MOTT MACDONALD

Section 19 Flood Investigation Report for July 2019 Event

Stockport Metropolitan Borough Council

26 November 2020

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Section 19 Flood Investigation Report for July 2019 event.

Stockport Metropolitan Borough Council

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Executive summary

During the period 28th July - 31st July 2019, areas across Northern England were hit by a low-pressure weather system and experienced periods of intense and significant rainfall. The Metropolitan Borough of Stockport was heavily impacted by the storms, which affected properties right across the borough and resulted in widespread flooding and transport disruption. Subsequently, a large number of reports of internal and external property flooding were raised with each of the flood Risk Management Authorities (RMAs). This Section 19 report investigates which authorities within the borough had relevant flood risk management functions and whether those authorities exercised those functions in response to the flood.

Prior to this significant flood events in 2016 were similarly investigated and reported upon in the June and September 2016 Flood Reports. This report also reviews the findings of the 2016 reports in the context of the further flooding in 2019 to identify if there are common themes. The report also considers the actions of the RMA's in the intervening period.

Analysis of the July 2019 rainfall and flood flow data indicates this event was more severe than both of the 2016 events and led to more widespread and locally more severe flooding. Rainfall exceeded current design standards for surface water drainage and some flooding or exceedance flows would have been expected. Flows in watercourses were high, some the highest on record, leading to flooding from banks and overtopping at bridges and culverts etc.

This study also aims to investigate whether the construction of the A555 Manchester Airport Relief Road has worsened, or has the potential to worsen, flood risk in the borough – with particular focus on the Poynton Brook/ Lady Brook/ Micker Brook watercourse and the adjacent communities.

Based upon gauged and radar rainfall the daily rainfall on Sunday 28th and Wednesday 31st July was significant. Whilst some flooding was reported on Sunday 28th the majority of flooding and disruption occurred on Wednesday the 31st. Alongside property flood reports, surface water flooding was reported at many locations across the borough along with flooding from some of the watercourses.

The incidence of flooding has been reviewed by reference to a number of 'hot spots' within the borough. This indicates a wide variation in flood sources dependent on local conditions. Surface water runoff from urbanised development is a contributory factor in some situations

Strategic and site-specific recommendations are included for action by the RMA's either singularly or in many cases in partnership with one another. Some of the recommended actions are common with those of 2016 but others are new. From a review of the 2016 actions it would appear that the majority have been actioned, but not necessarily completed. However, there are some recommendations from 2016 that are yet to be addressed.

On Micker Brook the flood extents were inconsistent with modelled and mapped flood extents; to the extent that a relatively recent housing development was flooded that was previously thought to lie out with the 1 in 1000 year flood outline. Other property alongside Micker Brook was similarly affected.

Each flood incident represents considerable disruption and hardship for affected residents and each resident seeks a solution. But in many cases there are no quick or easy wins, solutions will need to be evaluated to ensure the actions are appropriate, effective and affordable. Most incidences of flooding in the borough affect small numbers of properties and accordingly the

budget for interventions is relatively small if affordability is to be demonstrated. In a few instances benefits from groups of properties could justify a bigger programme of upstream attenuation storage or Natural Flood Management scheme in order to ‘slow the flow’ into Stockport. This would require careful quantification and working in partnership with upstream authorities and land owners.

Finally, the performance of the drainage of the A555 has been reviewed to understand the operational resilience of the highway and also whether the new road contributed to the 2019 flooding downstream on Lady Brook and Micker Brook. This review has highlighted some short comings in the A555 drainage design and construction but concludes these predominantly influence the resilience of the road and would have had little effect on the downstream flooding. A series of recommendations are made specific to the A555 to gain an understanding of how the roadway responds to rainfall events and how the robustness to flooding can be improved. Ongoing rectification of construction defects will improve the drainage system and can be expected to reduce the incidence of flooding. However, there are some design short-comings that will remain that mean the road will remain vulnerable to flooding from prolonged or frequent heavy rainfall.

1 Introduction

1.1 Flood Event Overview

During the period 27th July - 31st July, areas across Northern England were hit by a low-pressure weather system and experienced periods of intense and significant rainfall. The Metropolitan Borough of Stockport was heavily impacted by the storms, which affected properties right across the borough and resulted in widespread flooding and transport disruption and subsequently a large number of reports of internal and external property flooding. Rainfall was heaviest on Sunday 28th July and Wednesday 31st July. Flooding was reported on both days and in the days and weeks afterwards and their individual and cumulative effect will be considered in this report.

The number of properties which reported flooding are given in Table 1.1. These are shown divided by severity and by the authorities to which they were first reported. As such there is likely a small number of duplicate properties where reports were made to more than one RMA. It is also recognised that there is likely to be a degree of under-reporting where for one-reason or another property flooding was not reported to an RMA

Table 1.1: Reported Property Flooding

Authority	Number of flood reports by category							
	Cat. 1	Cat. 2A	Cat. 2B	Cat. 3A	Cat. 3B	Cat. 4	N/A	Total
Stockport Metropolitan Borough Council (LLFA)	17	149	52	30	157	70	2	477
United Utilities (UU)	-	61	6	118	64	6	-	255
Environment Agency (EA)	-	44	-	-	-	-	-	44
Total	**17**	**254**	**58**	**148**	**221**	**76**	**2**	**776**

Source: Contains Stockport Metropolitan Borough Council, Environment Agency and United Utilities data. For comparability, UU reports have been allocated to nearest LLFA severity category.
Severity categories:
Cat. 1 – threat to life or structural collapse
Cat. 2A – internal property flooding
Cat. 2B – low priority – outbuilding flooding (garages, sheds, barns, etc.)
Cat. 3A – basement/cellar flooding
Cat. 3B – minor highway incidents
Cat. 4 – gardens/fields/open spaces

In the same period, extensive flood damage was experienced in the catchments upstream of the SMBC boundary; notably within Lyme Park, in Poynton and more widely within the eastern part of the borough of Cheshire East.

1.2 Section 19 Investigation Requirements

The Flood and Water Management Act 2010[1] (the Act) requires the Lead Local Flood Authority (LLFA) to carry out duties for flood risk management. One of these duties is to carry out a flood incidents investigation following flooding events within their area which exceed a certain

[1] http://www.legislation.gov.uk/ukpga/2010/29/contents

threshold. These investigations are known as a Section 19 Flood Investigation and given the total of 776 flood reports this requirement of the Act is clearly triggered[2].

Section 19 Local authorities: investigations

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.

1.3 Report Objectives

In light of the flooding, Stockport Metropolitan Borough Council (SMBC) in its capacity as LLFA has commissioned this independent report to investigate the causes and major impacts of the event and to identify possible actions that can be taken by the LLFA and relevant Risk Management Authorities (RMAs) to mitigate the future risk of flooding. This investigation will broadly seek to:

(i) determine the causes of flooding at the most affected areas in the borough (the 'hotspots'), and identify high level/common issues across the remainder of the borough,
(ii) understand the roles and responsibilities of the RMAs operating in Stockport and whether these are being fulfilled, and
(iii) provide recommendations as to how the RMA's performance and response to flood incidents can be improved.

The widespread flooding in the borough in July 2019 comes soon after other significant flood events in 2016 that were similarly investigated and reported upon in the June and September 2016 Flood Reports. This report also reviews the findings of the 2016 reports in the context of the further flooding in 2019 to identify if there are common themes.

This study also aims to investigate whether the construction of the A555 Manchester Airport Relief Road has worsened, or has the potential to worsen, flood risk across the borough – with particular focus on the Poynton Brook/ Lady Brook/ Micker Brook watercourse and the adjacent communities. The effect of this road was looked at as part of the 2016 Section 19 report[3] when the road was under construction, however the extent of the flooding caused by the July 2019 event and aspects of the road's performance in the intervening period has renewed concerns regarding the road's water management capabilities.

[2] http://www.legislation.gov.uk/ukpga/2010/29/section/19

[3] Section 19 Investigation Report, June 2016 Flood Events, Jacobs, October 2016.

1.4 Relevant Risk Management Authorities

Risk Management Authorities (RMA's) have specified responsibilities, duties and powers related to local flood risk management. [4] Within Stockport MBC area the relevant RMA's are indicated in Table 1.2.

[4] Section 4 of "Local Flood Risk Management Strategy for Stockport" by Stockport Metropolitan Borough Council, dated April 2016

Table 1.2: Authority management of assets

	Stockport Council/LLFA	Environment Agency	United Utilities	Stockport Council as Highway Authority	Riparian Owners
Highways				✓	
Public sewers			✓		
Advising on flood protection	✓	✓	✓		
Culverts	✓	✓		✓	✓
Main river		✓			✓
Ordinary watercourse	✓				✓
Surface water from highway				✓	
Surface water from other sources	✓				✓
Sewer flooding			✓		
Groundwater flooding	✓				✓
Water supply infrastructure			✓		
Reservoirs	✓		✓		✓

1.4.1 Stockport Metropolitan Borough Council

As the Lead Local Flood Authority (LLFA) for the area, Stockport Metropolitan Borough Council (SMBC) has a range of duties which includes development of a Local Flood Risk Management Strategy document, carrying out flooding investigations, keeping a record of structures which influence flood risk, regulate ordinary watercourses and being a Statutory Consultee on major planning applications. SMBC also has a statutory duty to maintain the highways with its border; this includes taking reasonable care to make sure that it is properly drained.

1.4.2 Environment Agency (EA)

The Environment Agency's local role as a risk management authority is relevant in managing flooding from main rivers and reservoirs, to communicate flood risk warnings, to support flood resilience in communities, to advise on planning process, and to bring forward flood defence schemes.

1.4.3 United Utilities (UU)

Water and sewage companies have responsibilities around flood risk management including response to flood incidents involving their assets, maintaining a register of properties at risk of flooding due to hydraulic overload from sewers, maintaining and operating public sewers to effectively drain areas, undertake capacity improvements and have a duty for adoption of private sewers.

1.4.4 Highways England

As a Highway Authority, Highways England has the same obligation to co-operate on flood risk issues as the other risk management authorities. It also has further responsibilities under other legislation, including ensuring its highway drainage systems are maintained and deliver works to protect its highways from flooding. Highways England is responsible for the management of the

motorway and trunk road system in England; within the SMBC borough Highways England has responsibility only for the M60 motorway. In the 2019 flood reports there are no apparent linkages between reported flooding and the M60 and accordingly no investigation or consultation with Highways England has been undertaken.

1.4.5 Utility and Infrastructure Providers

Utility and infrastructure providers such as Network Rail, Canal and River Trust, energy companies and telecommunication companies are not risk management authorities. However, their roles are to maintain and plan for effective flood risk management for their assets and services. Moreover, they may have assets such as culverts (i.e. they are 'Riparian' owners) for which it is important to share information of these with the flood risk management authorities.

1.4.6 Businesses and Local Households

1.4.6.1 Property Owners and Residents

It is the responsibility of householders and businesses to look after their property, including protecting it from flooding.

1.4.6.2 Riparian Owners

Householders or businesses whose property is adjacent to a watercourse (a river, stream, culvert or ditch) are likely to be riparian owners with responsibilities (e.g. without detailed ownership knowledge the default property boundary is likely to be the centre of the watercourse). Riparian owners have the right to protect their property from flooding and erosion. They also have responsibility for maintaining the bed and banks of the watercourse and ensuring there is no obstruction, diversion or pollution to the flow of the watercourse. These responsibilities apply to all watercourses whether 'main river' or 'ordinary watercourse'. The LLFA have powers and additional responsibilities in respect of all 'ordinary watercourses' and the EA correspondingly for 'main rivers'; neither authority are routinely 'riparian owners' other than when a watercourse passes through property in their ownership.

1.5 This S19 Report

This Section 19 Investigation Report has been prepared by Mott MacDonald on instruction from SMBC. The report is an independent assessment of the flooding events of late July 2019, the response of the RMA's and contains findings and recommendations for implementation going forward.

The Report has been prepared following consultations and information exchanges as follows:

- Flood reports data bases from LLFA, EA and UU.
- Briefings with LLFA, EA and UU.
- Site walkovers in flood hot spot areas.
- Public consultations in flood hot spot areas.
- Construction drawings of the A555.
- On-site briefing of A555 drainage infrastructure.
- Supporting flood evidence from affected residents.

Inputs from all sources is gratefully acknowledged.

The report is structured as follows:

- Section 2; Overview of the July 2019 Flooding.

- Section 3; RMA responses to July 2019 Flooding.
- Section 4; Overview of Previous S19 Flood Investigations.
- Section 5; Discussion of findings of this S19 Investigation.
- Section 6; Conclusions and Recommended Actions
- Appendices A – O Including detailed discussions of SMBC flooding hotspots from 2019 reported flooding.

2 Overview of 2019 Flooding

2.1 Summary of Reported Flooding

Table 1.1 summarises the number of property flooding reports indicating the RMA to which the incidence of flooding was first reported and the severity of flooding. As such there is likely a small number of duplicate properties where reports were made to more than one RMA. It is also recognised that there is likely to be a degree of under-reporting where for one-reason or another property flooding was not reported to an RMA.

Figure 2.1 Indicates the locations of all 776 reported incidences of property flooding; the figure plots reported flooding by postcode and as such a spot on the figure is plotted at the central postcode location and does not locate individual properties affected. Accordingly, there are multiple spots overlaid in some locations giving the impression of fewer than 776 occurrences. The figure serves to indicate:

- Flooding was widespread across the borough,
- At the same time there are 'hot spots' where there are significant concentrations of flood reporting.

2.2 Property Flood Impacts and Sources of Flooding

Incidence of 'flooding' i.e. temporary inundation of areas not normally underwater and likely outwith the banks of river channels, is in itself not significant but where such flooding creates disruption and/or impacts travel or property then this is significant. Property impacts are broadly categorised by each RMA by severity as follows:

- Cat. 1 threat to life or structural collapse
- Cat. 2A internal property flooding
- Cat. 2B low priority – outbuilding flooding (garages, sheds, barns, etc.)
- Cat. 3A basement/cellar flooding
- Cat. 3B minor highway incidents
- Cat. 4 gardens/fields/open spaces

Flooding at a particular location can arise from one or more of the following main sources:

- Fluvial flooding, from overflowing of watercourses (main rivers, ordinary watercourses, brooks etc),
- Surface water flooding, from inundation by overland flow from permeable and impermeable surfaces,
- Sewer flooding, from flows exiting below ground drains and sewers (including surface water sewers, combined sewers and foul sewers),
- Groundwater flooding, from flows seeping out of the ground due to a high watertable.

In many situations the primary cause of flooding is not immediately obvious; e.g. local surface water flows on highways may be attributed to surface water flooding but could be the result of overflowing of surface water sewers or highway drains at a remote location. Nevertheless, an attempt has been made to allocate a primary and secondary source of flooding to each incidence of flooding in order to gain an understanding where the problem originates.

