley Brook)
 - 1 from ordinary watercourse
- Properties close to R Roch flooded internally to a depth of up to 400mm
- A number of cellars close to Hey Brook and the River Roch flooded from surface water/groundwater when brook reached high level but did not overtop
- Culverts overtopped on Hey Brook upstream of Foxholes Rd/Red Lane allowing floodwater on to Buckley Rd and Park Lane (online video)
- Nearby sub-stations were flooded causing loss of power supply to properties
- Allotments on Kellet Street flooded (and in 2012)
- Cellars of 4 houses in Wardleworth flooded in 2012 due to backing up of a drain into the river

Photos



Picture 71 Hector Avenue, 2015



Picture 73 Downstream



Picture 72 Upstream

Environment Agency

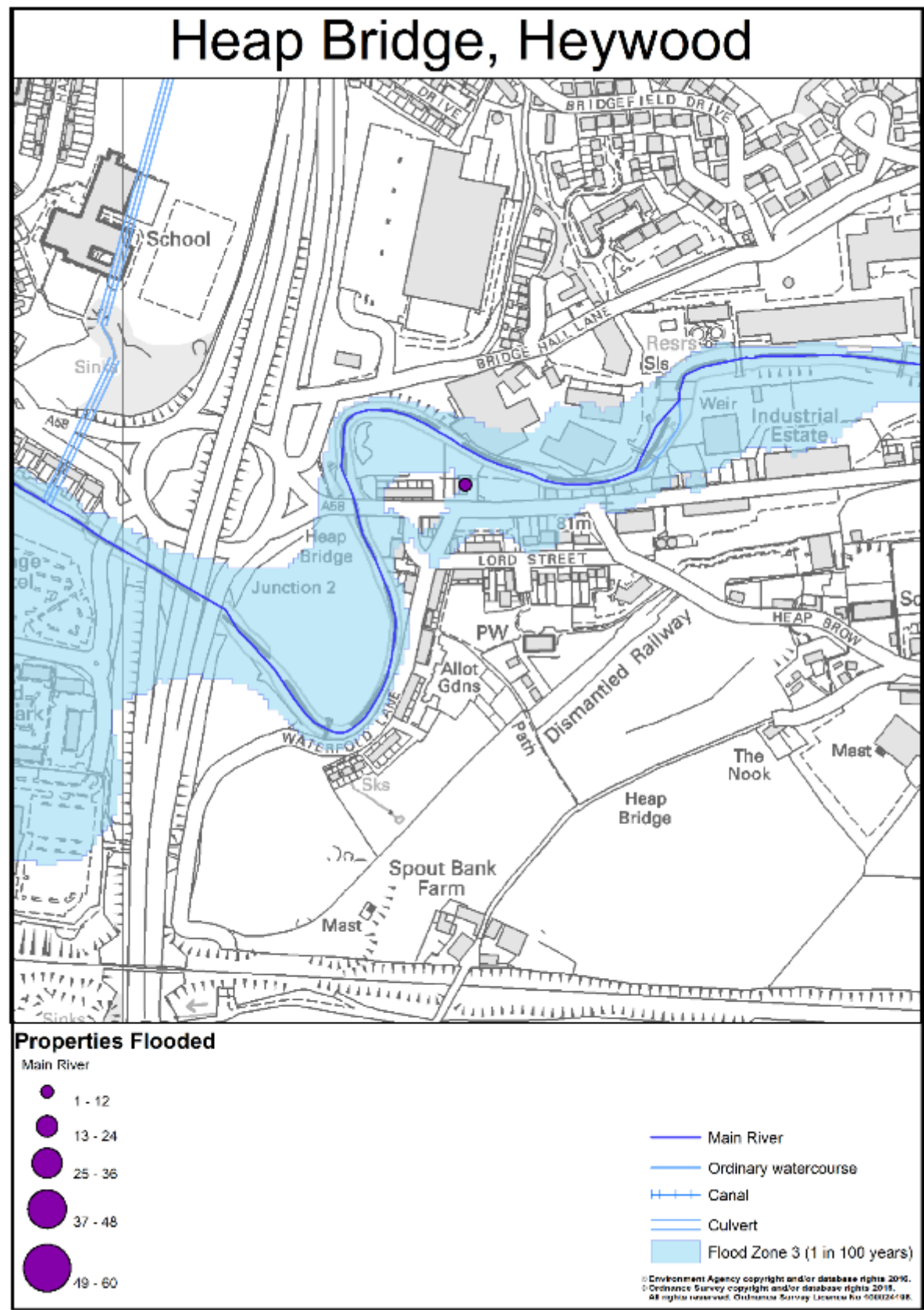
- A flood warning was issued to 25 properties at Hey Brook at Rochdale, properties adjacent to the watercourse
- A 2004 scheme improved protection to Rochdale and Littleborough. This included some raised defences at Wardleworth, but none on the River Roch in the vicinity of Gower St and Weedon St where properties flooded on Boxing Day
- Recorded rainfall in the Upper Roch catchment around Littleborough and the River Beal catchment around Milnrow wasn't that extreme – likely to occur about once in 5 to 7 years. However, ground was saturated even before this rainfall. Videos show dramatic footage of significant surface flows down moorland above Littleborough and other parts of these catchments
- The level measured by the Environment Agency's gauge in the River Roch at Albert Royds Street (just upstream of Wardleworth) was the highest in 22 years of records - 400mm higher than the previous highest recorded in January 2008 and 500mm higher than June 2012
- This river level is estimated to have a likelihood of occurring only once in 25 to 50 years
- A flood warning was issued for Wardleworth on Boxing Day
- The flood extent was broadly similar to Flood Zone 3 – the area which might be expected to flood once in 100 years
- Some cellars flooded from groundwater seepage or from surface water. These are typically in Flood Zone 2 (up to a 1 in 1000 chance of flooding in any given year)
- Impacts were assessed through survey and door knocking within days of the flood and a community drop-in session was held on 8 February
- The need for removal of any gravel deposits in the River Roch is being assessed and programmed where appropriate
- Proposals are being developed to alleviate flood risk from the River Roch from Littleborough to Rochdale town centre
- Hey Brook at Rochdale (Properties adjacent to the watercourse) (GM71) Flood Warning Area is currently being reviewed and, if necessary, improvements will be made to its coverage and the numbers of properties warned, as well as the threshold levels. These improvements are ongoing and local communities will be involved in the process where appropriate

Rochdale MBC

- A rest centre for Wardleworth was set up at Gower Street Youth Base
- Sand collection points/empty sand bags were provided at Gower Street
- There is an ongoing community resilience programme in Wardleworth, working with Wardleworth Flood Action Group

United Utilities

- There was no sewer flooding reported to United Utilities on Boxing Day 2015 in this area
- United Utilities attended the local community drop-in session on 10 February



Points shown above indicated clusters of reported flooding and do not represent the exact properties or extents that experienced flooding

Description/Main Issues

- The Environment Agency are leading investigations at this location as most flooding was from main river
- 10 properties flooded from River Roch
- Drains in rear yards of residential properties filled up, followed by flooding from the river that was gradual at first, then fast, muddy and polluted water flowed into properties to a depth of 600 to 900mm
- Riparian landowners cleared some debris from the river channel and a disused footbridge downstream of the weir following the flood and will consider possible bridge removal (3rd arch was blocked)
- Heap Bridge residents are keen to set up a residents group which would be useful for further discussions about flooding, resilience and potential measures

Photos



Picture 74 Pictures taken by resident on Bury Road, Heap Bridge from first floor window



Picture 75 Pictures taken by resident on Bury Road, Heap Bridge from first floor window

Environment Agency

- Recorded rainfall in the River Roch catchment upstream of Heap Bridge varied according to location. It had an estimated likelihood of occurring between once in 5 years and once in 50 years. Saturated ground will have exacerbated amount and rate of run-off
- Flooded properties are located within Flood Zone 3 (a 1 in 100 or greater chance of flooding in any given year)
- The Environment Agency does not have a river level gauge at Heap Bridge. The nearest is at Rochdale Wastewater Treatment Works about 7km upstream. That gauge recorded the highest level in 22 years of records - 400mm higher than the previous highest recorded in January 2008 and 600mm higher than in 1995
- This river flow is estimated to have a likelihood of occurring only once in 50 to 100 years
- Computer modelling to simulate flood flows and levels from the River Roch in this area is to be improved/updated and is out to tender Summer 2016. Data from this would be used in any future investigations if these can be justified based on priority of this location compared to others
- There is no direct flood warning service available to Heap Bridge
- Assessments will be done to see if any areas which flooded from 'main rivers' should be offered a direct Flood Warning service in future, if this is not currently available. Local communities will be involved as opportunities to improve or extend the Flood Warning service are explored

Rochdale Metropolitan Borough Council

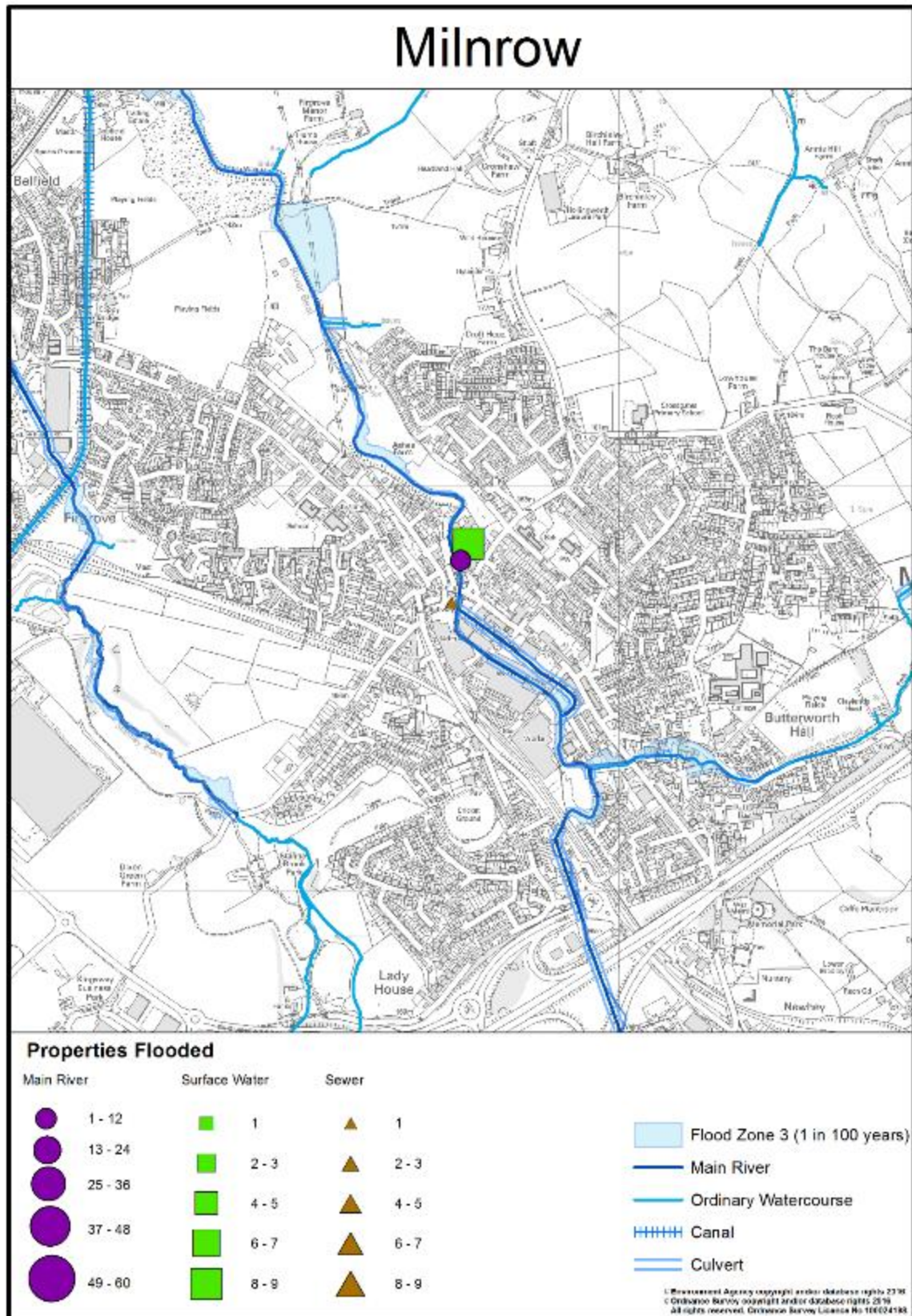
- Planning permission was granted in 2007 for development behind Bury Road, Heap Bridge. This development has stalled. Temporary lowering of ground levels as part of the works appears to have influenced the route of floodwaters affecting properties on Bury Road