As described earlier the incidence of flooding was widespread across the borough, with many isolated instances, but was also characterised by local flooding 'hot spots'. To better understand the flooding impacts, sources and reasons this investigation has focussed on the 'hot spots'. Accordingly, for these locations the flood reports and feedback at the public consultations has been reviewed to try to understand the local issues and identify practicable actions. The reviews of the following flooding hot spots are contained in Appendices C – N of this report:

- C. Bramhall Green
- D. Bramhall Moor
- E. Sandringham Road
- F. Queens Road
- G. Wilmslow Road
- H. Borrowdale Avenue
- I. High Lane (Woodside Drive/Cromley Road/Aldersgreen Avenue)
- J. Torkington and Hazel Grove
- K. Bean Leach Road (Poise Brook)
- L. Adswood Road
- M. Councillor Lane
- N. Gatley Brook
- O. Glenside Drive and Werneth Road, Woodley
- P. Romiley (Central Drive/ Guywood Lane/ Leyfield Avenue/Sandy Lane)

The findings of the hot spot reviews are carried forward to the conclusions and recommendations.

2.3 Stockport's catchments

For reference purposes the mapping shown in Figures 2.1 shows the SMBC boundary for comparison with the total watercourse drainage catchment passing through the borough. And on Figure 2.2 the critical catchments (for the 2019 flood events) of Micker/Lady/Poynton/Norbury Brooks and of Poise Brook. The figures serve to show that the rivers/brooks through the borough convey runoff from a wide area upstream and out-with the SMBC area; principally the drainage systems extend upwards to the East towards the Pennine watershed. Accordingly, SMBC is not in a position to directly influence runoff entering its boundary as a consequence of for example development or upland management.

Table 2.1: Borough Catchment Areas

			Borough area =	126	km2
Areas based on Borough Boundary					
River	Upstream of borough (km2)	Within borough (km2)	Total exiting borough (km2)	% US of borough	% Within borough
Goyt	311.2	54.3	365.5	85%	15%
Mersey	0.0	29.0	29.0	0%	100%
Tame	139.1	8.1	147.2	94%	6%
Micker Brook	31.1	28.2	59.2	52%	48%

Source: MM

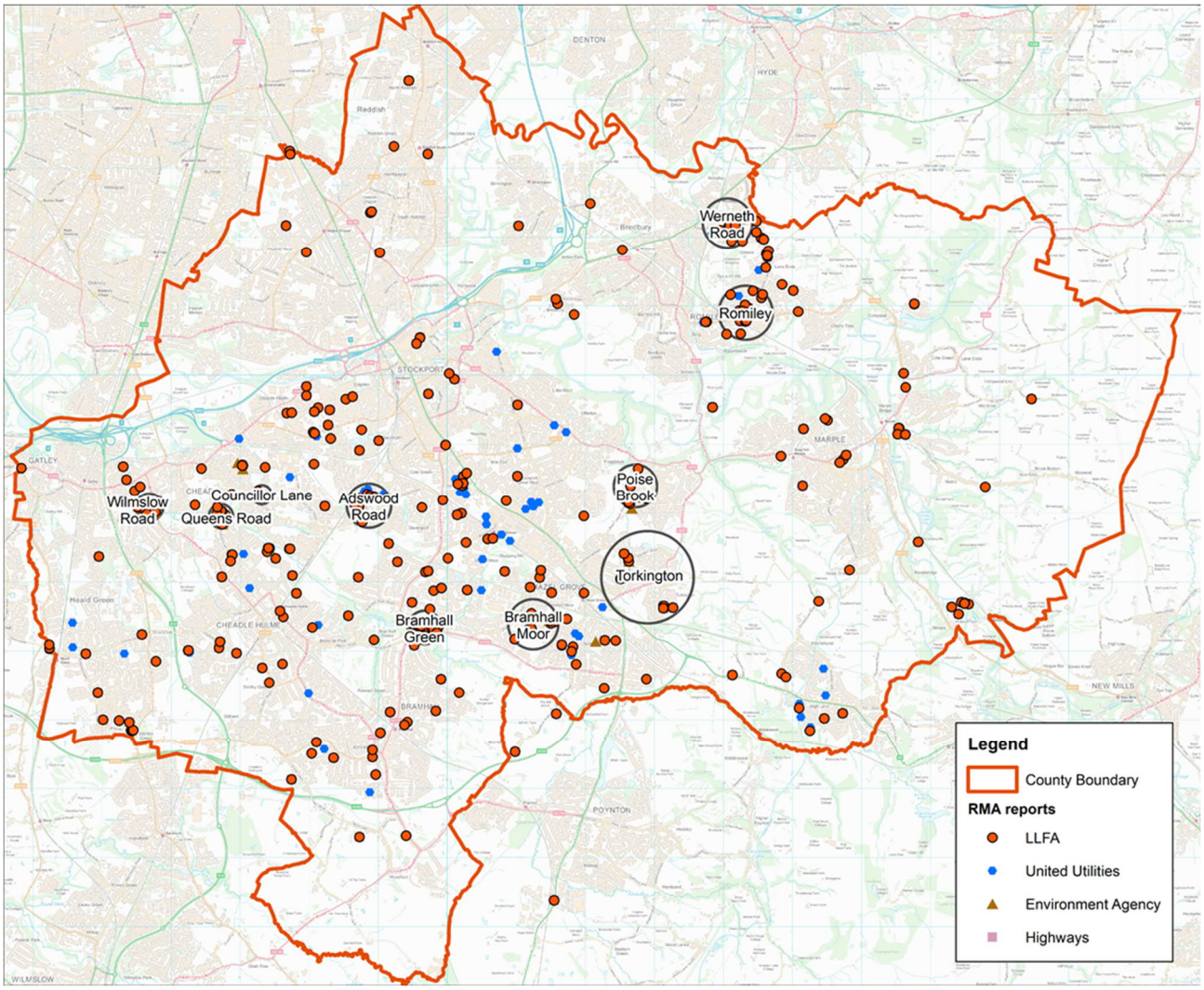
Table 2.2: Micker Brook Catchment Areas

Micker Brook	Area of catchment between points(km2)	Cumulative catchment area up to a point (km2)	% of catchment to A555	% of catchment to Bramhall Green	%To Demmings	% To Mersey
Up to A555	32.5	32.5	100%	75%	66%	55%
A555 to Bramhall Green	10.9	43.4		100%	88%	73%
Bramhall Green to Weir upstream of Demmings	6.1	49.5			100%	83%
Demmings to River Mersey	9.9	59.4				100%
Full Area to confluence with R Mersey	59.4					

Source: MM.

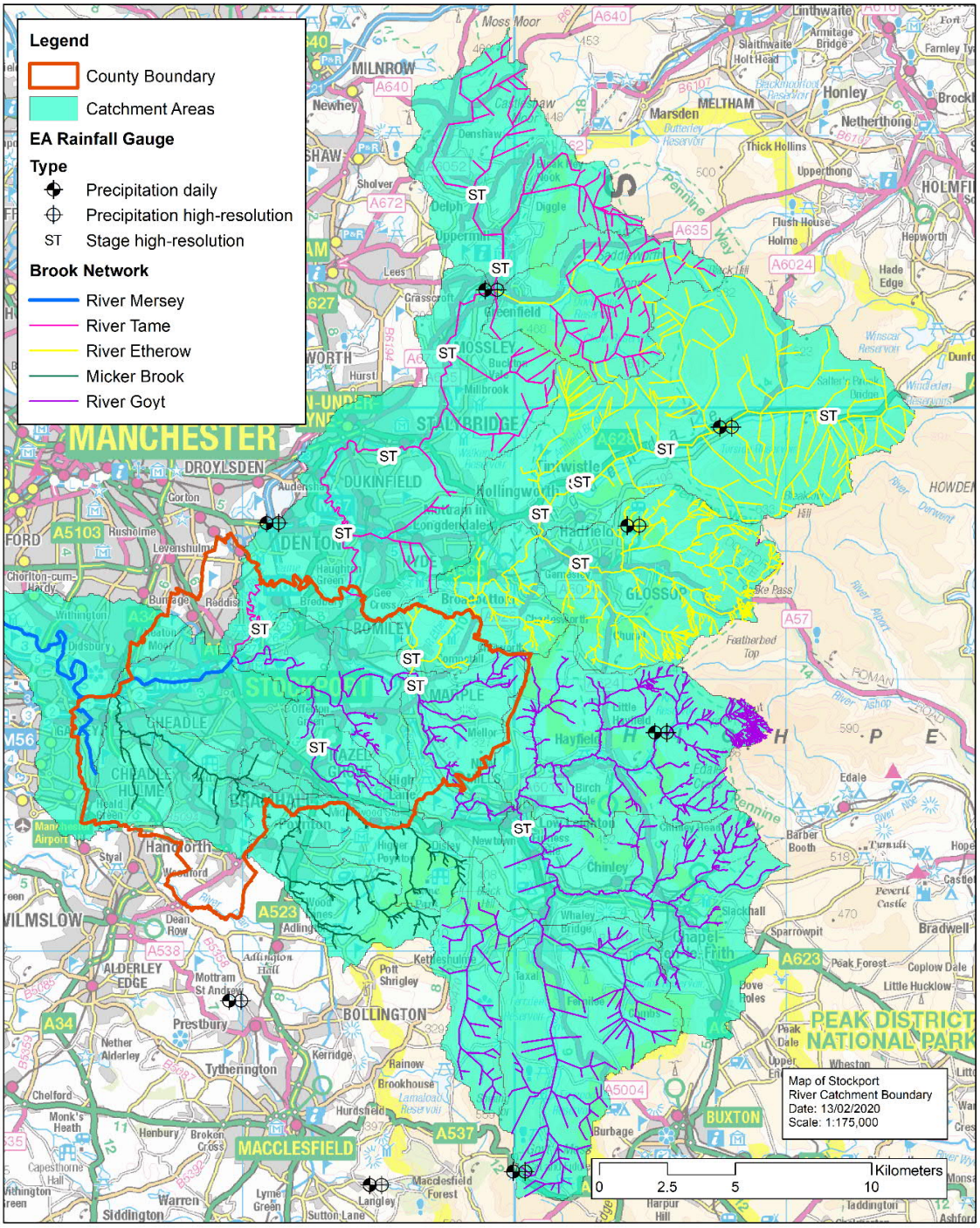
Note; Not all of the A555 drains to Ladybrook; the area of permeable and impermeable surfaces that are drained to Micker Brook (Lady Brook) as part of the A555 scheme is approximately 2.0km^2 (source MARR, Drainage Strategy Report), which represents approximately 5% of the total catchment to Bramhall Green and 4% of the catchment to the Demmings Industrial estate. The impermeable surfaces of the A555 drained to Ladybrook form just 5% of the drained area and accordingly represents less than 0.25% of the catchments at Bramhall Green and the Demmings.

Figure 2.1: All July 2019 reported flooding plotted by postcode; showing flooding 'hotspots'.



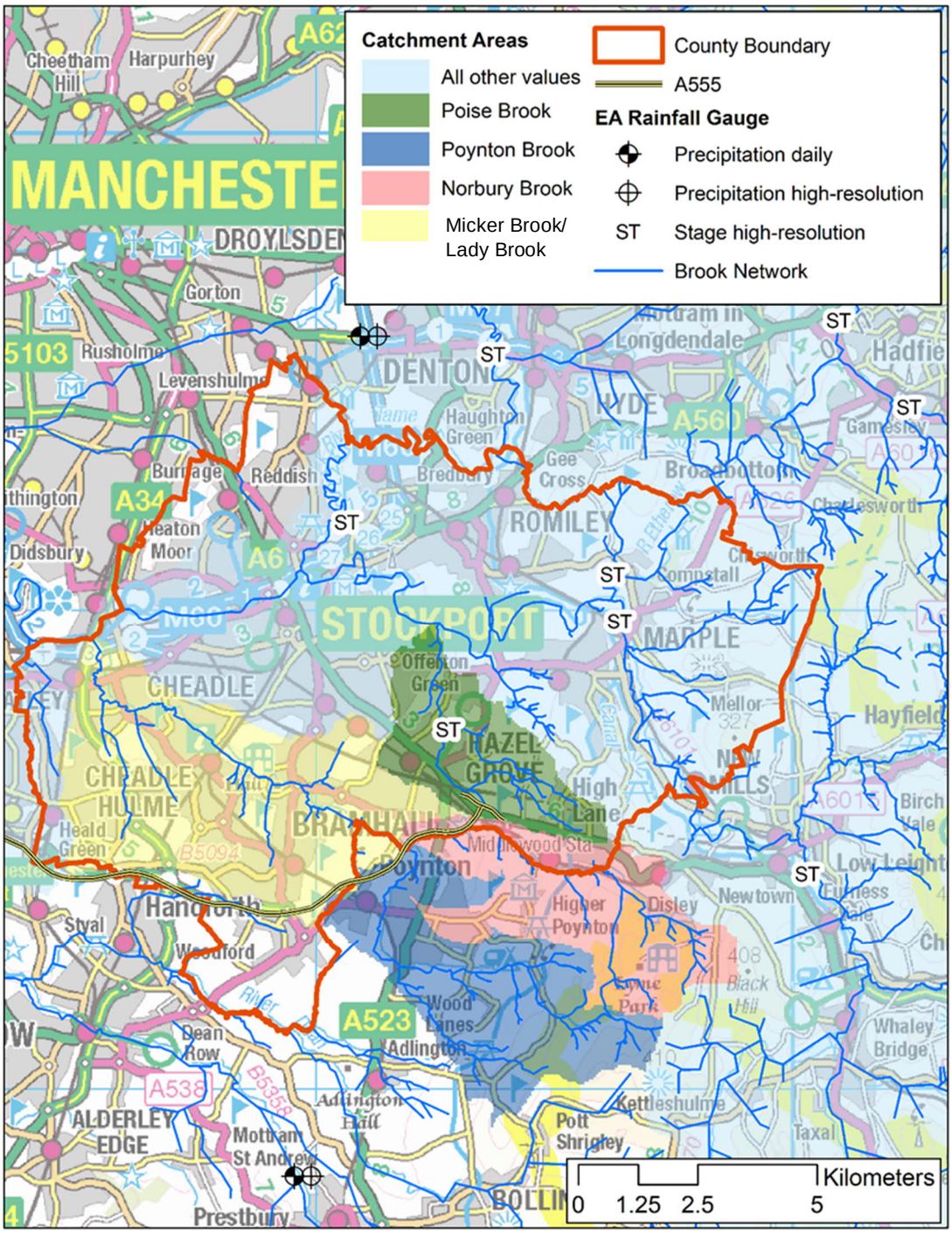
Source: Mott MacDonald; source data from RMA's and base map contains public sector information licensed under the Open Government Licence v3.0

Figure 2.2: Stockport borough boundary and catchment areas draining through the borough



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Figure 2.3: Micker/Lady/Poynton/Norbury Brook and Poise Brook detail catchment plans



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2.4 Event Rainfall

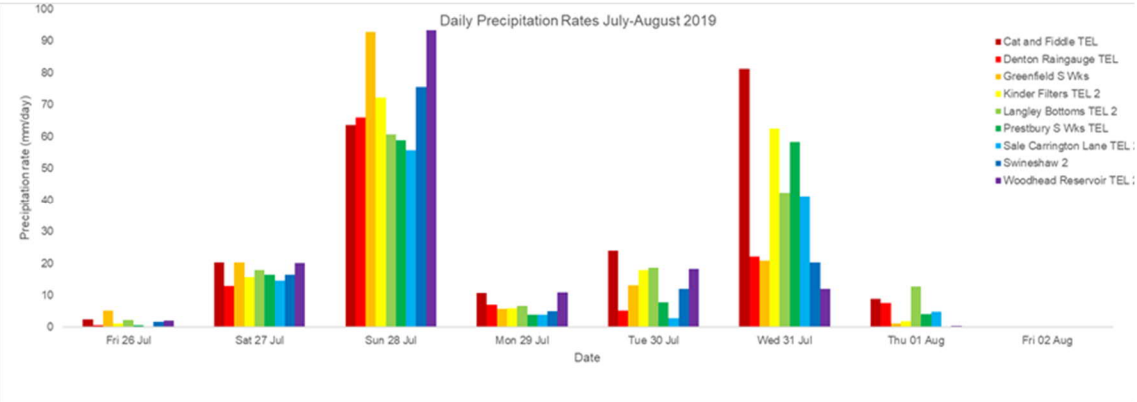
In order to understand the significance of the rainfall event(s) of late July 2019 detailed records of the rainfall pattern over the Stockport catchments have been obtained/inspected from the EA and other sources.

In the period Sunday 28th July to Wednesday 31st July 2019 (and beyond) an area of slow-moving low pressure tracked from southwest England up to the Yorkshire coast. The associated bands of rain and showers continually fed into northern England and across the Pennines, and the successive bands of slow-moving showers gave torrential downpours and spells of intense rain.

The Cat and Fiddle rain gauge at the top end of the R Goyt catchment is a good example of the pattern and severity of the rainfall that affected the borough in the period. This gauge recorded daily rainfalls of 20mm, 64mm, 11mm, 24mm and 81mm for Saturday 27th July to Wednesday 31st July; a total of 200mm in 5 days. The rainfall pattern, albeit with smaller total rainfall was repeated across the borough.

Rainfall data for the borough for the July event is sparse as rain gauges are located around the perimeter of the area of interest and the single centrally located gauge at Meadowbank School, Cheadle was found to have become blocked around the 28th July and was not cleared until 8th August. Accordingly, the Meadowbank rainfall data is not available. However, the available gauged rainfall data from the EA for gauge sites local to the borough is presented in Figure 2.4.

Figure 2.4: Daily rainfall totals for gauge sites local to Stockport

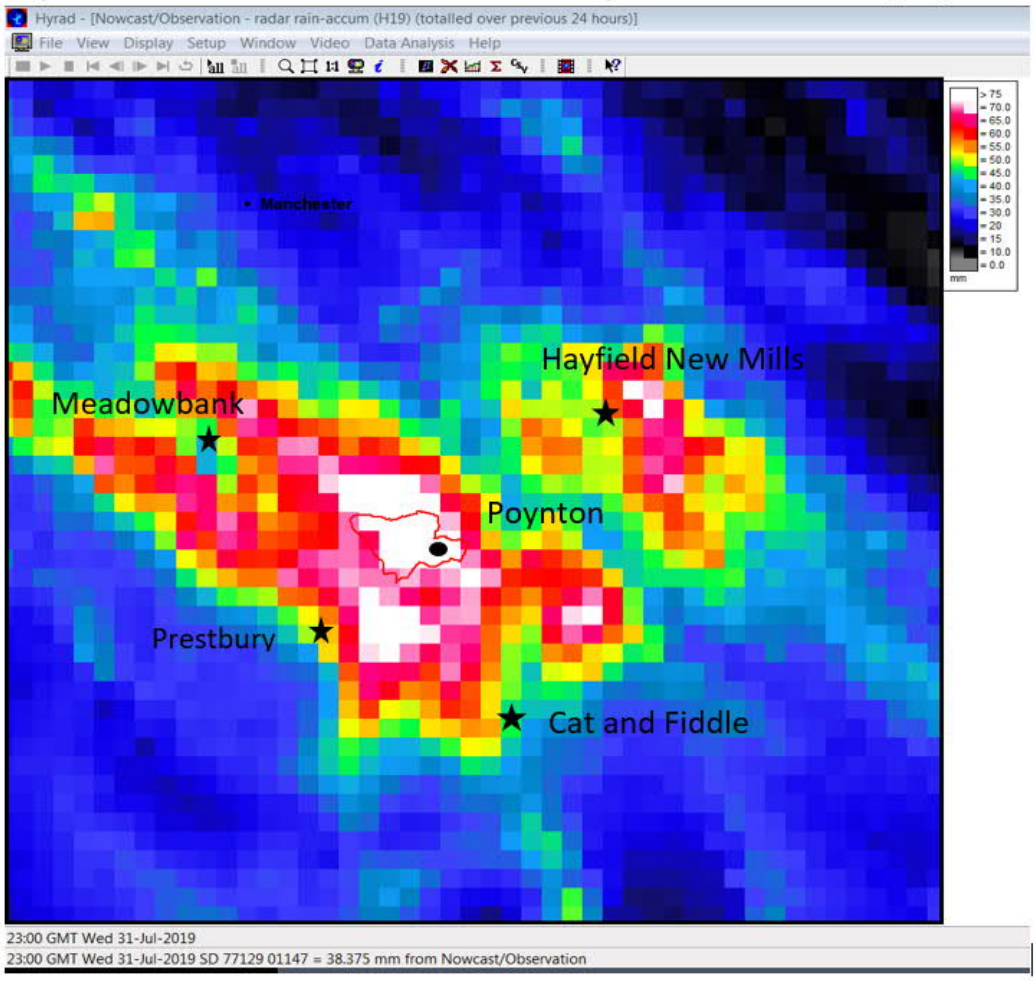


Source: Environment Agency

Figure 2.4 shows that, with the exception of Cat and Fiddle, all 1-day rainfalls were greater on the 28th than on 31st July, although some locations e.g. Prestbury received similar rainfall. Figure 2.6 shows the hourly distribution of the Prestbury rainfalls indicating that the 28th was characterised by steady but heavy rain whereas on the 31st there were pulses of intense rainfall.

The location of the key rain gauge sites is shown on Figure 2.5; this also shows for 31st July 2019 the distribution of 24 hour rainfall across the borough based upon rainfall radar measurements. This indicates that the highest total rainfall, in excess of 75mm (white area), was centred around Poynton which lies just upstream of the critical watercourse of Lady Brook/ Micker Brook.

Figure 2.5: Poynton rainfall radar accumulation 24 hours prior to 23:00 GMT 31/07/2019.



Source: Environment Agency

Table 2.3: Gauged rainfall totals local to Stockport borough for 1 day, 2 day, 3 day and 4 day durations.

Daily Precipitation Rates	22 Jul	23 Jul	24 Jul	25 Jul	26 Jul	27 Jul	28 Jul	29 Jul	30 Jul	31 Jul	01 Aug	02 Aug	HIGH	LOW
Cat and Fiddle TEL	0	0	0	0	2	20	64	11	24	81	9	0	93	56
Denton Raingauge TEL	0	0	0	0	1	13	66	7	5	22	8	0		
Greenfield S Wks	0	0	0	0	5	20	93	6	13	21	1	0		
Kinder Filters TEL 2	0	0	0	0	1	16	72	6	18	63	2	0		
Langley Bottoms TEL 2	0	0	0	0	2	18	61	7	19	42	13	0		
Prestbury S Wks TEL	0	0	0	0	1	16	59	4	8	58	4	0		
Sale Carrington Lane TEL 2	0	0	0	0	0	15	56	4	3	41	5	0		
Swineshaw 2	0	0	0	0	2	16	76	5	12	20	0	0		
Woodhead Reservoir TEL 2	0	0	0	0	2	20	93	11	18	12	1	0		

2 day RAIN DEPTH

Daily Precipitation Rates	22 Jul	23 Jul	24 Jul	25 Jul	26 Jul	27 Jul	28 Jul	29 Jul	30 Jul	31 Jul	01 Aug	02 Aug	HIGH	LOW
Cat and Fiddle TEL						23	84	74	35	105	90	9	113	70
Denton Raingauge TEL						14	79	73	12	27	30	8		
Greenfield S Wks						25	113	99	19	34	22	1		
Kinder Filters TEL 2						17	88	78	24	80	64	2		
Langley Bottoms TEL 2						20	78	67	25	61	55	13		
Prestbury S Wks TEL						17	75	63	12	66	63	4		
Sale Carrington Lane TEL 2						15	70	60	7	44	46	5		
Swineshaw 2						18	92	81	17	32	20	0		
Woodhead Reservoir TEL 2						22	113	104	29	30	13	1		

3 day RAIN DEPTH

Daily Precipitation Rates	22 Jul	23 Jul	24 Jul	25 Jul	26 Jul	27 Jul	28 Jul	29 Jul	30 Jul	31 Jul	01 Aug	02 Aug	HIGH	LOW
Cat and Fiddle TEL						23	86	95	98	116	114	90	124	74
Denton Raingauge TEL						14	80	86	78	34	35	30		
Greenfield S Wks						25	118	119	112	40	35	22		
Kinder Filters TEL 2						17	89	94	96	86	82	64		
Langley Bottoms TEL 2						20	81	85	86	68	74	55		
Prestbury S Wks TEL						17	76	79	71	70	70	63		
Sale Carrington Lane TEL 2						15	70	74	63	48	49	46		
Swineshaw 2						18	94	97	93	37	32	20		
Woodhead Reservoir TEL 2						22	115	124	123	41	31	13		

4 day RAIN DEPTH

Daily Precipitation Rates	22 Jul	23 Jul	24 Jul	25 Jul	26 Jul	27 Jul	28 Jul	29 Jul	30 Jul	31 Jul	01 Aug	02 Aug	HIGH	LOW
Cat and Fiddle TEL						23	86	97	119	180	125	114	180	104
Denton Raingauge TEL						14	80	87	91	100	42	35		
Greenfield S Wks						25	118	124	132	133	41	35		
Kinder Filters TEL 2						17	89	95	112	159	88	82		
Langley Bottoms TEL 2						20	81	87	104	128	80	74		
Prestbury S Wks TEL						17	76	80	87	129	74	70		
Sale Carrington Lane TEL 2						15	70	74	77	104	53	49		
Swineshaw 2						18	94	99	109	113	37	32		
Woodhead Reservoir TEL 2						22	115	126	143	135	42	31		

Table 2.3 indicates highlighted yellow that the most severe 1-day and 2-day rainfalls were almost exclusively up to midnight of Sunday 28th July 2019. Whereas, the most severe 4-day rainfall totals were almost exclusively up to midnight of Wednesday 31st July 2016.

A rain gauge at Lyme Park (Met Office data) recorded a 3-day total rainfall of 92mm up to and including 31 July 2019; this is comparable to the 116mm recorded in the same period at the Cat and Fiddle rain gauge but at higher elevation. Full data for this site has not been obtained.

Table 2.4 indicates 'indicative' return periods for rainfalls of duration between 3 hours to 120 hours (5 days) for selected rainfall locations. The 'indicative rainfall return periods show for short durations, up to 12 hours the return periods are quite small except for the values derived from radar rainfall data for Poynton where return period is estimated at circa 25 years. For 18 – 24 hours for Poynton a 50 year return period is estimated and for the Cat and Fiddle the corresponding value is 75 years. These estimated rainfall return periods indicate significant rainfall events but the table also serves to show that the rainfall was not as severe elsewhere with lower return periods indicated at Hayfield and Prestbury.

Table 2.4 also shows indicative rainfall return periods for storm durations up to 120 hours which capture the heavy rainfall on both the 28th and 31st July and indicate that taken together this leads to much greater rainfall return periods being forecast. For the relatively small catchments draining

to the borough such long durations are not pertinent because the catchment runoffs are swift such that runoff from the 28th event should have largely drained away by the 31st.

Table 2.4: Indicative Rainfall return periods

Duration (hours)	Raingauges						Radar	
	Cat and Fiddle		Hayfield/Kinder Filters		Prestbury		Poynton	
	Rain (mm)	Return Period (years)	Rain (mm)	Return Period (years)	Rain (mm)	Return Period (years)	Rain (mm)	Return Period (years)
3	30.4	6	25.2	-	23.3	4	40.2	27
6	40	7	32.4	4	30.1	4	45.7	23
12	51.6	7	47.1	7	35.8	4	53.4	22
18	80.8	40	67.9	20	58.3	2	71.1	51
24	97	75	72.9	15	64	25	75.4	49
36	105.2	70	85.6	20	66	18	80.3	43
48	105.6	48	85.6	16	78.7	31		
72	130	71	107.6	17	86.1	29		
96	187.8	540	160.7	106	134.9	266		
120	200.2	520	172.6	113	145.7	324		

Source: Environment Agency data.

For comparison purposes, both the 2016 S19 Flood Reports (June and September) indicate daily rainfall totals at Meadowbank School of 37mm; which is approximately half the corresponding figure from the Poynton radar data for 31st July 2019.

Accordingly, it is concluded from the rainfall data that:

- Rainfall in the period 28th to 31st July 2019 (4 days) was severe across a wide swathe of the borough; rainfall was both of short duration high intensity and accumulated significant rainfall depths over the course of the event(s). Highest daily rainfall on the 31st was centred on Poynton; where in excess of 75mm is indicated from rainfall radar records. 1 day and 4 day rainfall totals at the Cat and Fiddle Inn at the SE boundary of the catchments draining to Stockport were recorded as 81mm and 180mm respectively.
- 1 day rainfall return periods for the 31st July event are estimated to be in the range 25 years at Prestbury to 75 years at the Cat and Fiddle. 4 day rainfall return periods including the 31st July event are estimated to be in the range 266 years at Prestbury to 540 years at Cat and Fiddle. In simple terms, the rain on one day was the kind of rain we expect to get every 25 years or so, but when you look at it over 4 days it was the kind you expect to get every 266 years.
- The 4 day return periods are clearly significant but not directly applicable to the small river catchments and surface water runoff situations within Stockport. For such catchments the effects of the heavy rainfall on 28th July would be expected to have been largely dissipated by the 31st July. However, in the case of the A555 it is known that the attenuation ponds were still draining down and so storage available for the rainfall of 31st July will have been reduced.
- In addition, rainfall radar data indicates that for the 31st highest rainfall was centred around Poynton which is not captured by the more remote rain gauges; indicating the local event could have been more severe.