- Residential properties are within Rochdale Council's area and commercial properties (also affected by flooding) are within Bury Council's area – see also Junction 2 Business Park Appendix 1.2.6.

United Utilities

- There was no sewer flooding reported to United Utilities on Boxing Day 2015 in this area
- United Utilities attended the local community drop-in session on 10 February

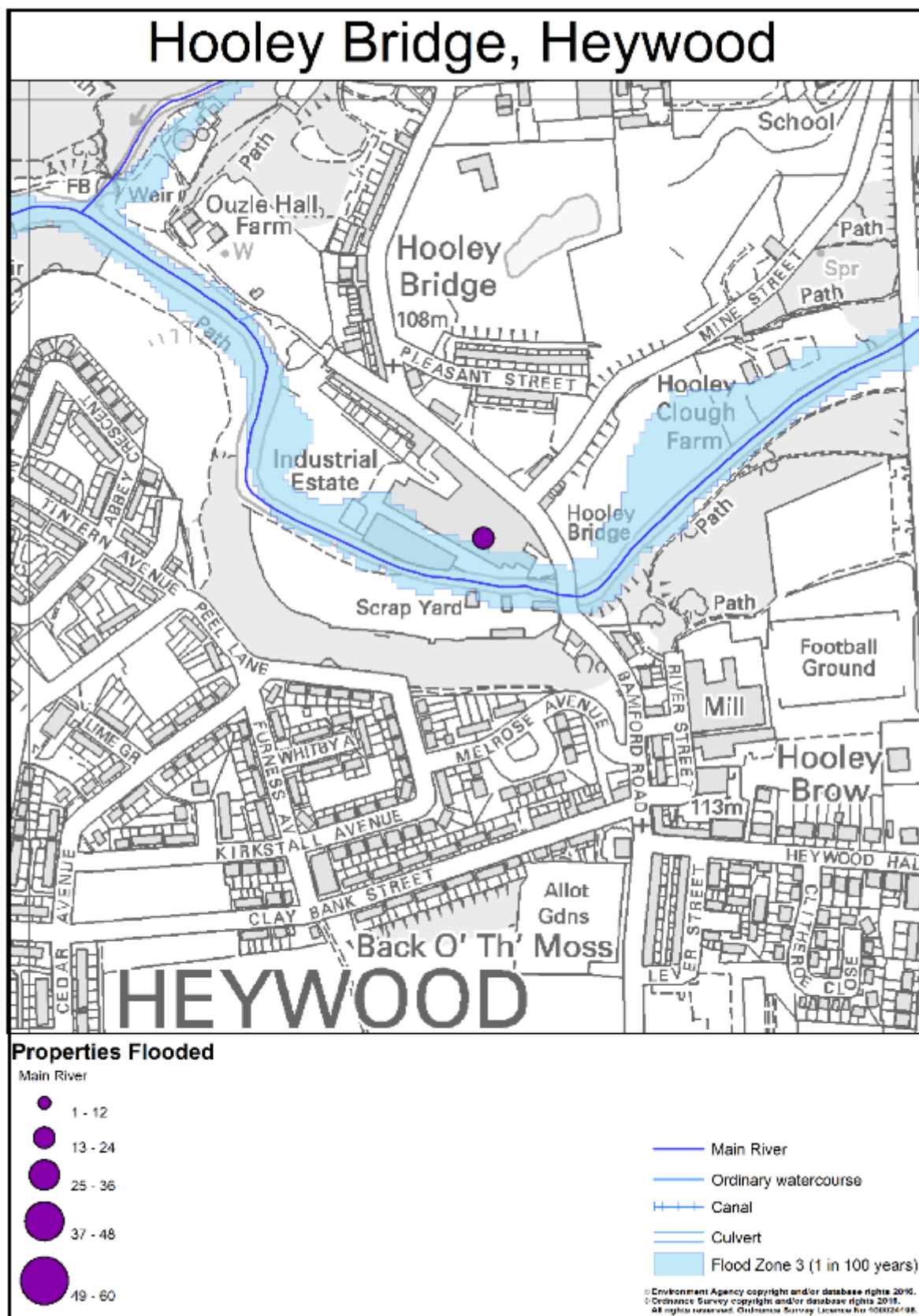
Appendix 1.5.5 Milnrow



Points shown above indicated clusters of reported flooding and do not represent the exact properties or extents that experienced flooding

Description/Main Issues
<ul style="list-style-type: none"> • Rochdale Metropolitan Borough Council are leading investigations at this location as most flooding was from surface water • 9 properties flooded at this location • Raised river levels and drainage built in retaining wall on right bank (beside cottages) has allowed flood water to spill into the cottage grounds. Natural dip of land has allowed it to pool. • In commercial property, flood water entered building through back wall (alongside river) • Previous flooding occurred in 2001
Environment Agency
<ul style="list-style-type: none"> • The level measured by the Environment Agency's gauge in the River Beal at Station Road, Milnrow was the highest in 21 years of records - 600mm higher than the previous highest recorded in January 2008 and 800m higher than June 2012. This river level is estimated to have a likelihood of occurring only once in 50 to 100 years • Properties flooded were in Flood Zone 1 (less than a 1 in 1000 chance of flooding in any given year), Flood Zone 2 (up to a 1 in 1000 chance of flooding in any given year) and Flood Zone 3 (a 1 in 100 or greater chance of flooding in any given year) • The Environment Agency and Rochdale Council have jointly visited the area and will investigate the potential for simple measures such as infilling gaps between some garden walls. Although not designed as flood defences, some walls provide some flood protection • Assessments will be done to see if any areas which flooded from 'main rivers' should be offered a direct Flood Warning service in future, if this is not currently available. Local communities will be involved as opportunities to improve or extend the Flood Warning service are explored
Rochdale Metropolitan Borough Council
<ul style="list-style-type: none"> • During the flood event on Boxing Day, 2016, the River Beal swelled beyond its normal level • As reported by residents post flood event, the water apparently seeped through gaps in the river wall adjoining flooded properties on Bridge Street. Floodwater also flowed down Lily Street and onto Bridge Street • Other flooded locations, primarily from the River Beal and associated surface water, included River Place • External flood depths reported at flooded properties were between 200-900mm in several cases • The Environment Agency and Rochdale Council have jointly visited the area and will investigate the potential for simple measures such as infilling gaps between some garden walls. Although not designed as flood defences, some walls provide some flood protection
United Utilities
<ul style="list-style-type: none"> • 1 property flooded from sewers in this area

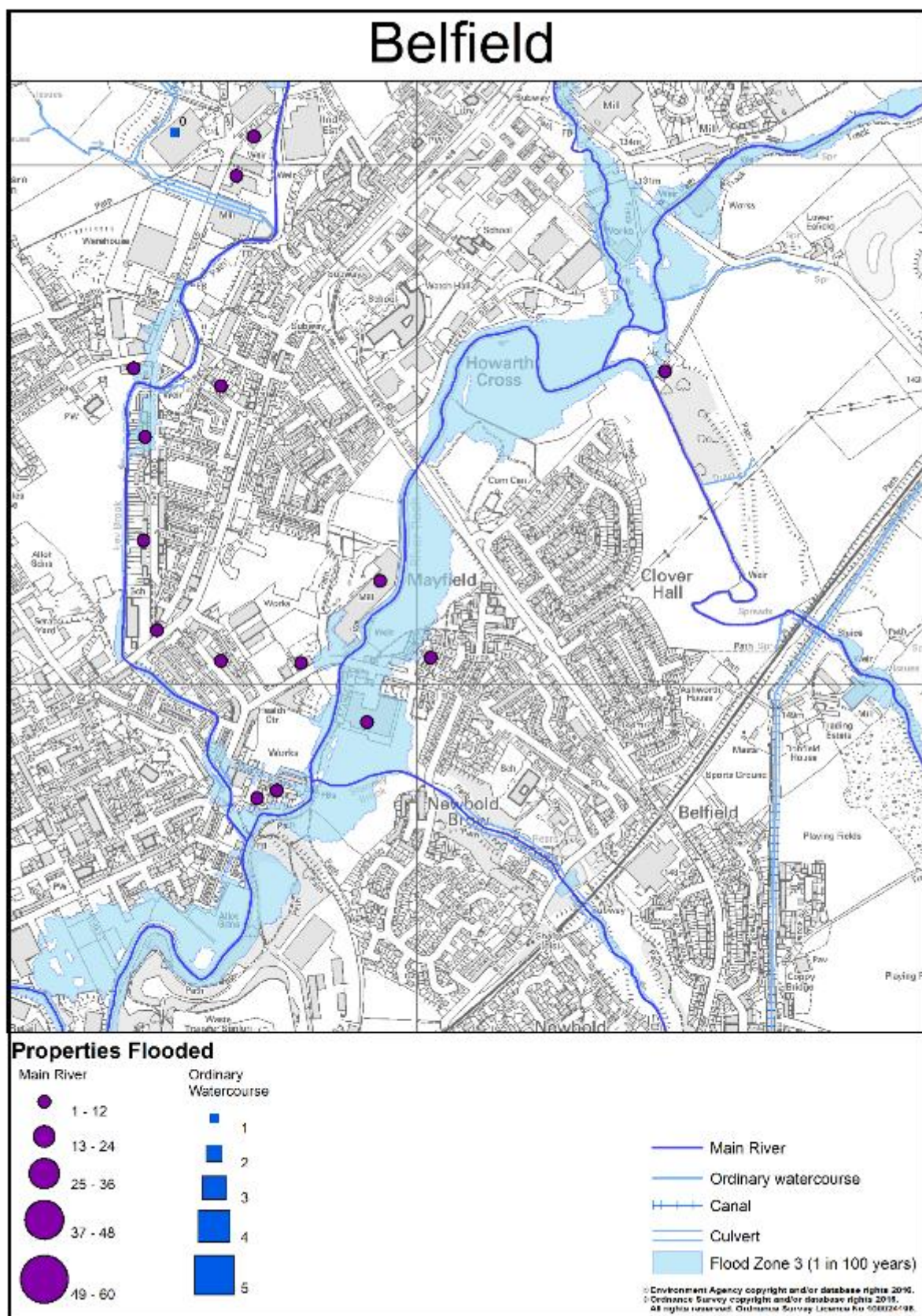
Appendix 1.5.6 Hooley Bridge, Heywood



Points shown above indicated clusters of reported flooding and do not represent the exact properties or extents that experienced flooding