- 1 day rainfall within the borough may have been approximately double the values reported in the June and September 2016 S19 reports.
- Based on the rainfall data alone it may be concluded that event rainfall is likely to have exceeded surface water drainage infrastructure design standards across a large area of the borough and surface water flooding would be expected even if all systems were designed to modern standards and fully functional.
- Also, given the rainfall intensities and total rain depth flooding on ordinary watercourses would be expected.

2.5 Event Runoff Response

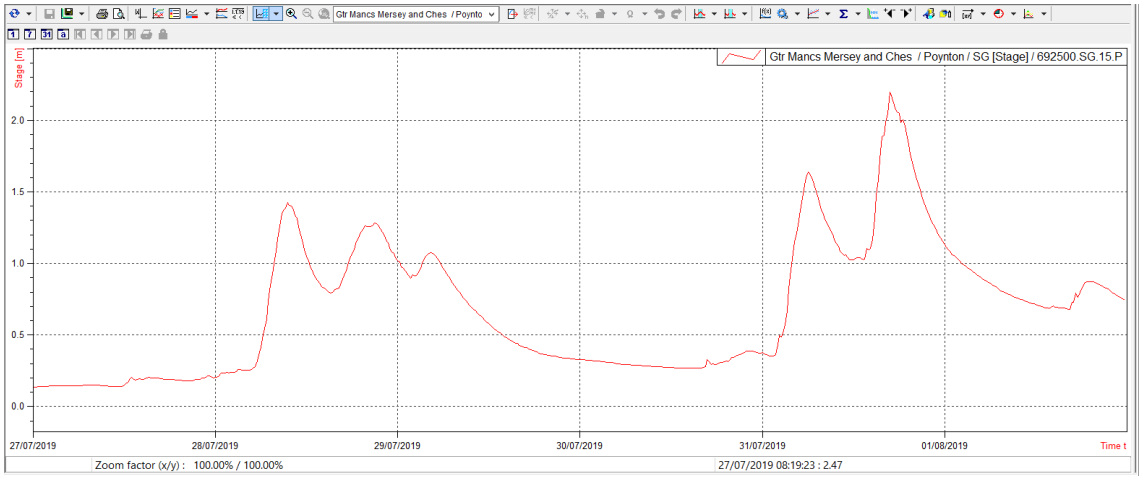
There are 3 flow gauge sites relevant to watercourse flow measurement in the borough; these are located as follows:

- Poynton Brook at Poynton
- River Goyt at Marple Bridge
- Poise Brook at Offerton

Figures 2.6, 2.7 and 2.8 show the recorded flow levels at each location respectively over the period 28th July to 31st July 2019. For flow gauge sites it is the flow depth that is measured to obtain an estimate the discharge using the site's rating curve. For this report we show only the flow levels with respect to time to indicate the catchments response to rainfall. For each location there are clear spikes in flood level on the 28th and 31st July. For Poynton Brook and the River Goyt the peak flood level on the 31st is significantly greater than the peak on the 28th. For Poise Brook the peak on 28th is slightly greater than the peak of the 31st and is perhaps indicative of less intense rainfall in the north of the borough on the 31st.

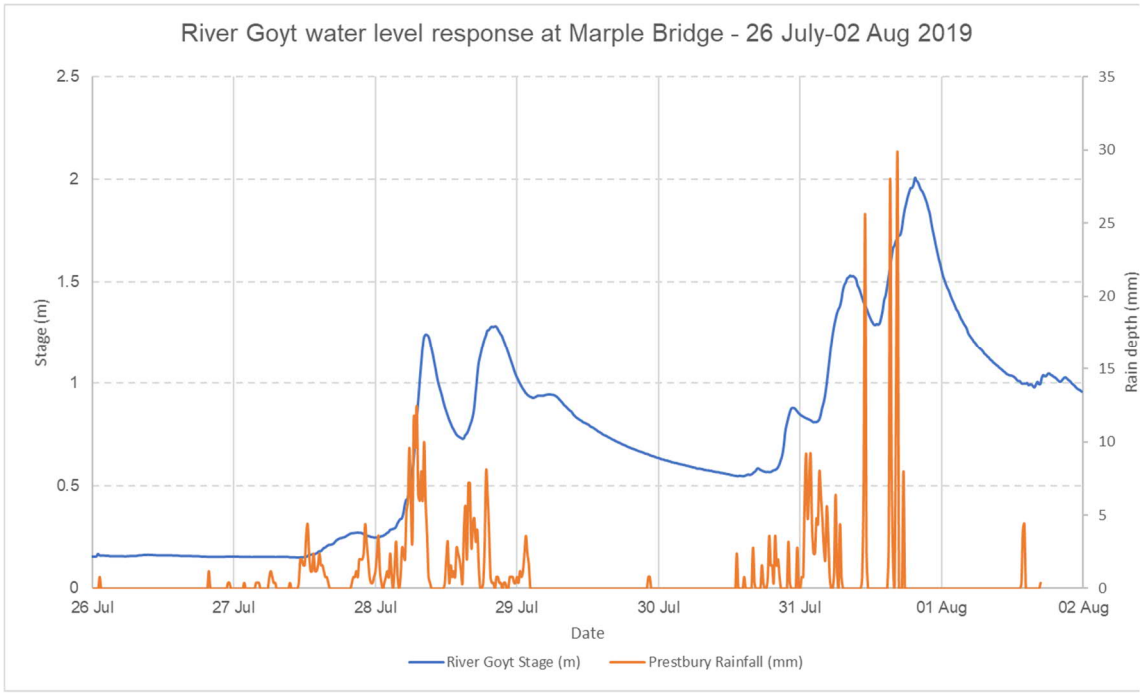
For the River Goyt flood levels, Figure 2.7, hourly rainfall is also shown to indicate the response in gauged flow depth. We have used the rainfall data from Prestbury to illustrate the behaviour but the actual catchment response is relative to the distribution of rainfalls across the whole catchment; in this case from the Cat and Fiddle in the south and east right down to the gauge site at Marple Bridge. The figure serves to show how the flood levels rise rapidly to spikes of rainfall and then decline more slowly. Also relevant in all of Figures 2.6, 2.7 and 2.8 is that the flow level between 28th and 31st almost returns to the starting condition; indicating for these watercourses, which have a rapid rainfall to runoff response, that the events of 28th and 31st are almost independent. It is relevant however that the 31st rainfall would have fallen on saturated ground and most likely a higher percentage would have immediately runoff to watercourses.

Figure 2.6: Poynton Brook at Poynton gauge level response to 28th July 2019 – 01st August 2019 rainfall



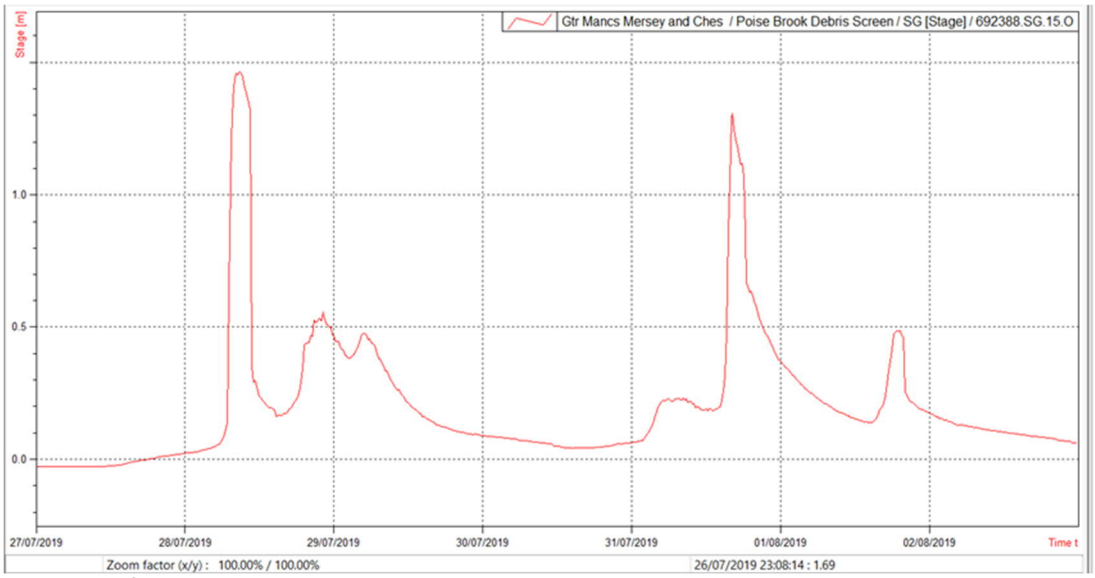
Source: Environment Agency

Figure 2.7: Runoff response; River Goyt Flood levels with Prestbury Rainfall data



Source: Environment Agency data presentation by MM

Figure 2.8: Runoff response; Poise Brook flood levels



Source: Environment Agency

As a result of the rainfall on 31st July 2019 the water level at Poynton gauge reached 2.195m, the highest since records began in December 2008 (i.e. in around 11 years). Flood frequency analysis, based on rough flow estimates at Poynton level gauge, gives a peak flow for the July 2019 event of around 12 $m^{3/}$s with an indicative return period of around 45 years.

As a result of the rainfall on 31st July 2019 (and preceding days) the water level on the R. Goyt at the Marple Bridge gauge reached 2.01m at 19:30pm, the second highest since the site opened in 1969. The highest event recorded was in July 1973 at 2.70m. The July 2019 recording is only slightly higher than the 3rd and 4th highest recordings. The 2019 flood flow is tentatively considered to represent approximately a 20 year return period event on the River Goyt.

Accordingly, from the flow gauge records the following conclusions can be drawn:

- Flow gauging on both the River Goyt and Poynton Brook indicates that flows had receded substantially following the rainfall of the 28th July indicating the events should be considered separately; albeit the severity of the flood event of 31st was likely driven by that day's rainfall falling on already saturated ground with any flood storage already (or still partially) occupied. For both flow gauges the peaks of the 31st exceed those of the 28th despite generally lower rainfall on the 31st as compared to the 28th.
- Peak watercourse flows were recorded on the 31st July on the River Goyt and Poynton Brook. Flood flow return period for the R. Goyt at Marple Bridge has been provisionally estimated by the EA as circa 20 years; this was the 2nd highest event on record (since March 1969).

2.6 Event Timeline

The severe rainfall led to isolated reports of flooding commencing on Sunday 28th July and culminating in widespread reporting of flooding commencing on Wednesday 31st July. The headlines are:

- Sunday 28th July, heavy rainfall but few reports of property flooding.
- Sunday 28th July, A555 closed due to flooding.

- Wednesday 31st July, further heavy rainfall and reports of flooding borough-wide.
- Wednesday 31st July, A555 closed due to flooding at 3 locations (2 locations within SMBC area).
- Thursday 1st August, major reservoir safety incident declared at Toddbrook reservoir, Whaley Bridge with risk of imminent dam failure.
- Friday 2nd August pumping commences at Toddbrook reservoir to lower the volume of stored water; all pumped water is discharged to the River Goyt which flows into the River Mersey.

Throughout the above period, drainage of the section of the A555 referred to as catchment E was by temporary pumping at the location of the permanent pump station close to Hall Moss Lane bridge (over A555). This temporary pumping had been in place following failure of the pump station earlier in 2019. Discharge from the temporary pump at Hall Moss Lane was up the adjacent cutting and directly to Spath Brook, a tributary of the River Dean which flows outside the borough. The temporary discharge was into the same watercourse as the permanent pumps and no water was diverted from the usual route i.e. there was no temporary pumping into Lady Brook from the A555.

2.7 A555

Scheme Overview

The A555 is a new dual carriageway road linking the A6 at Hazel Grove to Manchester Airport and the M56 motorway. The new road was opened in October 2018. The eastern end of the A555 lies within SMBC and since its opening has been operated and maintained by SMBC Highways Department. Prior to completion of the full route the original central section was maintained by Cheshire East Council (formerly Cheshire County Council).

The new sections of the road were built under a 'design and build' contract by a joint venture construction consortium of Carillion and Morgan Sindall. The financial collapse of Carillion meant the work was completed by Morgan Sindall. The construction was managed by SMBC with partners at Manchester City Council and Cheshire East Council.

The new A555 is of relevance to this S19 Flood Report because the road and road drainage has the potential to alter runoff to adjacent watercourses that flow through the borough. Additionally, the new road had already suffered from flooding on several occasions between its opening and July 2019 and had been implicated in the 2016 S19 Flood Reports whilst the road was still under under-construction.

The full details of the A555 drainage networks and the drainage review are contained in Appendix B.

A555 Flood incidents

The completed A555 was opened to traffic in October 2018 and the council record subsequent flooding event(s) as follows:

Incident Saturday 16th March 2019

- Heavy rain; original A555 pumps failing.
- All power off. Two of four pumps working.
- A555 flooding at Hall Moss Lane-Saturday Night.
- Road Closed from 20.00hrs 16th March.
- Reopened Monday 18th March at 20.00hrs.
- Attenuation Ponds damaged at Woodford Rd gyratory; these ponds drain to Spath Brook via the original A555 pumping station.

The March event exposed the original A555 pump station at Hall Moss Lane to be in a deteriorating condition and SMBC committed to replacing the pumps and controls. This work was planned to be undertaken in the first week of August 2019 but was delayed due to the impacts of the July 2019 flooding.

Incident Sunday 28th July 2019 (at this time drainage at the original A555 pumping station at Hall Moss Lane bridge was reliant on a temporary pump within the wet well pumping to Spath Brook; this temporary arrangement was pending installation of new permanent pumps).

- Heavy rain over several days.
- A555 flooding at Woodford Road (Poynton),
- Network C Pump alarm triggered,
- A555 flooding at Hall Moss Lane,
- Police call at 11.45 am, road closed 1.30pm.
- A555 closed both ways between A523 and A34 from 1.30pm 28th July 2019.
- Monday 29th July –A555 flooding at Woodford Rd cleared and road reopened between A523 and Woodford gyratory.
- Network C attenuation pond (discharge into Lady Brook) overflowing and damaged.
- Tuesday 30th July; A555 temporarily opened at 5pm but closed later due to more rain bringing levels in tanks back up over road level (at Hall Moss Lane).
- Wednesday 31st July; A555 closed again westbound from A523 before being closed from Woodford gyratory to A34.
- A555 closed westbound A34 to Woodford gyratory.
- A555 Manchester section (within the boundary of Cheshire East Council) also closed under Wilmslow Rd bridge (not SMBC responsibility).
- Friday 2nd August; A555 Eastbound carriageway open at 6pm.
- Monday 5th August- A555 Westbound carriageway open at 7pm. Remains one lane shut until 14th August to carry out fitment of new pumps and to desilt attenuation tank.

Clearly, within the SMBC area, in the July 2019 event the A555 carriageway flooded at 2 locations:

- At the Network C pump station, adjacent to Woodford Road, and
- At the original A555 pump station, Network E, adjacent to Hall Moss Lane.

On Sunday 28th July 2019 the pump maintenance contractor APS was called to site and whilst they could do nothing at Hall Moss Lane due to the depth of flooding they were able to access the Network C pump station and they noted the following:

- Attended Network C pump station on Sunday 29th July 2019 at 15:00hrs,
- A555 carriageway flooded; see Figure 2.9.
- Both pumps had tripped but tested ok and were re-started and the floodwater was cleared.
- The pumps were noted to be drawing 31 to 31.4 Amps across all phases with overload trips set at 32 Amps.
- At the time the water level in the Network C pond was 300mm below the delivery pipe.
- It was understood the pond level had been higher earlier in the day.
- Revisited site on Monday 29th July 2019 to investigate cause of pump tripping but no explanation found; pumps running at 29 to 30Amps.

On Wednesday 31st July 2019 APS were alerted at 15:00hrs that a pump had tripped again and proceeded to site to investigate and they reported:

- By the time they arrived both Network C pumps had tripped and the high-level alarm had activated.
- A555 carriageway starting to flood at Woodford Road bridge.
- Pumps were re-started but drawing 33A (over the 32A overload setting).
- APS visited the Network C pond and found it completely full and the delivery pipe submerged.
- Pond C then started overflowing (see Figure 2.10) and flowing overland to the river (Lady Brook) which was noted as being 'very high'.
- Returning to the pump station the pumps had tripped on overload after 5 minutes.
- Re-starting a pump it then tripped on start-up (60A starter breaker).
- The pumps were re-set but not started. The engineers concluded the high pond level was increasing the pump duty' leading to overload conditions.
- A555 carriageway completely flooded at Network C pump station.

APS concluded that the high Network C pond water level was increasing the pump duty' leading to overload conditions and the pumps should not be re-started until water level drops.

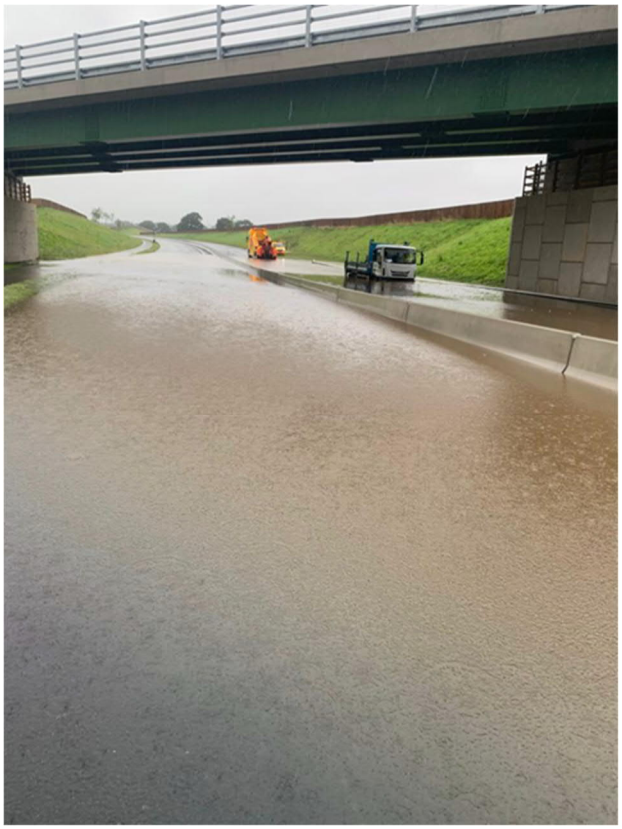
In retrospect it appears the conclusion the pump duty increased is probably correct, but this is not directly linked to the pond water level because there is a long section of gravity drain linking the pumped rising main to the pond. Nevertheless, in the severe rainfall events of 28th and 31st July 2019 the gravity drain is likely to have become surcharged and thereby increased the effective head the pumps were required to work against. In terms of the pumping station, actions to resolve appear to be:

- Check the rising main and receiving drain for obstructions/blockages.
- Review raising the overload settings if equipment is suitable,
- Review upgrading the pumps and/or electrical equipment for the higher 'flood condition' duty..

The Network E ponds and pumping station were overwhelmed on both 28th and 31st July 2019. At the start of this this period, it is understood only a single temporary pump was in operation, pending the installation of the new pumps. It is understood the temporary pump was operational throughout the period of flooding but was unable to cope with the runoff collected at Hall Moss Lane. As the event unfolded and as conditions permitted, supplementary temporary pumps were used to drain-down the flooded carriageway and drain the attenuation storage. It is also understood that the attenuation ponds E1 and E2 overflowed in the period. Overflow at these ponds was onto the A555 carriageway and along it in a westerly direction towards the original pump station. En-route some of the overfow will have been absorbed into the carriageway drainage. Carriageway drainage ultimately reaches another flow control device at the connection with the original road. At this point excess flow may have again overflowed and flowed above ground before reaching the original pump station where the carriageway became flooded. It is likely the overflowing, unattenuated flow from the new road was a contributory factor in the flooding at the pump station.

During the above incidents there are no reported issues in respect of Networks A or B.

Figure 2.9: 28th July 2019 A555 carriageway flooded at Woodford bridge, Network C.



Source: APS

Figure 2.10: Network C attenuation pond overflowing 31st July 2019



Source: APS

3 RMA responses to July 2019 Flooding

3.1 Background

As far as is known, other than property level defences, there are no flood storage or flood mitigation measures within SMBC area which are temporary and/or require manual installation. Accordingly, there is limited action the RMA's can do in preparation for immediate flooding. Inspection of critical flood constraints/flood control structures would be beneficial provided time and resource was available to intervene ahead of the floodwater arriving. It would be better to carry out regular inspections and maintenance.

It is the responsibility of individual residents to make their own preparations in advance to improve flood resilience.

During the events the Fire and Rescue service provided 'rescue' services to recover vulnerable residents from flooded properties; e.g. at Bramhall Green. They also pumped-out numerous properties to aid the recovery situation. The Fire and Rescue service do not have a remit to attempt flood mitigation measures and are therefore re-active in their response.

Severe weather warnings were issued via weather forecast services through the period 28th July to 31st July 2019. However, as is the nature of these summer, high intensity events it is usually rather hit or miss whether a particular location is badly affected. Accordingly, with a significant number of 'non-events' there comes an expectation that the location will again be spared. Accordingly, we are not aware of any preparatory actions ahead of the rainfall on 28th. In the period 28th to 31st the council/LLFA reacted to flooding on the A555 and in Romiley for example. Resolution of some specific issues and attempts to clear floodwater were made ahead of forecast rainfall on 31st July, but no other flood mitigation measures/actions were recorded to have taken place.

It is noted from public reports and the public consultations that there is public perception that re-opening roads was a priority rather than providing support to affected residents.

3.2 Stockport MBC/LLFA/Highways

Significant council effort on the days of flooding was directed at controlling the situation on the A555; inspecting the situation, implementing road closures and mobilising and coordinating the pump maintenance contractor. Alongside this, the council provided humanitarian support where necessary to households identified as at risk. Other actions by the Highways team were to deploy gulley clearance contractors to reported blockages and attend other flood incidents around the borough.

Administering the large number of flood reports from the 31st July 2019 was a significant task that overwhelmed the available resource until additional staff were drafted in from other sectors of the council.

In the immediate aftermath the council provided access to housing for those who needed it and provided other social support. Many flood reports were gathered from welfare visits.

Later, SMBC/LLFA investigated at high level each reported incidence of flooding (particularly pluvial and ordinary watercourse flooding).

3.3 Environment Agency

The EA issued the following flood alerts and flood warnings for the Stockport area:

Type	Date and Time Issued	Name
Flood Warning	28/07/2019 10:19	Poynton Brook at Wigwam wood and parts of Armcon Business Park
Flood Alert	28/07/2019 10:23	Middle River Mersey catchment including areas near Bramhall, Stockport, Sale, Altrincham and Urmston
Flood Warning	28/07/2019 19:20	River Mersey at Cheadle Wood and Ford lane
Flood Warning	31/07/2019 06:21	Poynton Brook at Wigwam wood and parts of Armcon Business Park
Flood Alert	31/07/2019 08:57	Middle River Mersey catchment including areas near Bramhall, Stockport, Sale, Altrincham and Urmston
Flood Warning	31/07/2019 16:07	River Mersey at Cheadle Wood and Ford lane
Flood Warning	31/07/2019 16:36	River Goyt at Marple Bridge
Flood Warning	31/07/2019 16:39	River Goyt from Marple Dale to Offerton
Flood Warning	31/07/2019 18:05	Poynton Brook at Poynton and Midway

Accordingly, of relevance to Lady Brook and Micker Brook there were only 'flood alerts' on 28th July and on 31st July; there were no 'Flood warnings' given. And for Poise Brook there were no alerts or warnings in the period. For Micker Brook the flood warning is based upon trigger levels on the River Mersey and as such the warning system is insensitive to localised intense rainfall on the Micker Brook (including Norbury, Poynton and Lady Brook) catchments.

In line with the EA's responsibility for overseeing Main Rivers, the EA response to the flooding was focussed upon clear-up operations along Norbury Brook, Poynton Brook, Lady Brook, Micker Brook, Chorlton Brook and Poise Brook. Accumulated debris was cleared from watercourses and flood reports processed; including a basic review of the reported flooding against their flood mapping.

3.4 United Utilities

United Utilities advise that they carried out investigations of their network and although system capacity was exceeded in many locations there was little evidence of significant blockages.

New public sewer networks are designed for up to 1 in 30 return period storm events and accordingly the capacity of the public sewer network is likely to have been exceeded during the July 2019 rainfall events. Historic elements of the public sewer network are likely to have a lower design standard and could be expected to reach capacity sooner.

3.5 Flood Reporting, Policy Requirement

From the public consultations there is evidence that when calling for assistance or simply to make a report of flooding, affected residents were passed from one RMA to another based upon the caller's initial description of the flooding. In many cases the source of flooding is not immediately evident due to the complex or unknown elements of some of the drainage networks. For example, highway gullies frequently appear blocked (not admitting runoff) but are clear and flow is prevented by surcharged conditions in downstream pipework. Highway gullies are often connected to the UU surface water or combined sewer network and can appear blocked or even releasing surcharged flow to the road surface; in which case the source of flooding could be considered to be the UU network. Also, gullies that become blocked in an event are in many cases blocked as a consequence of unplanned overland flows or other exceedance conditions carrying large quantities of debris into them.

The RMA's need to work together to take flood reports and respond where appropriate and subsequently assign to the responsible authority based on their combined better understanding of the situation, though there are several not insignificant barriers in place – particularly in the form of the General Data Protection Regulation (GDPR, 2018) regulations and the Data

Protection Act (1998). In preparing this investigation report in the period November 2019 to May 2020 there was little evidence of sharing of flood reporting between the RMA's.

4 Overview of Previous S19 Flood Investigations

4.1 Previous S19 Flood Investigations

Reference to the SMBC website indicates there have been 5 Section 19 Flood Investigation reports issued for events prior to July 2019; as follows:

- May 2012, Cataract Bridge Mill flood investigation report
- March 2016, Flooding investigation report - Dorset Avenue - Cheadle Hulme
- June 2016, Flooding investigation report
- September 2016, Flood investigation report
- November 2016, Woodbrook Road Flood Investigation Report (Cataract Bridge Mill site)

Two of these reports refer to the site of the former Cataract Bridge Mill and are related to specific aspects of that site and will not be discussed further in this report, save to say that there was no reported flooding here in July 2019.

The March 2016 Flood Investigation Report for Dorset Avenue is a specific localised incident of screen blockage that has been followed up by the council and is also not discussed further in this report.

This leaves the 2 flood investigation reports of 'borough wide' flooding for the events in June 2016 and September 2016. The events, the impacts and the findings of the investigation reports are discussed in the following sections with a view to identifying if there are any similarities with the July 2019 event. Finally, in Section 4.4 we discuss which recommendations from the 2016 S19 Flood Reports have been actioned. To highlight these actions the recommendations in Tables 4.1 to 4.4 have been colour coded as follows:

- Red; no known action.
- Yellow; some known action.
- Green; specific action taken.

4.2 June 2016 Flood Report

In June 2016, the borough of Stockport received intense and prolonged rainfall events, leading, it is reported, to 4 flooding events to occur between 8th June and 16th June. In total, 295 properties suffered from flooding, along with disruption to roads and railways.

4.2.1 Jacob's Section 19 Investigation Report of the June 2016 event

The report characterised the June 2016 rainfall event thus:

- Unpaved ground was likely to be saturated from the wet period leading up to specific rainfall days.
- Peak daily rainfall at the Meadowbank gauge (Cheadle) was 37mm.
- Intense short duration rainfall recorded for 8th, 10th, 11th and 16th June.
- Peak rainfall intensity of 38mm/hr recorded for 16 June.

There was however no estimate made as to the severity of the rainfall conditions; i.e. no estimate of Annual Exceedance Probability (AEP) or return period.

The impact was to generate large quantities of surface water runoff from urban areas and local watercourses; there were reports of flooding from highway runoff, surface water runoff, surface water sewers and limited fluvial flooding.

4.2.2 June 2016 Report Recommendations

The report concluded with a list of recommendations of general actions for each RMA based on the full Stockport borough area (see Table 4.1) and on specific community areas (see Table 4.2).