Description/Main Issues
<ul style="list-style-type: none"> • The Environment Agency are leading investigations at this location as flooding was from main river • 20 properties flooded at Hooley Bridge Industrial Estate from the River Roch
Environment Agency
<ul style="list-style-type: none"> • The level measured by the Environment Agency's gauge in the River Roch at Rochdale Wastewater Treatment Works was the highest in 22 years of records - 400mm higher than the previous highest recorded in January 2008 and 600mm higher than January 1995 • This river level is estimated to have a likelihood of occurring only once in 40 to 100 years • Properties flooded were in Flood Zone 1 (less than a 1 in 1000 chance of flooding in any given year), Flood Zone 2 (up to a 1 in 1000 chance of flooding in any given year) and Flood Zone 3 (a 1 in 100 or greater chance of flooding in any given year) • The Environment Agency and Rochdale Council will work together to better understand the flood risk at this location and consider the types of measures that may reduce it • Assessments will be done to see if any areas which flooded from 'main rivers' should be offered a direct Flood Warning service in future, if this is not currently available. Local communities will be involved as opportunities to improve or extend the Flood Warning service are explored
Rochdale Metropolitan Borough Council
<ul style="list-style-type: none"> • All Risk Management Authorities are working together to share available information about flood risk from all sources and engage with communities, so the flood risk can be better understood and appropriately managed
United Utilities
<ul style="list-style-type: none"> • There was no sewer flooding reported to United Utilities on Boxing Day 2015 in this area

Appendix 1.5.7 Belfield



Points shown above indicated clusters of reported flooding and do not represent the exact properties or extents that experienced flooding

Description/Main Issues

- The Environment Agency are leading investigations at this location as most flooding was from main river
- 10 industrial storage units flooded at Firgrove Business Park from the River Beal
- Channel and culvert capacity exceeded. Culvert has smaller section at inlet than at outlet
- Flows overtopped banks at inlet of culvert and flooded adjoining units and yard areas
- Previous flooding occurred in 1991, 1995, February and August 2002

Photos



Picture 76 Culvert inlet



Picture 77 Debris downstream

Environment Agency

- The level measured by the Environment Agency's gauge in the River Beal at Station Road, Milnrow was the highest in 21 years of records - 600mm higher than the previous highest recorded in January 2008 and 800mm higher than June 2012. This river level is estimated to have a likelihood of occurring only once in 50 to 100 years
- Similarly, the River Roch at Albert Royds Street (between Belfield and town centre) saw its highest level in 22 years of records - 400mm higher than the previous highest level in January 2008 and 500mm higher than June 2012. This river level is estimated to have a likelihood of occurring only once in 40 to 100 years
- Some properties that flooded were outside Flood Zone 3 (a 1 in 100 or greater chance of flooding in any given year)
- Possible measures will be considered at Belfield as part of a future scheme which is being developed to improve flood protection from Littleborough to Rochdale
- Assessments will be done to see if any areas which flooded from 'main rivers' should be offered a direct Flood Warning service in future, if this is not currently available. Local communities will be involved as opportunities to improve or extend the Flood Warning service are explored

Rochdale Metropolitan Borough Council

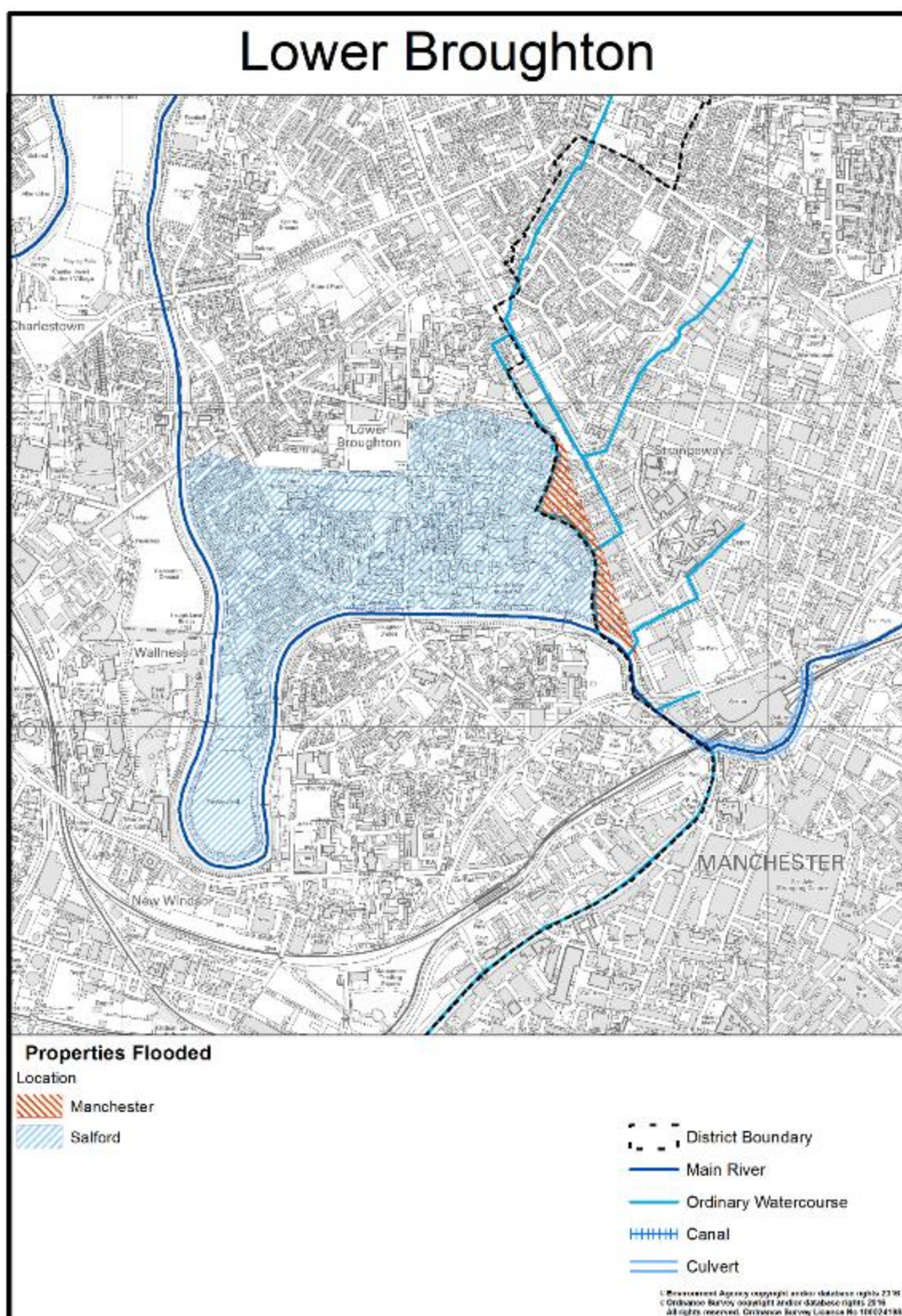
- All Risk Management Authorities are working together to share available information about flood risk from all sources and engage with communities, so the flood risk can be better understood and appropriately managed

United Utilities

There was no sewer flooding reported to United Utilities on Boxing Day 2015 in this area

Appendix 1.6 – Salford Local Flood Information

Appendix 1.6.1 Lower Broughton



Points shown above indicated clusters of reported flooding and do not represent the exact properties or extents that experienced flooding

Description/Main Issues

- The Environment Agency are leading investigations at this location as flooding was from the River Irwell which is main river.
- Flooding occurred when high levels of rainfall caused the River Irwell to overtop raised defences and natural bank levels and exceed the capacity of the surface water network.
- The flood level was exacerbated by debris blockage as the river flowed beneath Hough Lane footbridge
- Water level continued to rise eventually overtopping the left bank flood defences between Wallness Bridge and Hough Lane Bridge. There were three distinct flow routes into the rest of Lower Broughton:
 - Down Lower Broughton Road towards Mocha Parade
 - Through the Heath Avenue area to Riverside
 - Through Green Grosvenor Park and along Broughton Lane into Cambridge Industrial Area
- Around 750 properties were internally flooded in Lower Broughton.
- In addition to the above a further 164 properties were impacted through power loss and access restrictions and flooding occurred to Agecroft cemetery.
- Flooding to external areas was also experienced in Salford Quays with damage to the Helly Hansen Watersports Centre pontoons.
- The flooding caused damage to river walls and walkways at the rear of the Soapworks site, erosion to the abutment of a footbridge in Clifton Country Park and deposited large amounts of debris along the banks of the river Irwell.
- A substantial amount of debris was washed down from the upper reaches of the Irwell catchment, large amounts of which were deposited in Salford along reaches of river bank and also at Media City, which will require specialist barges to be removed.
- The Environment Agency has historical records of flooding affecting Castle Irwell in 2008, 1998, 1980, 1954, 1946, 1866 from Main River and in 1980 from sewer flooding.