Table 4.1: June 2016 Recommended and ongoing actions – Stockport wide

Lead RMA	Recommended Action
Council Highways Department	1.1 Maintain efficient operation of highway drains
	1.2 Ensure necessary maintenance is carried out to local highway drains following flood events
	1.3 Consider ways to raise awareness of damage caused by driving through floods
Council as LLFA	2.1 Consider provision of Property Level Protection for properties at risk
	2.2 Review response to and management of road closures during flood events
	2.3 Ensure property owners are aware of their responsibilities as riparian owners of watercourses (whether open or culverted watercourses)
	2.4 Investigate and address issues identified as relating to private drains
	2.5 Continue to manage flood risk from new development through local strategic planning and development management process, with advice from the Environment Agency where required. Seek flood risk benefits from new development where possible.
United Utilities	3.1 Maintain efficient operation of surface water and combined sewers
	3.2 Ensure effective communication with the Council regarding flooding events/ potential flood issues
Environment Agency	4.1 Review borough-wide flood management
	4.2 Ensure watercourses are suitably maintained
	4.3 Review trigger levels for Flood Alerts in this area
	4.4 Ensure effective communication with the Council regarding flooding events/ potential flood issues
Property Owners	5.1 Consider installation of Property Level Protection

Source: Jacobs, Section 19 Investigation Report, June 2016 Flood Events, December 2016

Table 4.2: June 2016 Recommended and ongoing actions – community specific

Lead RMA	Recommended Action	Community
Council Highways Department	6.1 Consider options to improve highway drainage in the Kintore Avenue area Hazel Grove	Hazel Grove
Council as LLFA	7.1 Consider options to improve drainage of Bonar Park and surrounding pavement (currently being reviewed)	Edgeley
	7.2 Consider options to increase highway drainage capacity in the Myrtle Street area (e.g. additional gullies or combined kerb and drainage solutions)	Edgeley
	7.3 Consider options to direct runoff safely away from properties (e.g. raised kerbs on Myrtle and Ash Street)	Edgeley
United Utilities	8.1 Review options to relieve flooding from the surface water sewer (including investigation of the performance of the surface water sewer outfall)	Offerton Green
	8.2 Review cause of blockage on Myrtle Road sewer and how to prevent in the future (currently being undertaken)	Edgeley
Environment Agency	9.1 Consider options to reduce fluvial flood risk on Lady Brook Bramhall Green	Bramhall Green
	9.2 Consider options to reduce fluvial flood risk on Hazel Grove Brook, Hazel Grove	Hazel Grove
	9.3 Review performance of Torkington Park debris screen during event, Hazel Grove	Hazel Grove
	9.4 Consider options to reduce fluvial flood risk on Poise Brook	Offerton Green
	9.5 Review Flood Warnings and trigger levels for the Poise Brook flood warning area Offerton Green	Offerton Green

Source: Jacobs, Section 19 Investigation Report, June 2016 Flood Events, December 2016

4.3 September 2016 Flood Report

On 13th September 2016, the borough of Stockport again received an intense rainfall event, from which 660 properties were affected by flooding.

4.3.1 Jacob's Section 19 Investigation Report of the September 2016 event

The report characterised the September 2016 rainfall event thus:

- Peak daily rainfall at the Meadowbank gauge was 37mm.
- Peak rainfall intensity of 45mm/hr recorded for 13th September.

There was no estimate made as to the severity of the rainfall conditions; i.e. no estimate of AEP or return period. However, the report stated that 'The Met Office considers that rainfall intensities exceeding 32mm/hour are indicative of torrential downpours'.

The impact was to generate large quantities of surface water runoff from urban areas and local watercourses; there were reports of flooding from surface water runoff, surface water and combined sewers and limited fluvial flooding. 365 more properties were affected by flooding in September, when compared to the flooding event that hit Stockport in June 2016. During the September event, 82% of the total properties flooded by public combined sewers. No significant infrastructure damage was recorded. It is also worth noting that 24 properties in Cheadle were flooded from fluvial sources.

4.3.2 September 2016 Report Recommendations

The report concluded with a list of recommendations of general actions for each RMA based on the full Stockport borough area (see Table 4.13) and on specific local areas (see Table 4.24).

Table 4.3: September 2016 Recommended and ongoing actions – Stockport wide

Lead RMA	Recommended Action
Council Highways Department	1.1 Maintain efficient operation of highway drains
	1.2 Ensure necessary maintenance is carried out to local highway drains following flood events
	1.3 Consider ways to raise awareness of damage caused by driving through floods
Council as LLFA	2.1 Consider provision of Property Level Protection for properties at risk
	2.2 Ensure property owners are aware of their responsibilities as riparian owners of watercourses (whether open or culverted watercourses)
	2.3 Investigate and address issues identified as relating to private drains
The Council as LLFA and the Environment Agency	3.1 Continue to manage flood risk from new development. Seek flood risk benefits from new developments where possible.
United Utilities	4.1 Maintain efficient operation of surface water and combined sewers
	4.2 Ensure effective communication with the Council regarding flooding events/ potential flood issues
Environment Agency	5.1 Review borough-wide flood management
	5.2 Ensure watercourses are suitably maintained
	5.3 Review trigger levels for Flood Alerts in this area
	5.4 Ensure effective communication with the Council regarding flooding events/ potential flood issues
Property Owners	6.1 Consider installation of Property Level Protection
	6.2 Check weather forecast and flood warnings regularly.

Source: Jacobs, Section 19 Investigation Report, September 2016 Flood Events, April 2017

Table 4.4: September 2016 Recommended and ongoing actions – local specific

Lead RMA	Recommended Action	Community
Council Highways Department	7.1 Review a possible tree root problem at Saint Lesmo Road	Edgeley and Cheadle Heath
Council as LLFA	8.1 Review Heaton Moor culvert	Heatons North
	8.2 Review Park House culvert	Cheadle and Gatley
	8.3 Consider options to reduce fluvial flood risk on Micker Brook Tributary.	Cheadle and Gatley

Source: Jacobs, Section 19 Investigation Report, September 2016 Flood Events, April 2017

4.3.3 Comparison of Recommendations arising from the 2016 Flood Investigations

Comparing Tables 4.1 and 4.3 shows that the borough-wide recommendations for the June and September events are the same; however, the site or location specific recommendations are different. Given the significantly greater incidence of flooding in the September event it is surprising that there are so few specific recommendations arising from this event; perhaps the intent was to build upon the recommendations of the investigation of the June event, although the report does not explicitly say this.

4.4 Actions post 2016

To highlight the actions taken following the 2016 flooding and corresponding flood reports, the recommendations in Tables 4.1 to 4.4 have been colour coded as follows:

- Red; no known action.
- Yellow; some known action.
- Green; specific action taken.

The colour coding is based upon the authors knowledge that an action has been taken and it is possible that some actions have been taken that have not been brought to our attention. Also, it is known that the LLFA, in particular, has pursued many worthwhile flood risk management actions that were not in the recommendations from 2016 which are likely to have been of value in mitigating impacts in the July 2019 flooding event. Some notable examples are as follows:

- Adswood Road (including Clover Avenue and Culver Road); it is surprising there was not a specific recommendation in the report of investigations of the September 2016 flooding. Flooding in this area has apparently been a long-standing issue that the council/LLFA have been pursuing. Appendix L details the timeline of previous actions and the impacts of the July 2019 flooding. Since 2010 the council and Network Rail have been aware that there is a significant blockage of grout (50% of section) within a culverted watercourse under the Stockport to Crewe railway line. Clearance works under difficult conditions have been carried out by the council and another riparian owner to the boundary with Network Rail (NR) land. With limited access upstream, NR have only recently (mid 2020) been able to access the culvert from the downstream chamber to assess the internal condition and extent of the grout within the culvert under their riparian ownership. NR have not yet attempted clearance works but have advised that a contractor has been engaged to undertake the works. Since 2016 NR have been consistently reminded of their obligations. This blockage of grout may have originated when the upstream area was redeveloped c.1990's or could be associated with railway stabilisation works or possibly the railway electrification in the 1960's as the culvert is below a base for the overhead power supply.
- Bramhall village centre and under the railway bridge; investigations carried out and some remedial works completed.
- Buckingham Road West Culvert: flooding investigation and culvert rehabilitation works by Stockport Council and various riparian owners to restore the flow to the culverted watercourse and complete the internal condition survey.
- Although not a specific recommendation in either of the 2016 S19 Flood Reports the LLFA has recognised that the systems for receiving and logging flood incidents was overwhelmed following the 2016 events and again in the July 2019 event. Accordingly, a new system is being set-up for future events.

5 Discussion of findings of this S19 Investigation

5.1 RMA 2019 event actions

RMA actions in the July 2019 event appear to have been largely reactive. Some reduction of flooding may have been achieved had critical structures been checked for blockages and where necessary maintained either in response to severe weather forecasts or as a part of regular planned work in readiness for the summer downpours that the area appears vulnerable to. To make this approach effective and affordable the LLFA should compile a register of structures likely to have a significant effect on flood risk (requirement of the FWMA); this register should be concise and perhaps ranked in order of likely impact on flood risk. The register should include relevant structures of all RMA's and riparian owners; it would for example include the Adswood railway culvert that is known to be partially blocked. Attached or linked to the register it is recommended information is recorded of the ownership details and details of the structural condition.

5.2 The rainfall event and flood flows

Section 2.4 indicates the local rainfall conditions driving the July 2019 flooding; the daily rainfall totals are significantly greater than either of the 2016 events. As a result of these heavier and more prolonged rainfalls, as would be expected, there was more significant fluvial flooding in July 2019, especially for Micker Brook onto which the heaviest rainfall appears to have been centred. The larger watercourses e.g. the Goyt and Mersey rose to significant levels but did not flood within the borough.

The daily rainfall at gauge sites surrounding the borough generally showed slightly higher rainfall totals on Sunday 28th July whereas the most significant flooding was reported to have occurred on Wednesday 31st July. This is likely to be attributed to the later event falling on saturated ground and also due to the rainfall intensity on the 31st.

Given the severe rainfalls it is not surprising that highway and surface water drainage flooding was experienced as the severity appears to have exceeded even current design standards. From the records of gauged flows, some fluvial flooding would also be expected at pinch points on the smaller river systems within the borough. There is evidence to suggest the 2019 flood extents are not consistent with mapped EA flood extents on Micker Brook at Sandringham Road, Queens Road/The Demmings and Broadway Avenue and on Poise Brook at Bean Leach Road and accordingly it is recommended the modelling and mapping in these areas is reviewed (refer to specific details in the relevant 'Hot Spot' Appendices). The review of Micker Brook should be extended upstream to Bramhall Green and possibly upstream into Cheshire East to understand and evaluate what mitigation measures could be effective for the catchment as a whole.

5.3 Actions post 2016 S19 reports

Of note; we have not seen evidence of action by the EA in respect of the following key recommendations:

- 9.1 Consider options to reduce fluvial flood risk on Lady Brook Bramhall Green
- 9.2 Consider options to reduce fluvial flood risk on Hazel Grove Brook, Hazel Grove

- 9.4 Consider options to reduce fluvial flood risk on Poise Brook

The full history of flooding and actions at Adswood Road has been reviewed and whilst a good deal has been achieved it appears the crucial clearance of the Network Rail culvert has still not been carried out. NR have been aware of the problem for a number of years now and will now be in a position to access the culvert to undertake the grout removal works following on from the works completed to date. The LLFA have been leading on this and have recently engaged with the contractor appointed by NR to undertake the works. Once the grout removal works are complete NR will be able to complete an internal condition survey of the culvert and undertake rehabilitation works to mitigate the risk of structural collapse & further flooding.

5.4 The problem areas

The flooding 'hot spots' reviewed in Appendices C – P highlight a full range of issues in respect of property flooding; these are summarised in Table 5.1.

Table 5.1: Summary of Review of Flooding Hot Spots

Flooding Hot Spot	S19 Report Appendix	Principle Flood mechanism	Secondary Flood Mechanism	Comments	Summary of Recommended Actions	By whom:
A555	B	Surface water		Repeated occurrences of surface water flooding at pumping stations which failed during severe rainfall events Attenuation ponds overflowing due to design and construction defects. Road completely impassable due to overloading of original A555 pump station no. 4 at Hall Moss Lane.	Review/recalculate drainage design for Network C (possibly Network B also) Upgrade Network C pump station. Create reinforced overflow for Pond C (possibly Pond B also) Review/recalculate drainage design for Network E and enlarge Ponds E1 and E2 or equivalent other mitigation. Contingency Plan to drain storage. Recalculate total system draining to Hall Moss Lane pumping station to establish designed/actual frequency of flooding and remediate if proven unsatisfactory.	SMBC Highways (some remedial actions by A555 construction contractor).
Bramhall Green	C	Main River; Lady Brook	Highway drainage	Initial flooding from highway runoff due either to capacity issue or restricted discharge due to high level in Lady Brook or possibly both. Widespread flooding across roundabout due to Lady Brook flow exceeding capacity of upstream channel and at Bramhall Bridge (Bramhall Lane South)	1. Consider fitting non return valves to highway drains (2 no.) upstream of Bramhall Bridge. 2. Review benefit of adding pumped discharge of above drains for when Lady Brook is high. 3. Update hydraulic model of this reach (including re-survey as appropriate to monitor siltation); validate against 2019 event. 4. Update flood mapping for this reach. 5. Review options for Flood Risk Management Scheme in reach and/or upstream flood management. 6. Promote appropriate FRMS.	1 & 2 SMBC Highways; Remainder EA with support from LLFA; note actions link with Apps E, F and G.

Bramhall Moor	D	Surface water	Drainage network	Not clear if floodwater at Mostyn Road and Corfe Crescent is solely attributed to SW runoff from adjacent roads and fields or if the flooding is in part fed by surcharge from the local drainage system. Some investigation of the drainage network is required,	Investigate the performance of the local drainage network and try to eliminate inflow to the flood locations, eliminate obvious defects. Residents at risk should consider property level protection measures.	LLFA/UU Residents
Sandringham Road	E	Main River; Micker Brook		July 2019 flood outline exceeds extent of current 1 in 1000 flood extents causing flooding of new residential properties.	1. Update hydraulic model of this reach (including re-survey as appropriate to monitor siltation); validate against 2019 event. 2. Update flood mapping for this reach; was 2019 flood extent due to blockage(s)? 3. If required review options for Flood Risk Management Scheme in reach and/or upstream flood management. 4. If required promote appropriate FRMS.	EA with support from LLFA; note actions link with Apps C, F and G.
Queens Road	F	Main River; Micker Brook		July 2019 flood outline exceeds extent of current 1 in 1000 flood extents. Flood mapping does not show exceedance flow path around buildings (Brook House). Debris in riverbed upstream and downstream of The Demmings culvert. Are service pipes within Brook House Culvert and below Queens Road bridge considered in model?	1. Update hydraulic model of this reach (including re-survey as appropriate to monitor accumulated debris); validate against 2019 event. 2. Promote removal of debris by riparian owner. 3. Update flood mapping for this reach; was 2019 flood extent due to blockage(s)? 4. If required review options for Flood Risk Management Scheme in reach and/or upstream flood management. 5. If required promote appropriate FRMS.	EA with support from LLFA; note actions link with Apps C, E and G.
Wilmslow Road	G	Main River; Micker Brook		July 2019 flood outline exceeds extent of current 1 in 1000 flood extents e.g. properties on Broadway Avenue flooded. 2019 flood extent may have been increased by upstream blockage release at Brook House, The Demmings.	1. Update hydraulic model of this reach (including re-survey as appropriate to monitor accumulated debris); validate against 2019 event. 2. Promote removal of debris by riparian owner. 3. Update flood mapping for this reach; was 2019 flood extent due to blockage(s) and/or surges from blockage release from upstream. 4. If required review options for Flood Risk Management Scheme in reach and/or upstream flood management. 5. If required promote appropriate FRMS.	EA with support from LLFA; note actions link with Apps C, E and F.
Borrowdale Avenue	H	SW from railway	Combined sewers overwhelmed by railway runoff.	SW runoff from railway appears to overwhelm UU combined drainage.	Investigation is required to confirm what the Network Rail drainage arrangements are intended to be, their current state and to remediate if necessary. UU may have an input due to the foul	Network Rail/UU. UU to coordinate.