Photos



Picture 78 internal property flooding – Lower Broughton



Picture 79 Silt as a result of internal property flooding – Lower Broughton



Picture 80 High water levels in the River Irwell



Picture 81 Inlet to Littleton Road flood storage basin, River Irwell



Picture 82 Silt as a result of internal property flooding – Lower Broughton



Picture 83 Vehicle stuck in flood waters – Lower Broughton



Picture 84 River Irwell overtopping at Heath Avenue



Picture 85 Mountain rescue teams evacuating residents



Picture 86 debris from flooded homes



Picture 87 Flooding at Lyra Place – Lower Broughton

Environment Agency

- Rain gauges relevant to Lower Broughton include: Heaton Park (Bury) and Holden Wood (Rossendale) in the Upper Irwell catchment. Recorded rainfall is estimated to have a likelihood of occurring once in up to 50-120 years at Holden Wood and up to 5 years at Heaton Park. The response of the upper catchment was made more extreme by saturation of the ground before any of this rain fell
- The Environment Agency's gauge in the River Irwell at Manchester Racecourse recorded a river level of 5.67m (29.83 AOD), which is 1.3m higher than any other reading in its 75 years of recording
- This river level is estimated to have a likelihood of occurring only once in 100 to 150 years

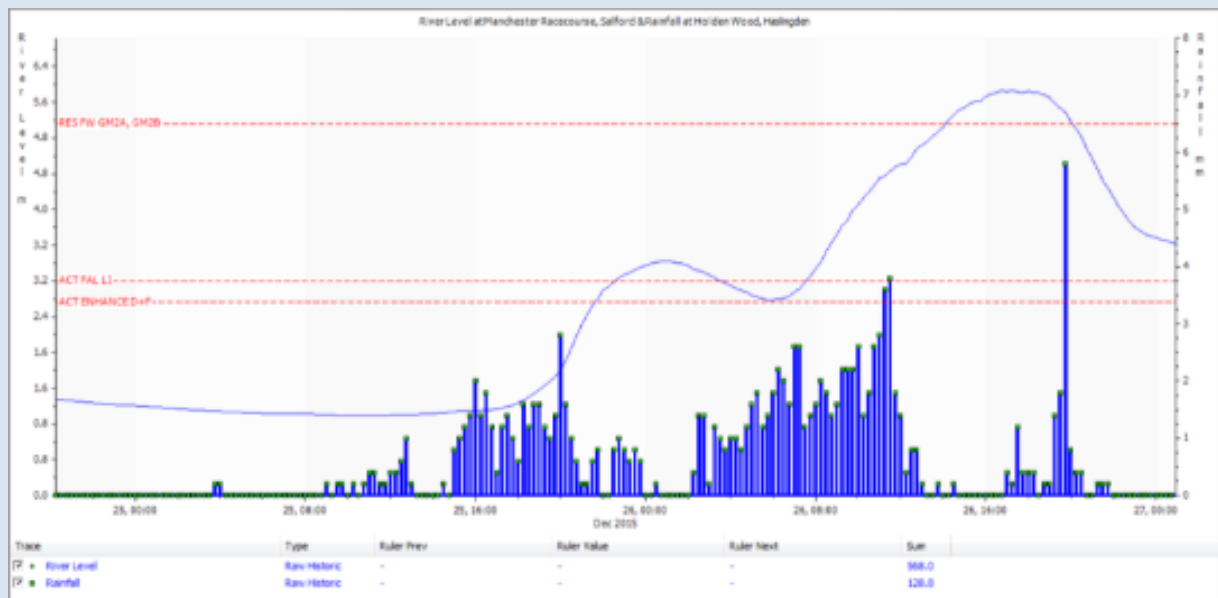


Figure 14 Levels in the River Irwell at Salford and the corresponding rainfall in the upper catchment

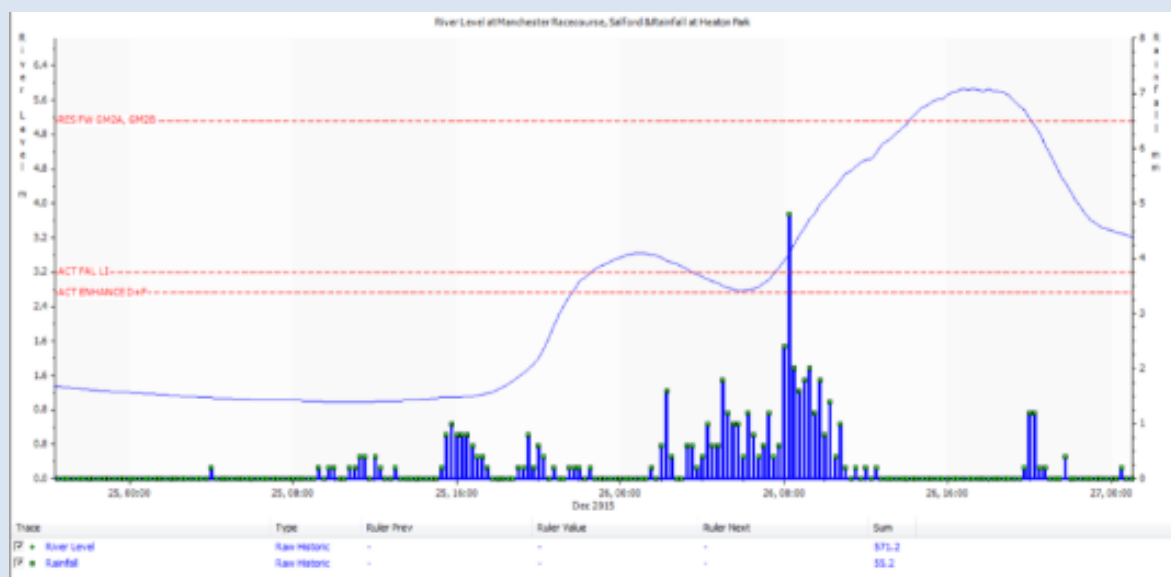


Figure 15 Levels in the River Irwell at Salford and the corresponding rainfall in the lower catchment

- Properties flooded above ground floor are in Flood Zone 2 (up to a 1 in 1000 chance of flooding in any given year) and Flood Zone 3 (a 1 in 100 or greater chance of flooding in any given year)
- At around 09:25 on 26 December 2016, the Littleton Road Flood Storage area started to operate. River levels continued to rise in response to ongoing rainfall
- A Flood Warning was issued for the River Irwell at Salford – area B Flood Warning Area Castle Irwell flood storage area is nearing completion of construction and was not operational at the time of the flood. Nevertheless, high water levels also resulted in inundation of the Castle Irwell basin
- Flood debris was surveyed after waters receded and this data has been used to support mapping of

flood extents by the Environment Agency and Salford City Council

- Flood model simulations are nearing completion and will show how much flooding at Salford would have been averted had the second basin at Castle Irwell been complete
- Model simulations will highlight whether any further measures should be investigated after the second basin becomes operational
- River Irwell at Salford Area B (GM2B) Flood Warning Area is currently being reviewed and, if necessary, improvements will be made to its coverage and the numbers of properties warned, as well as the threshold levels. These improvements are ongoing and local communities will be involved in the process where appropriate

Salford City Council

- Salford City Council are producing a separate, more detailed report of the flooding at Lower Broughton, with further details of investigations and possible next steps.
- Salford City Council representatives were present on site and liaised with other parties (Environment Agency, Greater Manchester Police, Fire and Rescue Service and Urban Vision) during the flooding to ensure that all appropriate measures were being taken.
- Sandbags were made available to residents at the Swinton Highways Depot.
- Rest centres were opened and made available to affected residents.
- A structural assessment of the affected bridges was undertaken to ensure that the high river levels hadn't caused structural damage. Widespread waste collection and disposal was also required post event to remove flood debris and damaged property.
- A wide scale clean-up operation was carried out over a number of days after the event
- £500 funding was made available to affected parties directly.
- Community events such as road shows and numerous door knocking exercises have taken place to ensure that concerns from Salford residents have been heard and to advise affected parties.
- A property level flood protection scheme is in place to provide resilience measures to affected properties
- A flood extent outline has been mapped.
- Salix Homes have a number of properties within the flooded area and were very active in assisting their tenants during the flooding.

United Utilities

- United Utilities received reports of two properties which experienced sewer flooding in the Lower Broughton area.
- This sewer flooding was to external grounds rather than internal property flooding.

Appendix 1.7 – Wigan Local Flood Information

Wigan borough summary

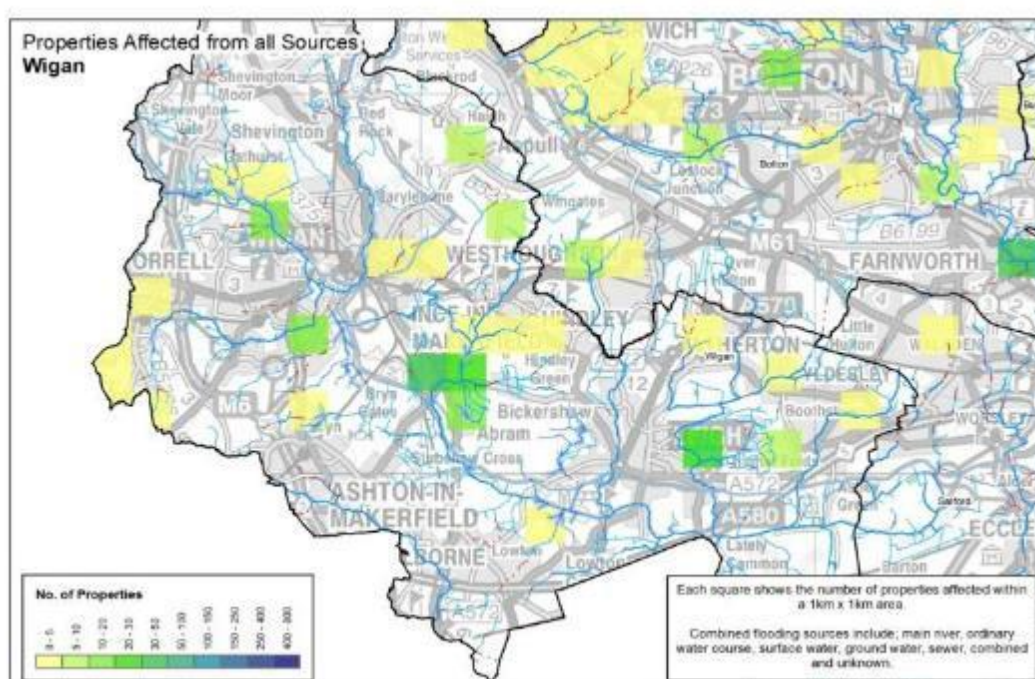
A total of 93 properties in the Wigan borough were affected by internal flooding (all statistics exclude cellars unless they are habitable accommodation).

These were in multiple areas. Worst affected were:

- Platt Bridge - 18 properties flooded from Hey Brook
- Lilford – 14 properties flooded from Lilford Park Brook (main river)
- Bickershaw and Abram – 15 properties flooded from Hey Brook (main river) and ordinary watercourse)
- Worsley Mesnes – 9 properties flooded from sewer
- Aspull – 4 properties flooded from surface water and/or sewers
- Standish – 6 properties flooded from River Douglas (main river), Frodshams Brook (ordinary watercourse), surface water and sewer
- Hindley – 5 properties flooded from combined sources – surface water, sewers and main river

Other flooding clusters were at:

- Tyldesley (4 properties)
- Atherton (1)
- Ashton-in-Makerfield (2)
- Whelley (2)
- Beech Hill (2)
- Scholes (1)
- Orrell (2)
- Billinge (4)



Data from Wigan Metropolitan Borough Council indicates that sewer flooding may have been a factor at 4 locations – Worsley Mesnes, Hindley, Aspull and Standish. Data from United Utilities corresponds only to the first 2 places, so there is a need to now reconcile data on

flooding causes for Aspull and Standish.

Representative rain gauges and readings are:

- Worthington – 66mm/24 hrs
- Bedford Pumping Station – 33 mm/24 hrs

River levels:

- 2.55m at the River Douglas, Wigan, which is 1m higher than any other reading in its 38 years of records
- 2.19m at the River Douglas, Red Rock, which is 0.7m higher than any other reading in its 14 years of records
- 4.51m at Atherton Lake Brook, Lilford Park Basin, which is 1.3m higher than any other reading in its 10 years of records
- River Douglas peaked at 14:15 hours on 26 December. The river rose quickly – 1.4m in the 2 hours 15 minutes preceding the peak

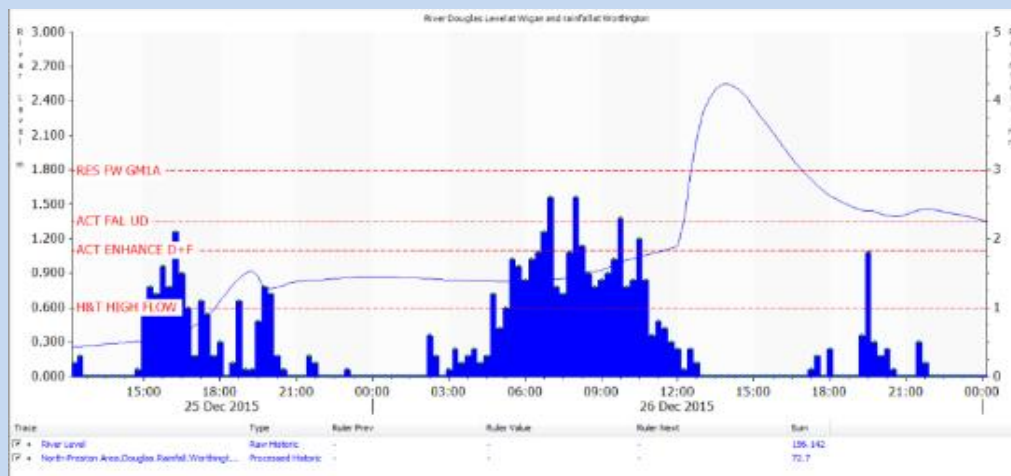


Figure 16 Levels in the River Douglas at Wigan and the corresponding rainfall at Worthington

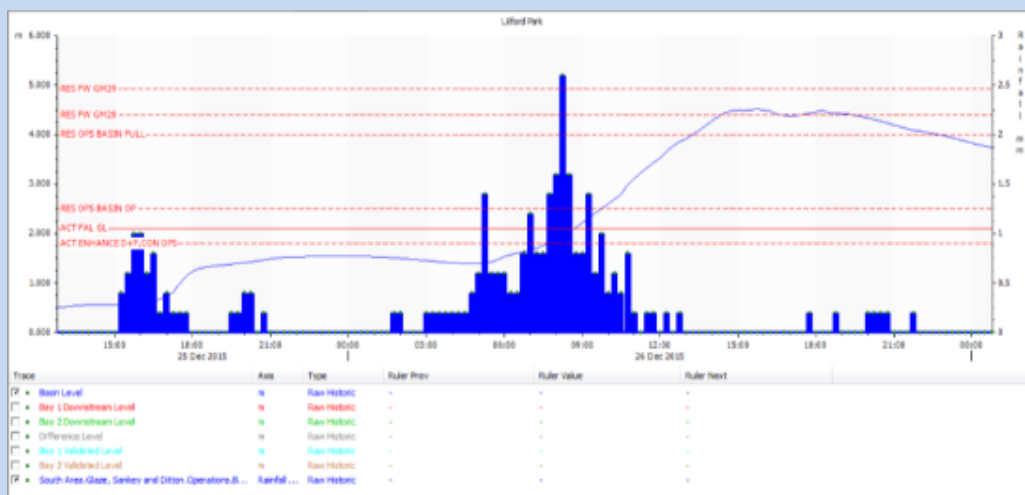
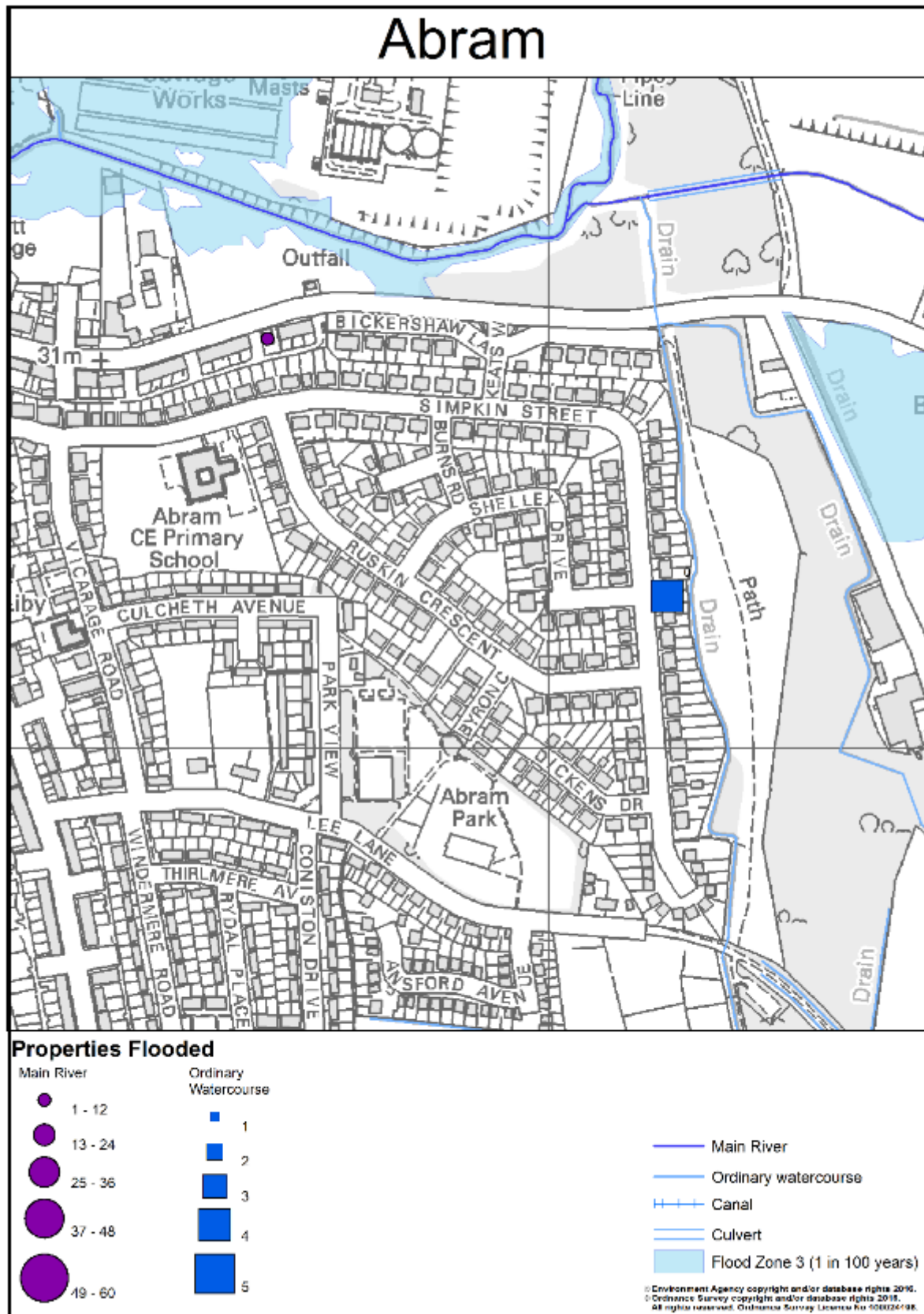


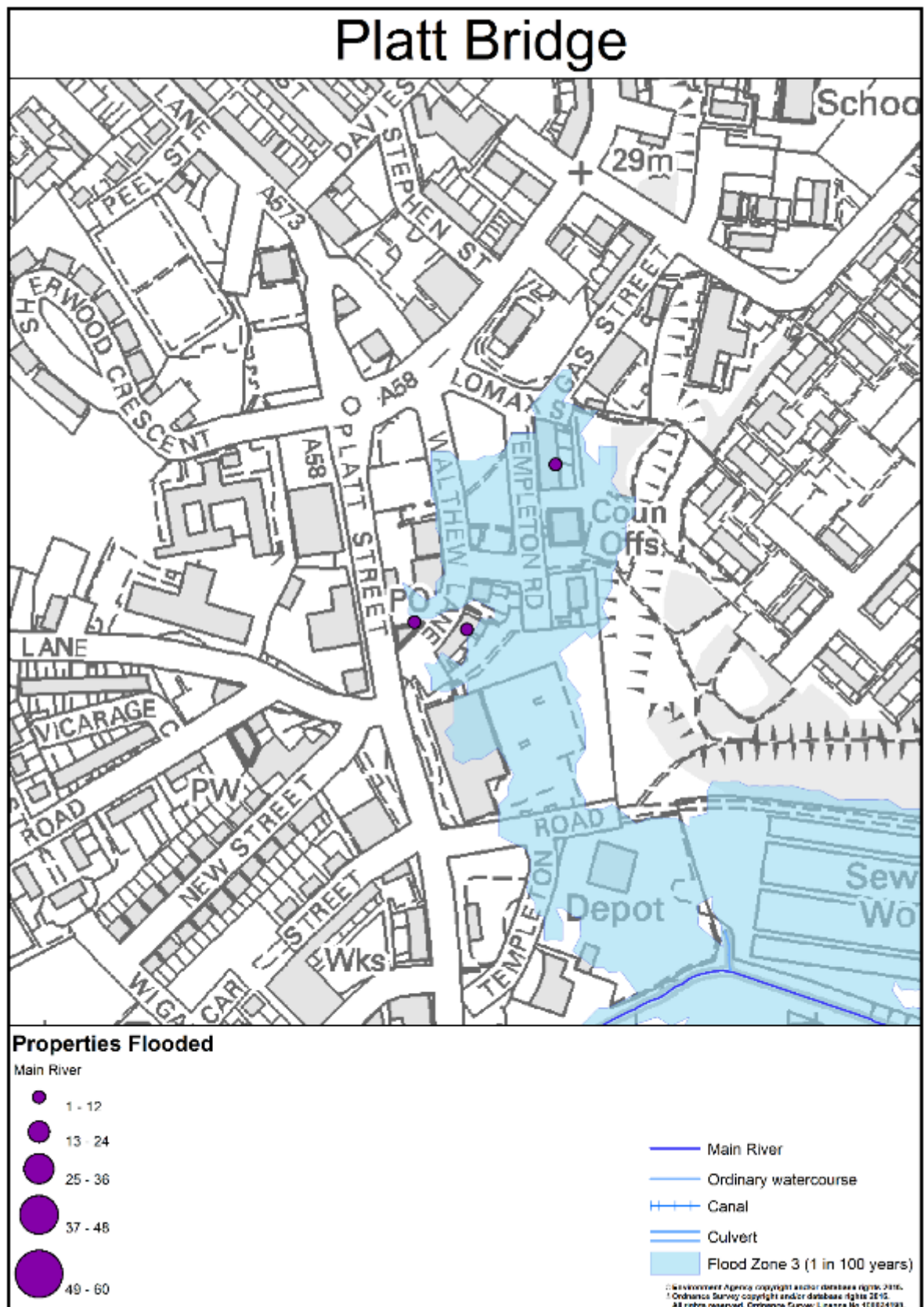
Figure 17 Levels in Lilford Park flood storage basin and the corresponding rainfall



Points shown above indicated clusters of reported flooding and do not represent the exact properties or extents that experienced flooding