					flooding reported. LLFA should coordinate.	
High Lane	I	Surface water sewers		Flooding on Cromley Road likely caused by surcharge in UU SW drainage.	Review and report on drainage network and capacity.	UU with support from Highways
Torkington and Hazel Grove	J	Main River Torkington Brook	Surface water sewers.	Flooding on Hazelwood Road likely caused by surcharge at culvert entrance below Clarendon Road.	Regular inspection and maintenance of culvert entrance.	EA/Highways
Bean Leach Road	K	Main River; Poise Brook	Flooding from surface water sewer and highway gullies	EA flood mapping inconsistent with 2019 flood extents. When capacity of Bean Leach Road bridge over Poise Brook is exceeded, excess flow runs along the road (bypassing 3rd party defences) and spills off road into Minsmere Walks and adjacent property. Exceedance flow surcharges highway and SW drainage systems leading to flooding of properties on Shearwater and adjacent roads. Siltation at UU SW outfall restricting discharge?	1. Consider fitting non return valves to UU SW outfall?. 2. As possible 'quick win' consider highway surface modification (speed table?) to ensure Poise brook exceedance flow is tipped to the downstream brook and links with 3rd party defence structure. 3. Update hydraulic model of this reach (including re-survey as appropriate to monitor siltation); validate against 2019 event. 4. Update flood mapping for this reach. 5. Review options for Flood Risk Management Scheme in reach and/or upstream flood management. 6. Promote appropriate FRMS.	EA with support from LLFA, UU and Highways
Adswood Road	L	Blockage in culverted watercourse under Network Rail	Flooding from surface water sewer and highway gullies	The known blockage in culverted watercourse under NR land appears crucial to the incidence of flooding in this area. As a result of this blockage UU SW network surcharges and directly floods but also highway drains are affected, and it is likely there is some linkage to UU foul or combined system.	LLFA should continue to push for remediation by NR and use available powers to enforce action. SMBC Highways should ensure critical gullies are cleared regularly and in particular in springtime ahead of summer storm season. UU should monitor effectiveness of clearance on incidence of surcharge in SW system to ensure there is no other problem.	SMBC Highways LLFA UU
Councillor Lane, York Close	M	UU Surface water system surcharged; blockages identified and cleared.		It appears likely the clearance of the UU network should have improved the local situation and given the local nature of the flooding reported no further action appears warranted at this time.	No action required.	
Gatley Brook	N	No flooding		Concerns raised over silt build-up.	No action at present.	
Glenside Drive and Werneth Road	O	Surface water runoff	Highway drainage	Uncontrolled surface runoff from permeable and impermeable surfaces runs off Werneth Low and Werneth Low Road and overwhelms highway drainage and causing blockages.	Explore possible 'slow the flow' approaches in permeable areas. Prioritise maintenance of gullies and drainage along Werneth Road to capture runoff; add gullies if required. Maximise discharge to local watercourses. Review possibility of local highway surface level adjustments to prevent	SMBC Highways and LLFA

					exceedance flows tipping into Glenside Drive.	
Romiley	P	Surface water runoff	Flooding from surface water sewer and highway gullies	Flooding in Guywood Lane, Central Drive, Sandy Lane, Compstall Road and Leyfield Avenue are interlinked; some sw overland flows from high ground. UU surface water network overwhelmed and spills to roads. Road gullies blocked by debris. All exceedance flows focus on Leyfield Avenue.	Develop area-wide understanding of drainage networks and overland flow routes and identify all discharge routes to Main River (R. Etherow). Develop area-wide integrated above-ground and below-ground drainage network model as basis for evaluation of improvement actions. Promote appropriate FRMS for the area; prioritise actions giving benefit for Leyfield Avenue.	Joint action by LLFA, UU and SMBC Highways

Source: MM

5.5 Development Control

The National Planning Policy Framework (NPPF) requires that each new development coming forward must regulate surface water release to downstream watercourses to the estimated greenfield (or pre-development) condition. This is now standard practice at the planning stage but needs to be reinforced with verification that detail designs and as-built arrangements deliver the agreed restricted discharges. With such checking/verification it is hoped the shortcomings of the A555 drainage could have been avoided; whereby the design of A555 drainage focussed on gaining consent rather than deliver a holistic and robust drainage design. The result being that drainage networks A, B and C were designed for up to 100year return period events but Network E was apparently only designed for up to 30year events, because there was no requirement for consenting to consider greater events. In addition, Network E (which discharges via the original A555 Hall Moss Lane pumping station) was designed solely against a stated historic provision in the original A555 design; no checks were made of the combined system.

Planning for exceedance and the effect of blockages at bridges and culverts needs to be considered as part of the development control process. There is evidence that relatively recent development e.g. adjacent to The Demmings has been approved without, it would appear, due consideration of exceedance flow paths and provisions for access to the watercourse. In this case it is recognised that mapping of Flood Zone 2 or 3 may have suggested all flows would pass via the culvert, however, this would appear unlikely as has proven to be the case. There is an action for EA and LLFA to remain vigilant with regards to future planning applications.

5.6 Issues and actions identified on the A555 through post-flood investigations

Based upon information reviewed in the course of producing this report on the July 2019 flooding we have identified the following issues and actions:

Network B

- Vegetated or ‘green’ areas are drained directly, without attenuation, to Norbury Brook via several outfalls. It is difficult to justify this approach as meeting the intent of the FRA to limit discharge to the pre-existing condition, the act of providing the drains at top and base of slopes and routing these directly to watercourse is likely to increase the speed and volume of runoff to the watercourse. Discharge via some form of SuDS would have been appropriate. However, in the 2019 flooding it is likely the additional runoff was insignificant compared to the volume in Norbury Brook from upstream catchments. The total area drained by the A555 scheme to Lady Brook (including carriageway drained to attenuation ponds) is only approximately 5% of the total Lady Brook catchment to this point; so the A555 drainage is influencing only a small part of the total and the ‘green’ areas are only a part of the A555 drained area.
- Suspicion that attenuation pond B did not fill and accordingly may not have attenuated runoff flows as intended. Evidence from 3rd parties suggests there was no flattening down of grass around the margins of this pond that would have indicated an elevated water level. However, SMBC officials believe from their post-event site visits that they observed evidence of filling and overflowing. There does not appear conclusive evidence one way or the other. Further investigation is warranted to prove the inlet drainage is not blocked leading to unattenuated spillage upstream of the pond.
- Upstream of the pond is an oil interceptor and upstream of that is a manhole sat very close to the steep bank of Norbury Brook. At this manhole the brook bank has slipped away partially exposing the manhole and taking with it the outfall headwall of an adjacent drain from ‘soft’ landscaping. It is possible the slippage has been caused by leakage/spilling from the surcharged carriageway drain.
- Large amount of debris located in the outlet pipe from Pond B trapped by the outlet grille. The origin of the debris is unknown as this is downstream of the pond flow control device; it is possible the debris was carried there prior to fitting of the flow control. This is a construction defect that is indicative of no maintenance by the contractor prior to handover. However, the outfall pipe is oversized for the duty downstream of the flow control and its partial blockage would likely only have a small effect on outflow. Presence of the flow control has been confirmed.
- The grating on the incoming pipe into the pond was more than 50% blocked with debris This could have lead to surcharge upstream and unplanned discharge to the watercourse.
- This pond, if functioning correctly, may also have overtopped, as pond C, and its design may be undersized; see discussion and actions below for Network C.
- A number of construction defects have been identified post the flood event and these are to be addressed by the construction contractor.

Network C

- As for Network B, within Network C vegetated or ‘green’ areas are drained directly, without attenuation, in this case to Lady Brook and the same comments apply.
- Attenuation pond C overtopped at several locations in the July 2019 flood event. The outlet flow control chamber is situated very close to the bank of Lady Brook and overtopping erosion/slippage has exposed the manhole construction. There is a risk of further bank erosion and potentially a breach of the pond into Lady Brook. This pond needs a robust overflow spillway and the flow control chamber needs to be made water-tight (it is of standard unsealed manhole

rings without seals or concrete surround) to avoid saturating the riverbank. Bank slippage needs to be reinstated.

- Survey of Pond C has revealed that the outlet pipe has been installed 680mm higher than designed; thus reducing the flood storage volume available. This defect is to be corrected in 2020 by the construction contractor. See Figure B3.
- Because the outlet pipe has been installed too high, there is a suspicion that this pond is too small for the drained area to achieve the 1 in 100year flow control.
- Relevant design calculations should be sought and/or new calculations made to determine the as-built design standard using storm durations appropriate to the attenuated drainage arrangement.
- Network C pumping station; pumping discharge capacity appears adequate, but the pumps/pump controls need to be capable of sustaining the higher duty when pumping to a surcharged network. As a pre-cursor to this action the rising main should be surveyed to ensure it is free of blockage(s).

Network E

- Network E all drains into the original A555 drainage system and is all pumped to Spath Brook which flows to the River Dean and does not enter the borough. Flows that cannot be pumped are temporarily stored on or below the A555 carriageway. There are no calculations available to confirm the original A555 pump station at Hall Moss Lane together with the original below ground storage can support the additional flows from the new A555 Network E.
- Drainage from the new A555 Network E is connected to the original A555 via a 'Hydrobrake ' to limit pass forward flow to circa 200 l/s and further upstream there are 2 attenuation ponds in cascade (E1 and E2) to hold back flows from the gyratory junction and east to the network boundary. Pond E1 has a storage volume of 4527m^3 and discharge 'Hydrobrake' with a pass forward flow of 17 l/s and Pond E2 has a storage volume of 981m^3 and discharge 'Hydrobrake' with a pass forward flow of 14.6 l/s
- In addition, this network has been expanded through design development to include what was a network D that was intended to drain to local watercourses at the Woodford gyratory. The impact is that in excess of 1300m of carriageway plus substantial 'green areas' are drained into the original A555 drainage network to the west. This compares to stated provision of capacity for 700m of carriageway in the original A555 design. There is therefore potential for increased peak flows and volumes to the existing storage and pumping station.
- Based on the above pond volumes and pass forward flows the E1/E2 combination is likely to have an unusually long 'drain-down' time of between 4.5 days (no further inflow) and 2 weeks (steady inflow 10 l/s). This extended 'drain-down' time should have been investigated at design stage as it leaves the scheme vulnerable to long duration events and to follow-on rainfalls after an initial event. DMRB makes suggestions to check these scenarios.
- From the history of flooding it is likely the original pump station is inadequate to drain the combination of the new road and the original to a reasonable standard. Accordingly, calculations should be sought and/or new calculations made to determine the as-built design standard using storm durations appropriate to the attenuated drainage arrangement and consideration of 'follow-on' events..
- It appears that the new components of Network E have been designed with a 1 in 30 year design flood capacity (on the grounds the exceedance flow is

retained on the carriageway and not passed to downstream communities). This is acceptable for control of flood risk to downstream communities but leaves the highway vulnerable to flooding. Given the extended 'drain-down' times for the ponds and that it also appears the design did not consider extended duration rainfall events or 'follow-on' events, it is likely the design does not in practice provide a 1 in 30 year standard. There is no indication that the effect (e.g. the flooded extents of a 1 in 100year storm) has been considered.

- It is noted that there are significant inflows to the A555 drainage network from external catchments to the original A555 and to the new section; these inputs should be explicitly allowed for in the drainage calculations based on catchment areas and runoff characteristics or other appropriate means.
- To achieve the intended designed standard, it will be necessary to increase flood storage unless the consented release can be increased by negotiation with the EA. Accordingly, it is likely either one or both ponds E1 and E2 will need to be enlarged. The drainage calculations will indicate to what extent this is practical with the existing scheme layout, levels and boundaries and what design standard can be achieved.
- It is likely that storage drain-down will be longer than normal practice and there will be a residual risk that follow-on storms may have significant impact. This situation should be tested with the developed drainage model and if necessary a contingency plan developed for circumstances when significant flood storage is already occupied. This plan might incorporate some temporary emergency pumping in exceedance of consented discharge with the prior approval of the EA and limited to defined conditions.
- It is noted that the Hall Moss Lane pumping station is in a vulnerable location; being sited immediately below Spath Brook to which it discharges. The brook was noted as being of relatively small dimensions and somewhat overgrown. To minimise risk of the brook overflowing to the A555, due to natural runoff plus the A555 pumped discharges, the ownership and responsibilities for maintenance should be confirmed and actioned.

5.7 Additional areas that did not form part of this report

There will be other areas in Stockport that may have experienced issues during the flooding during the June 2019 event. Areas such as Gotherage Lane, Cherry Tree Lane and Andrew Lane. The records of these and other areas are maintained on file but the assessment of the data received does not significantly add to our understanding of the key causes of the event.

6 Conclusions and Recommended Actions

6.1 Conclusions

The following conclusions have been drawn based upon all the information collected for this investigation including data received from the RMA's, from the public consultation exercise in January/February 2020 and from private information forwarded subsequently.

- Flood reports have been received for events on Sunday 28th and Wednesday 31st July 2019; however, the majority of reported flooding was on the 31st. In total 776 flood reports were received by the flood RMA's for locations distributed widely across the borough. The reported flooding is likely to represent an underestimate of the total number of properties affected.
- There were 'Risk to Life' conditions reported at Bramhall Green, Queens Road, The Demmings and Twinning Brook Road due to the deep and fast flowing floodwaters of Lady/ Micker Brook and at Guywood Lane, Romiley due to flooding of a basement flat. Additional 'risk to life' reports, 9 in total, in the Strines area related to the potential for inundation from the reservoir safety incident at Toddbrook Reservoir, Whaley Bridge that developed on 1 August 2019 (as a result of the rainfall on 31st July), but thankfully that inundation was averted by emergency actions at the reservoir.
- Rainfall in the period 28th to 31st July 2019 (4 days) was severe across a wide swathe of the borough; rainfall was both of short duration high intensity and accumulated significant rainfall depths over the course of the event(s). Highest daily rainfall on the 31st was centred on Poynton; where in excess of 75mm is indicated from rainfall radar records. 1 day and 4 day rainfall totals at the Cat and Fiddle Inn at the SE boundary of the catchments draining to Stockport were recorded as 81mm and 180mm respectively.
- 1 day rainfall return periods for the 31st July event are estimated to be in the range 25 years at Prestbury to 75 years at Cat and Fiddle. 4 day rainfall return periods including the 31st July event are estimated to be in the range 266 years at Prestbury to 540 years at Cat and Fiddle. The latter return periods are significant but not directly applicable to the small river catchments and surface water runoff situations within Stockport.
- In addition, rainfall radar data indicates that for the 31st highest rainfall was centred around Poynton which is not captured by the more remote rain gauges; indicating the local event could have been more severe.
- 1 day rainfall within the borough may have been approximately double the values reported in the June and September 2016 S19 reports.
- Flow gauging on both the River Goyt and Poynton Brook indicates that flows had receded substantially following the rainfall of the 28th July indicating the events should be considered separately; albeit the severity of the flood event of 31st was likely driven by that day's rainfall falling on already saturated ground with any flood storage already (or still) partially occupied. For both flow gauges the peaks of the 31st exceed those of the 28th despite generally lower rainfall on the 31st as compared to the 28th.
- Peak watercourse flows were recorded on the 31st July on the River Goyt and Poynton Brook. Flood flow return period for the R. Goyt at Marple Bridge has been provisionally estimated by the EA as circa 20 years; this was the 2nd highest event on record (since March 1969).
- Accordingly, based on the rainfall data alone it may be concluded that event rainfall is likely to have exceeded surface water drainage infrastructure design standards across a

large area of the borough and surface water flooding would be expected even if all systems were designed to modern standards and full functional..