Description/Main Issues
<ul style="list-style-type: none"> • Environment Agency are leading investigations at this location as the majority of the flooding occurred from main river. • 15 flooded properties; <ul style="list-style-type: none"> ○ 4 from Ordinary watercourse ○ 11 from main river • Flooding probably exacerbated by high levels in receiving Brookside Brook and Hey Brook (Main Rivers)
Environment Agency
<ul style="list-style-type: none"> • Flooding from main rivers Brookside Brook and Hey Brook • Recorded rainfall is estimated to have a likelihood of occurring once in up to 20-25 years. This was likely made more extreme due to combination of following; <ul style="list-style-type: none"> ○ high flows within Ordinary Watercourse itself, ○ high levels/flooding downstream in receiving watercourses Brookside Brook and Hey Brook, ○ history of surface water/sewer flooding locally. • Improvements to the standard of flood protection at Abram/Bickershaw are to be investigated. Options will have been considered by the end of 2018 and a preferred solution recommended
Wigan Metropolitan Borough Council
<ul style="list-style-type: none"> • Flooding from Ordinary watercourse tributary of Brookside Brook • All Risk Management Authorities are working together to share available information about flood risk from all sources and engage with communities, so the flood risk can be better understood and appropriately managed
United Utilities
<ul style="list-style-type: none"> • There was no sewer flooding reported to United Utilities on Boxing Day 2015 in this area • Pumping station almost flooded • Hey Brook came out of channel downstream of Hindley and Bickershaw Pumping Stations where Browns Service Centre (SD 60516 02465) meets Bickershaw Lane – flowed under wagons and silt left on the road

Appendix 1.7.2 Platt Bridge, Wigan



Points shown above indicated clusters of reported flooding and do not represent the exact properties or extents that experienced flooding

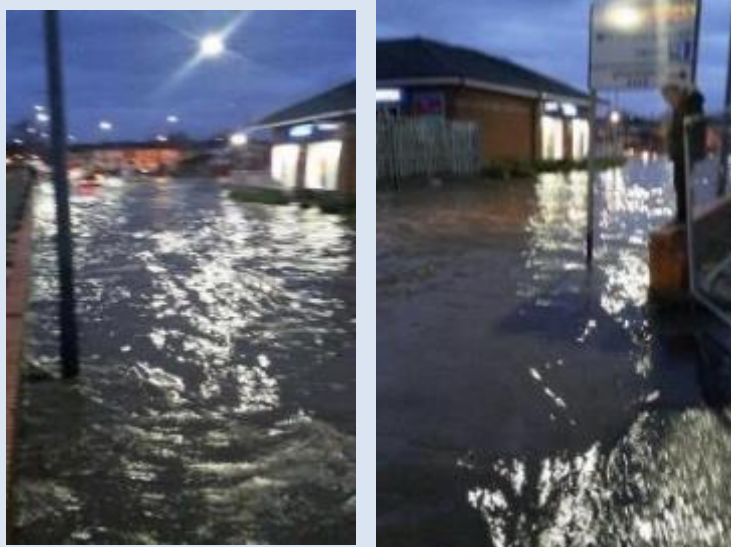
Description/Main Issues

- The Environment Agency are leading investigations at this location as flooding was from Hey Brook which is main river
- 18 flooded properties from Hey Brook
- Known surface water flooding – 525mm diameter culvert/highway drain on Platt Street severely blocked by tree roots
- Surface water flooding may also have been exacerbated by high levels in the receiving watercourse (Hey Brook)
- Possible fluvial flooding from Hey Brook – exiting right bank at rear of Browns Garage

Photos



Picture 88 Flooding at Walthew Parade/Walthew Lane



Picture 89 Flooding on Platt Lane (looking North)



Picture 90 Flooding in Aspinall Street (looking east from junction with Platt Street)

Environment Agency

- Recorded rainfall is estimated to have a likelihood of occurring once in up to 20-25 years.
- Hey Brook (flooding of right bank) is likely to be the mechanism for flooded properties on Templeton Road
- Properties flooded above ground floor are in Flood Zone 2 (up to a 1 in 1000 chance of flooding in any given year) and Flood Zone 3 (a 1 in 100 or greater chance of flooding in any given year)
- Improvements to the standard of flood protection at Platt Bridge are to be investigated. Options will have been considered by the end of 2018 and a preferred solution recommended
- Assessments will be done to see if any areas which flooded from 'main rivers' should be offered a direct Flood Warning service in future, if this is not currently available. Local communities will be involved as opportunities to improve or extend the Flood Warning service are explored

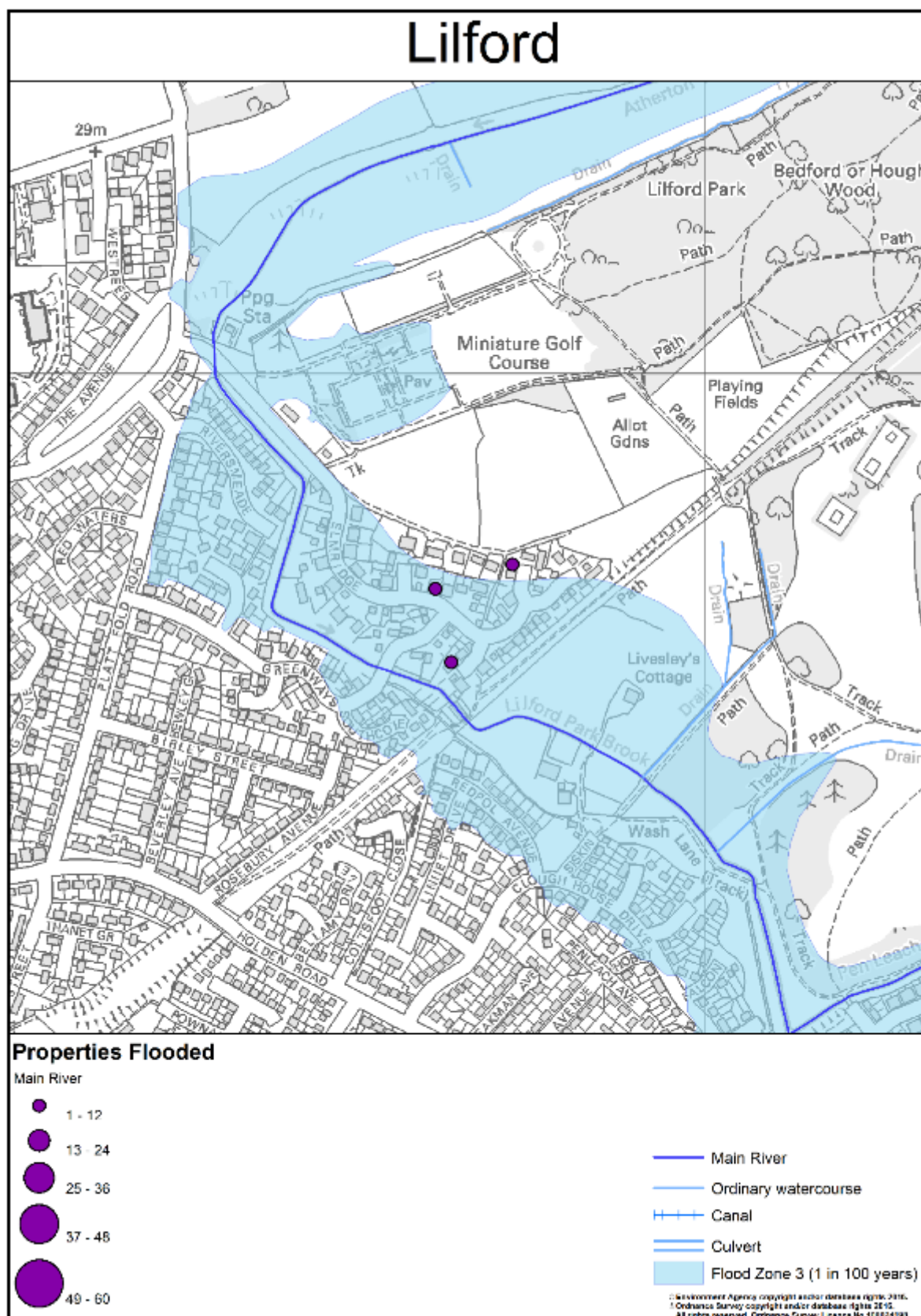
Wigan Metropolitan Borough Council

- The non-main (crossing the B5237) could not discharge due to high levels in Brookside Brook. This caused the pedestrian bridge at the end of Keats Way to surcharge and the water backed up into properties on Keats Way and Simpkin Street.
- Wigan Council will continue to work closely with the Environment Agency to explore ways of reducing flood risk from multiple sources in this area

United Utilities

- There was no sewer flooding reported to United Utilities on Boxing Day 2015 in this area

Appendix 1.7.3 Lilford, Wigan



Points shown above indicated clusters of reported flooding and do not represent the exact properties or extents that experienced flooding

Description/Main Issues

- The Environment Agency are leading investigations at this location as flooding was from Lilford Park Brook which is designated as main river
- 14 flooded properties flooded
- The catchment was saturated – persistent rainfall from November onwards
- 33mm fell over much of the catchment
- Lilford Park flood storage basin operated. Sluice gates here were affected by debris washed down by high flows and did not open fully, so the water that should have gone to the pumping station backed-up into the basin and overtopped its spillway.
- Lilford Flood Basin overflow spillway operated, with excess flow proceeding across a car park and down Elmridge and flooding properties in Hathaway Court, rather than returning into channel of Lilford Park Brook near to the spillway
- Overland surface water flood flow also occurred in the vicinity of Woodlands and through properties in Eden Bank

Photos



Picture 91 Installation of temporary defences being tested during an exercise in July 2016. These defences aim to improve protection to properties including those which flooded on Boxing Day.



Picture 92 View from Environment Agency compound into Lilford Park car park

Environment Agency

- A flood warning was issued for Lilford Park Brook at Lilford
- Sandbags were distributed to previously identified drop-off points for use by the Council and residents
- Recorded rainfall is estimated to have a likelihood of occurring once in up to 2 years
- The level measured by the Environment Agency's gauge in Atherton Lake Brook, Lilford Park Basin, was the highest in 10 years of records – 1.3m higher than the previous highest levels
- Assets on the Bedford System of watercourses protect over 800 properties from flooding. This combination of flood storage reservoir, pumps and downstream channel are collectively known as the Bedford System
- The system protects properties from permanent flooding due to mining subsidence. It does this by storing and lifting up water so that it can then continue to flow away by gravity. A 'flash' (lake filling a depression in the ground) would otherwise form.
- The Bedford System was originally constructed in 1964, upgraded in 1995 and pump refurbishment and basin improvements carried out in 2012. Bedford Pumping Station performs a balancing act, working with the Lilford Park flood storage basin, to ensure flood and flood warning levels on Lilford Park Brook and Penleach Brook are not exceeded
- The system also limits the flow in Bedford Brook downstream of the pumping station and so protects properties there from flooding too
- The pumping station is in constant operation and the Lilford park storage basin can be operated frequently in winter
- After developing a fault, one pump had been removed from the station prior to Boxing Day. However, there was adequate capacity at the pumping station to pump the flows from Lilford Park Brook and Penleach Brook during this flood event
- Bedford pumping station improvements in 2015 included units to monitor the temperature of the pump motors and the integrity of water seals
- The storm pumps at Bedford pumping station tripped out several times during this flood event due to overheating. However, there was adequate capacity to pump the flows from Penleach Brook and Lilford Park Brook. Pumping station operation has since been temporarily modified to eliminate overheating and a permanent solution is planned
- The effectiveness of the sluice (penstock) gates at Lilford Park flood basin could have been affected by debris build up and the velocity of water against the structure. The torque settings on the penstocks have since been altered which should improve the effectiveness of the asset.
- Since Boxing Day a procedure has been adopted to erect temporary aluminium barriers to divert over-spilling floodwater from the basin back into the river channel in the vicinity of an access track to the basin and across the road at Elmridge. This will better protect properties, including those which flooded recently. An exercise in July 2016

tested this procedure

- Drop-off points for sandbags have been reviewed and some small changes made
- Minor refinements are planned to existing computer modelling of river flows and levels
- Improvements to the standard of flood protection at Lilford/Bedford are to be investigated. Options will have been considered by the end of 2018 and a preferred solution recommended
- Properties flooded above ground floor are in Flood Zone 2 (up to a 1 in 1000 chance of flooding in any given year) and Flood Zone 3 (a 1 in 100 or greater chance of flooding in any given year)
- Lilford Park Brook at Lilford (GM28) Flood Warning Area is currently being reviewed. Threshold levels will be altered if necessary. These improvements are ongoing and local communities will be involved in the process where appropriate

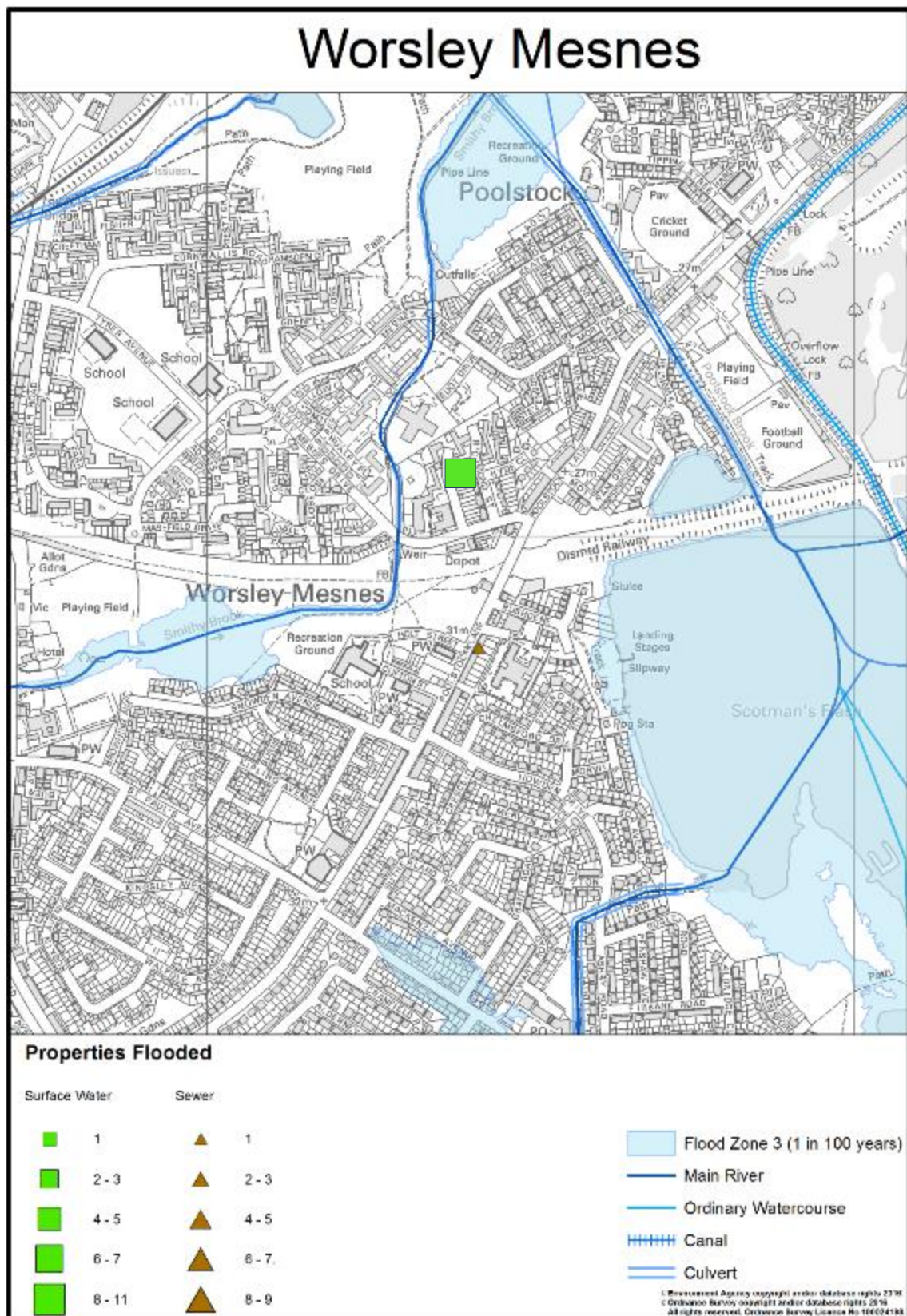
Wigan Metropolitan Borough Council

- Sandbags were deployed by Wigan Council to local residents in response to an Environment Agency flood warning. The Council used sandbags supplied by EA from Bedford, as previously agreed and set out in emergency plans
- Council have obtained funding to improve road drainage on Elmridge. Work will include lowering the footpath and constructing a speed table in the road. This will encourage initial surface water run-off / flood basin spills back into Lilford Park Brook immediately downstream of the culvert under Elmridge
- Infrastructure repairs have already been completed at a number of locations, including a culvert collapse at St David's Crescent/St Elizabeth's Road, drainage network damage throughout the borough, and lengths of the River Douglas retaining walls which were damaged in the event.

United Utilities

- There was no sewer flooding reported to United Utilities on Boxing Day 2015 in this area

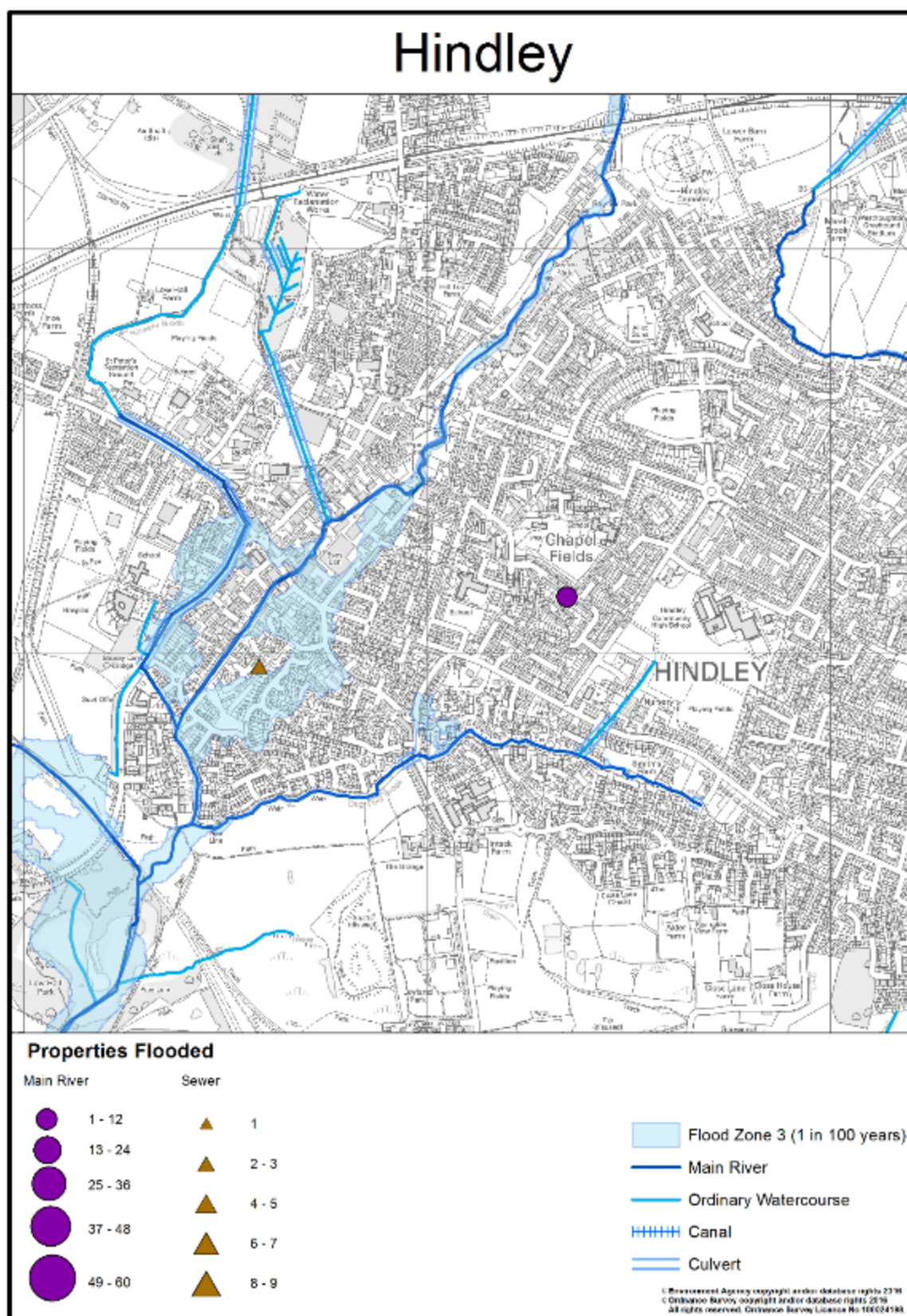
Appendix 1.7.4. Worsley Mesnes, Wigan



Points shown above indicated clusters of reported flooding and do not represent the exact properties or extents that experienced flooding

Description/Main Issues
<ul style="list-style-type: none"> • 9 properties flooded in this location – 8 from surface water and 1 from sewers • The surface water flooding in this area was compounded by high levels in Smithy Brook, which is a tributary of the River Douglas.
Environment Agency
<ul style="list-style-type: none"> • Recorded rainfall is estimated to have a likelihood of occurring once in up to 20-25 years • The level measured by the Environment Agency's gauge in the River Douglas at Wigan was the highest in 38 years of records – 1m higher than the previous highest level • Flows in rivers with a 1 in 100 chance of occurring in any given year are expected to stay within the river banks at this location. • Flooded properties are within Flood Zone 1 (less than a 1 in 1000 chance of flooding in any given year) • Assessments will be done to see if any areas which flooded from 'main rivers' should be offered a direct Flood Warning service in future, if this is not currently available. Local communities will be involved as opportunities to improve or extend the Flood Warning service are explored
Wigan Metropolitan Borough Council
<ul style="list-style-type: none"> • 8 properties were flooded from surface water, either direct standing water or from drains being unable to discharge due to high levels in Smithy Brook.
United Utilities
<ul style="list-style-type: none"> • 1 property reported as flooded from sewers in this area

Appendix 1.7.5 Hindley, Wigan



Points shown above indicated clusters of reported flooding and do not represent the exact properties or extents that experienced flooding

Description/Main Issues

- The Environment Agency, Wigan Council and United Utilities are working together on investigations at this location as flooding came from a variety of sources.
- 5 properties flooded from Borsdane Brook
- High river levels spilled over the left bank of the channel of Borsdane Brook and flowed south-westerly along Platt Lane, into Prescott Street, and through Aughton Street and Meadows Close before returning into Borsdane Brook. Other affected locations are Atherton Road and Lord Street
- Flooding previously occurred in 1999 and 2002 (unknown source - cause; blocked channel)

Photos



Picture 93 Water mark, Lord Street



Picture 94 Silt deposit; Aughton Street



Picture 95 Silt deposit; Lord Street

Environment Agency

- A flood warning was issued for Borsdane and Hockery Brook at Hindley
- The level measured by the Environment Agency's gauge in the River Douglas at Wigan was the highest in 38 years of records – 1m higher than the previous highest levels
- Flooded properties are located within Flood Zone 1 (less than a 1 in 1000 chance of flooding in any given year) and Flood Zone 2 (up to a 1 in 1000 chance of flooding in any given year)
- Improvements to the standard of flood protection at Hindley are to be investigated. Options will have been considered by the end of 2018 and a preferred solution recommended
- Natural measures to slow the flow into Borsdane Brook upstream of Hindley will be considered, such as by the creation of woody debris dams and ponds in or near woodland areas. These could also reduce potential blockages and resulting flood risk in the larger watercourses
- Borsdane and Hockery Brook at Hindley Flood Warning Area is currently being reviewed. Threshold levels will be altered if necessary. These improvements are ongoing and local communities will be involved in the process where appropriate

Wigan Metropolitan Borough Council

- A large number of properties were sandbagged by Wigan Metropolitan Borough Council

United Utilities

- 2 properties reported as flooded from sewers in this area



The Manchester Ship Canal – Boxing Day 2015

The Manchester Ship Canal Company Limited ("MSCC") is the statutory harbour authority for the Harbour and Port of Manchester, which includes the Manchester Ship Canal ("the Canal").

The Canal, which opened in 1894, was constructed by canalising the Rivers Irwell and Mersey above Latchford and by constructing a new watercourse between Latchford and Eastham (the entrance to the Canal).

There are various inflows into the Canal, most notably the Rivers Irwell, Irk, Medlock, Mersey, Bollin and Weaver, plus various smaller streams, brooks, industrial discharges and surface water drains/run-off. The outflows from the Canal comprise the River Mersey above Latchford and primarily the Weaver Sluices at Runcorn.

The Canal enables sea-going vessels to reach the heart of Manchester, and MSCC's primary function is, as required by statute, to ensure the safety of navigation for vessels using the Canal.

To enable MSCC to fulfil this primary function (and having regard to the environment created by the various inflows/outflows mentioned), there are various lock, sluice and weir structures along the Canal's length, which are used to maintain, so far as is reasonably practicable, water levels for safe navigation. The sluice structures are computer controlled and react to changes in water level by opening/closing as required. The computer control system is monitored on a 24-hour basis and is backed-up by personnel available on a call-out basis should additional assistance be required. During periods of increased inflows, the sluice/weir structures regulate the passage of water downstream through the Canal to the estuary of the River Mersey.

According to information provided by the Environment Agency, the Boxing Day rainfall within Greater Manchester was such that a combination of heavy rainfall and saturated catchments led to very high flow rates. The Environment Agency also recorded unprecedented water levels and flow rates in many of the rivers and tributaries which flow into the Canal. MSCC's infrastructure responded in the normal way (as outlined above) with the sluices opening under the computer control to enable water to flow downstream towards the estuary of the River Mersey. However, owing to the significant (in some cases unprecedented) flows which were experienced, lengths of the Canal's banks were washed away, infrastructure was damaged and in some areas banks were breached by the unprecedented flood waters. Where it was safe to do so, personnel were deployed to ensure that assets which were of critical importance to the regulation of water levels in the Canal (such as sluices) remained in operation. A considerable amount of debris was carried downstream from the River Irwell and was deposited into the Canal at Salford Quays. This amounted to circa. 70,000 tonnes and was subsequently cleared, when safe to do so, once the volume and velocity of the water had subsided.

At Latchford Locks, heavy rainfall in mid-December had carried a significant amount of debris into the Canal, and this debris caused damage to one of the sluice gates. Flows subsided sufficiently for the sluice to be dammed and safely assessed on 17th December, when it was discovered that the damage sustained by the sluice gate was considerable, thus rendering it inoperable.



Owing to the on-going repairs to the damaged sluice gate, sluicing capacity at Latchford was reduced by a third on Boxing Day. Furthermore, the Spring tide which also occurred on Boxing Day night reduced the outflow capacity of the River Mersey at Woolston, which meant that flows down the Canal tended naturally towards Latchford Locks. This naturally occurring combination of Spring tide, extreme rainfall and the already significant flows coming down the Canal from the Manchester area resulted in higher than normal water levels at Latchford Locks (a perfect storm scenario).

To avoid any risk to members of the public, at MSCC's request Cheshire Police closed the public right of way at Latchford Locks during this event.

The Environment Agency (as part of the Cheshire Strategic Command Group) was in communication with MSCC, via an incident management teleconference, and information was shared regarding how flows down the Canal were being managed.

The Canal is fed by main rivers, principally the Irwell and Mersey at its eastern end and the Weaver at its western end. In recognition of this, MSCC, the Environment Agency and the seven Lead Local Flood Authorities along the Canal's route agreed in 2015 to meet bi-annually to discuss issues of mutual interest and to improve co-ordination between the respective parties. The events on Boxing Day confirmed the necessity of this group, and the need to broaden the understanding of how the Canal's water levels are managed and how this relates to the wider flood management for areas adjacent to the Canal.

JB2AFL

June 2016

Appendix 3 – Rainfall and river level data

* - low confidence

Upper Irwell catchment which impacted on downstream areas	Rain Gauge	Local Authority area	National Grid Reference			6hr rainfall (mm)	Return Period (Yrs)	12hr rainfall (mm)	Return Period (Yrs)	24hr rainfall (mm)	Return Period (Yrs)	36hr rainfall (mm)	Return Period (Yrs)
	Worthington	Wigan	SD	58095	10271	39.0	10	46.5	10	66.2	20-25	73.8	20-25
	Bedford Pumping Station	Wigan	SD	66865	00032	22.2	2.0	25.4	2	33.2	2	36.2	1
	Holden Wood	Rossendale	SD	76657	22605	50.8	15	71	25-35	108.8	50-120	127.8	50-160
	Bacup	Rossendale	SD	87258	24742	47.4	10-15	71.2	25-40	102.8	50-90	117.8	50-100
	Cowm Res	Rossendale	SD	88131	18588	47.8	10	69.6	15-20	106.6	40-70	116.4	30-50
	Blackstone Edge	Rochdale	SD	96800	18300	37	4	47.8	3	74.4	7	79	5
	Sweetloves	Bolton	SD	70953	12620	39.2	6	50.4	6	72.8	10-15	83.4	10-15
	Ringley	Bolton	SD	76722	4896	34.8	6	41.6	6	52.2	5	56	4
	Heaton Park	Bury	SD	82636	4301	31.8	5	39.4	5	49.8	5	54.4	4
	Royton	Oldham	SD	90719	07122	32	4	40.8	4	56.4	6	64.2	5
	Greenfield	Oldham	SD	99157	04322	29.2	2	37.2	2	51.8	2	56.6	2
	Denton	Tameside	SJ	91123	95737	11.20	< 1 month	15.80	< 1 month	23.8	1	26.4	< 1 month
	Platt Fields	Manchester	SJ	84942	94449	9.6	< 1 month	11.4	< 1 month	18.6	< 1 month	20.6	< 1 month
	Sale	Trafford	SJ	76614	92651	11.0	< 1 month	12.3	< 1 month	20.2	< 1 month	24.5	< 1 month

Station	River	Local Authority area	Peak river gauge level (m)	Peak flow (m ³ /s) (2)	Years of data	Rank	Peak river level (mAOD)	Highest Historical (m)	2nd Highest Historical (m)	Annual Probability: less than (years)	Annual Probability: more than (years)
Wigan	Douglas	Wigan	2.55	37.1	38	1	34.149	1.517 (21/01/08)	1.489 (26/10/08)	75	50
Red Rock	Douglas	Wigan	2.19	-	14	1	51.052	1.51 (21/01/08)	1.49 (26/09/12)	75	50
Lilford Park Basin	Atherton Lane Brook	Wigan	4.515	-	10	1	25.205	3.214 (25/08/04)	3.103 (22/06/12)		1000 *
Irwell Vale	Irwell	Rossendale	3.428	177.0	17	1	142.651	2.834 (22/06/12)	2.266 (21/01/08)	100	75
Stubbins	Irwell	Rossendale	2.763	-	24	1	133.763	2.565 22/06/12	2.488 (14/06/12)	5 *	0 *
Ramsbottom	Irwell	Bury	3.385	-	10	1	127.415	2.726 (22/06/12)	2.385 (21/01/08)	200	101
Bury Grounds	Irwell	Bury	2.178	284.0	37	1	81.903	1.758 (22/06/12)	1.633 (21/01/08)	180	120
Kearsley Ultrasonic	Irwell	Bolton	6.330	500.0 *	13	1	46.660	4.677 (21/01/08)	4.643 (22/06/12)	150	100
Manchester Racecourse	Irwell	Salford	5.668	500.0	75	1	29.828	4.334 (21/01/08)	4.283 (23/06/12)	150	100
Pioneer Mills	Irwell	Bury	5.331	-	5	1	62.968	4.445 (23/06/12)	3.728 (31/03/15)	200	100
Littleborough	Roch	Rochdale	2.003	20.4	19	1	144.681	1.719 (22/6/12)	1.587 (2/8/02)	50	25
Station Rd, Milnrow	R Beal	Rochdale	1.861	-	21	1	145.046	1.269	1.092m (22/06/12)	100	50

Station	River	Local Authority area	Peak river gauge level (m)	Peak flow (m ³ /s) (2)	Years of data	Rank	Peak river level (mAOD)	Highest Historical (m)	2nd Highest Historical (m)	Annual Probability: less than (years)	Annual Probability: more than (years)
								(21/01/08)			
Albert Royds Bridge	Roch	Rochdale	2.425	50.8	22	1	125.101	2.008 (21/01/08)	1.905 (22/06/12)	50	25
Rochdale ETW	Roch	Rochdale	2.222	92.8	22	1	112.476	1.788 (21/01/08)	1.637 (31/01/95)	100	50
Blackford Bridge	Roch	Bury	3.362	192.0	64	1	66.282	2.264 (22/06/12)	2.192 (21/1/08)	180	120
London Road	Medlock	Manchester	1.387	18	48	5	32.171	2.767 (suspect 12/08/92)	1.714 (suspect 20/07/02)	15	5
Collyhurst	Irk	Manchester	1.146	44.2	20	1	30.354	1.1 (26/06/08)	1.019 (02/07/06)	40	15
Uppermill	Tame	Oldham	1.242	28.7	17	1	156.792	1.014 (22/06/12)	0.994 (21/01/08)	100	50

* - low confidence