- Also, given the rainfall intensities and total rain depth flooding on ordinary watercourses would be expected.
- For Main Rivers, for which the EA has mapped flood risk the incidence of flooding appears to generally follow expectations. However, at Sandringham Road and The Demmings Industrial Estate the event flooded extent was out-with the mapped 1,000year extent; the reasons need to be investigated further. Is there a deficiency in the modelling or was/is there significant blockage(s) in the watercourse. Also, on Poise Brook at Offerton Green, areas shown to be defended (to the 1 in 1,000year event) were flooded by Poise Brook flows along Bean Leach Road outflanking a 3rd party defence and spilling towards the housing estate. This appears to be a deficiency in the flood mapping and should be investigated further to identify how this flood path could be closed-off.
- Flooding of property was from a range of sources/causes:
    - Surface water flooding/ overland flows
    - Highway flooding
    - Blockages of watercourses
    - Capacities of watercourses/sewers/drains exceeded
- Reviews of the A555 drainage design and the as-built A555 drainage systems against the consented and designed intent has revealed a number of shortcomings and the road is not as robust to rainfall events as would have been expected from newly constructed infrastructure. Post July 2019, some of the construction deficiencies have been or are in process of being rectified by the constructor.
- However, this investigation does not indicate A555 drainage deficiencies were a significant contribution to the downstream flooding in the borough either through temporary pumping or increased runoff.

6.2 Recommended Actions from this S19 Flood Report

As previously the recommended actions are presented as a list of recommendations of general actions for each RMA based on the full Stockport borough area (see Table 4.11) and on specific local areas (see Table 4.2). Many general actions are similar to those of the 2016 S19 Flood Investigation Reports and accordingly similar numbering is adopted to facilitate comparison; new recommendations are added in sequence. Local area recommendations are specific to the July 2019 flood event(s). However, due to the widespread and diverse nature of the reported flooding, all location specific actions are not captured. It is anticipated that Action 2.7 will be used to capture additional site-specific actions and formulate these into a prioritised programme of investigations and interventions that reflect the LLFA's and other RMA's resource, capabilities, budgets and wider aspirations for flood risk management.

Table 6.1: July 2019 Flood Event; Recommended actions – Stockport wide

RMA	Recommended Action	
The Council Highways Department	1.1	Maintain efficient operation of highway drains
	1.2	Ensure necessary maintenance is carried out to local highway drains following flood events.
	1.3	Consider ways to raise awareness of damage caused by driving through floods.
	1.4	Review criteria for 'flood event' road closures to protect road users AND roadside property.
	1.5	Develop 'risk based' gulley maintenance system and implement alongside routine gulley clearance programme. Monitor effectiveness of gulley clearance i.e. contractor performance.
The Council as LLFA	2.1	Consider supporting residents to improve their property resilience.
	2.2	Ensure property owners are aware of their responsibilities as riparian owners of watercourses (whether open or culverted watercourses)
	2.3	Investigate and support residents on issues related to private drains.
	2.4	The Council as LLFA to develop its QGIS spatial database system to provide a concise register of structures or features which are likely to have a significant effect on flood risk (as required by the FWMA cl. 21(1)). Register to include locations of hydraulic constraint and locations at risk of blockage including all assets including those under the influence of EA, UU and private owners.
	2.5	Utilise the above to drive a periodic inspection programme to identify need for maintenance.
	2.6	Develop with other RMA's an action-plan for pro-active checking of key locations in response to severe weather (rainfall) forecasts.
	2.7	Develop with the RMA partners a prioritized programme of investigations and interventions and publish intentions.
	2.8	Develop a process for public reporting of progress on actions of the LLFA.
	2.9	Consider development of policy for the control of 'paving-over' of gardens and the minimum requirements for control of surface water drainage.
	2.10	Engage with upstream RMA's, landowners and other agencies to identify potential for strategic policies to control upstream runoff e.g. Cheshire East Council, United Utilities (reservoir storage control) and National Trust (Lyme Park land management).
	2.11	Implement and test updated 'flood' reporting system.
	2.12	Identify key riparian owned assets and encourage riparian owners to form local watercourse 'teams' to share knowledge and coordinate with the LLFA.
The Council as LLFA and the Environment Agency	3.1	Continue to manage flood risk from new development. Seek flood risk benefits from new development where possible. Ensure provisions are made for exceedance flows, overland flow and runoff from remote catchments are considered. Consider the implications of downstream surcharge on local drainage capacity.
United Utilities	4.1	Maintain efficient operation of separate and combined sewers.
	4.2	Ensure effective communication with the Council regarding flooding events/ potential flood issues.
	4.3	Ensure all flood reports are captured and not 'deflected' to LLFA. Develop procedure to share reports with LLFA where the source or responsibility are uncertain.
Environment Agency	5.1	Review SMBC borough-wide flood management.
	5.2	Ensure Main River watercourses are suitably maintained.
	5.3	Review trigger levels for Flood Alerts in this area.
	5.4	Ensure effective communication with the Council regarding flooding events/ potential flood issues.
Property Owners	6.1	Consider installation of Property Level Protection (e.g. door and window barriers, air brick stoppers, flood valves or non-return valves on foul and surface water outlets - particularly from basements).
	6.2	Check weather forecast and flood warnings regularly.
	6.3	Develop an individual 'action plan' for a flood event. Reference EA publications.
Riparian Owners	7.1	Understand responsibilities as riparian owner.
	7.2	Carry out a periodic inspection programme to identify need for maintenance.
	7.3	Develop an action-plan for pro-active checking of key locations in response to severe weather (rainfall) forecasts.
Residents/ General Public	8.1	Act responsibly and with consideration when driving on flooded roads; restrict speed and thereby reduce bow-wave affecting flooded property.
	8.2	Limit surface water discharge from property; follow guidance for run-off control.

Table 6.2: July 2019 Recommended actions – local specific

RMA	Recommended Action		Location/Community
The Council Highways Department	9.1	Correct construction defects, clear all drainage networks and in particular ensure catchment B attenuation pond is functioning correctly.	A555
	9.2	Review practicality of enlargement of A555 attenuation storage, in all catchments, to achieve design intent of 100 year capacity. To achieve resilient highway infrastructure and to protect downstream communities. Review design storm conditions (duration and appropriate runoff coefficients) and attenuation drain down times. Action includes development of drainage models for each catchment, including all of catchment E (original construction + 2018 construction) taking input from Action 9.4.	A555
	9.3	Consider A555 resilience to flood exceedance events and prepare appropriate action plans. Understand inundation depths and potential impacts upon power supplies, pumping equipment and controls.	A555
	9.4	Compile record drawings and data sheets for catchment E drainage network, storage tanks and as-existing pumping installation to feed into Action 9.2.	A555
The Council as LLFA	10.1	Develop programme and lead RMA actions 9.1 and 12.1 to 12.4 in respect of Lady Brook/ Micker Brook.	Bramhall Green, Sandringham Road, Queens Road and The Demmings and Wilmslow Road/Broadway Avenue
	10.2	Develop programme and lead RMA actions 12.5 to 12.6 in respect of Poise Brook through Offerton Green.	Offerton Green; Minsmere Walks, Shearwater Road etc
	10.3	Promote possible 'quick win' short term flood alleviation measures on Bean Leach Road to prevent spillage from the road to housing and to promote spillage into the watercourse on the downstream side of the road. Coordinate actions with EA and Highways Department.	As above.
	10.4	Develop with UU (Action 11.1) an area-wide understanding of drainage networks draining Guywood Lane, Central Avenue and Sandy Lane to Compstall Road and discharge route. Identify capacity restrictions and review interventions including upstream source control measures, local storage, creation of exceedance flow paths and enhanced drainage of ponding areas.	Romiley; Guywood Lane, Central Avenue, Sandy Lane
United Utilities	11.1	Investigate full extents of drainage networks feeding into Guywood Lane, Central Avenue, Sandy Lane and discharge network and review capacity issues. Develop findings with LLFA and review opportunities to enhance capacity; including options to drain ponded water at Leyfield Avenue.	Romiley; Guywood Lane, Central Avenue, Sandy Lane
Environment Agency	12.1	Update fluvial flood mapping of the Lady Brook/ Micker Brook catchment to validate 2019 flood extents at Bramhall Green, Sandringham Road, Queens Road and The Demmings and Wilmslow Road/Broadway Avenue. Flood hydrology should review influence of rain on saturated ground.	Bramhall Green, Sandringham Road, Queens Road and The Demmings and Wilmslow Road/Broadway Avenue
	12.2	In support of Action 12.1 re-survey critical channel sections e.g. at bridges, culverts and other pinch points; identify service crossings within the flood flow section. Compare sections with historic surveys to highlight change e.g. bed debris, new/ unrecorded services, siltation, encroachment by trees.	As above.
	12.3	Using output of Action 12.1; develop Flood Alert system for Lady Brook/ Micker Brook based on Poynton Brook flow gauge.	As above.
	12.4	Using output of Action 12.1; review full range of options to deliver flood risk management scheme(s) on Lady Brook/ Micker Brook (including upstream runoff control, upstream attenuation, removal of bridge constraints, linear defences,	As above.
	12.5	Review fluvial flood mapping of Poise Brook through Offerton Green against the July 2019 flood mechanism (that indicates bulk floodwater along Bean Leach Road bypasses the mapped 3rd party flood defence bund)	Offerton Green; Minsmere Walks, Shearwater Road etc
	12.6	Using output of Action 12.5; review options to deliver flood risk management scheme(s) on Poise Brook through Offerton Green	As above.
	12.7	Review impact of revised Flood Alert trigger levels on Poise Brook	Poise Brook

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A. Abbreviations

Phrase	Meaning
EA	Environment Agency
FMAP	Flood Mitigation Action Plan
LLFA	Lead Local Flood Authority
MM	Mott MacDonald
MML	Mott MacDonald Limited
SMBC	Stockport Metropolitan Borough Council
SW	Surface Water
UU	United Utilities

B. A555

B.1 Scheme Overview

The A555 is a new dual carriageway road linking the A6 at Hazel Grove to Manchester Airport and the M56 motorway. The new road was opened in October 2018. The eastern end of the A555 lies within SMBC and since its opening has been operated and maintained by SMBC Highways Department. Prior to completion of the full route the original central section was maintained by Cheshire East Council (formerly Cheshire County Council).

The new sections of the road were built under a 'design and build' contract by a joint venture construction consortium of Carillion and Morgan Sindall. The financial collapse of Carillion meant the work was completed by Morgan Sindall. The construction was managed by SMBC with partners at Manchester City Council and Cheshire East Council.

The new A555 is of relevance to this S19 Flood Report because the road and road drainage has the potential to alter runoff to adjacent watercourses that flow through the borough. Additionally, the new road had already suffered from flooding on several occasions between its opening and July 2019 and had been implicated in the 2016 S19 Flood Reports whilst the road was still under under-construction.

Accordingly, Mott MacDonald have reviewed available documents to try to understand the design, to understand the constructed scheme and to understand the flooding issues that have arisen since completion. The following sections discus factual information and only where clearly stated express opinion upon the approach or decisions taken.

B.2 Drainage design principles

The concept for the road was taken through planning by SMBC, for which a Flood Risk Assessment (FRA) was prepared and approved. Upon appointment of the construction contractor the FRA was updated and again approved. The design intent within the FRA's was that the road drainage should achieve current highway drainage standards and not increase local and downstream flood risk. To achieve these objectives the road drainage systems were to be designed to mimic existing drainage mechanisms such that the paved surfaces would be drained but the releases to downstream would be regulated in volume and peak flows to correspond to the existing situation. The FRA recognised that the majority of the A555 construction corridor prior to construction was 'green field' whereby drainage would take place through natural processes of infiltration, surface runoff and surface storage as well as evaporation and transpiration.

The FRA proposed the drainage of the new road would be divided into several drainage networks and, based on the drained surface area, each drainage network was allocated a discharge limit calculated to replicate the 'green field discharge'. This is standard practice for the planning of developments. The as-built drainage networks relevant to the SMBC area are defined thus:

- Network A; New section of A6 and junction modification works. Outfall to Oxhey Brook by gravity.
- Network B; A6 to A555 crossing of Lady Brook just downstream of the confluence of Poynton Brook and Norbury Brook. Outfall to Lady Brook by gravity.
- Network C; A555 crossing of Lady Brook south-westward to the Stockport to Macclesfield railway line. Internal to the drainage system, the section from the railway to Woodford Road is pumped along the A555 carriageway then to gravitate with the rest of the network to outfall to Lady Brook.
- Network D; there is no system D in the developed design.
- Network E; the Stockport to Macclesfield railway line south-westward to join with existing drainage provision adjacent to the A5102 Woodford Road. Outfall to original A555 drainage and all flows pumped to Spath Brook, a tributary of the River Dean, adjacent to the Hall Moss Lane bridge over the A555.

The construction contractor and his designers developed the layout of the new road and the drainage design prior to and during the construction phase. Their design broke down each drainage network into separate sub-systems for impermeable surfaces (e.g. road and pavement) and 'soft' areas (e.g. grassed or otherwise vegetated areas). Their reasoning being threefold:

- Runoff from impermeable areas would be increased over the greenfield case and would need to be slowed or attenuated in some way.
- Soft areas could be expected to yield less runoff than impermeable surfaces.
- Runoff from soft areas could expected to be similar to the existing 'greenfield' runoff.

Accordingly, the contractors developed design sought to separate where possible the soft area drainage from the impermeable areas so that only impermeable area drainage would be discharged via attenuation storage. Separate soft area discharges are made from Networks A, B and C; but not from Network E because all runoff needs to be attenuated prior to pumping to outfall.

B.3 Runoff Attenuation Storage

The contractors developed design incorporates attenuation storage as follows:

- Network A; Pond A adjacent to the west end of the new section of A6.
- Network B; Pond B at Mill Hill Hollows on the right bank (looking downstream) of Norbury Brook just before its confluence with Poynton Brook (adjacent to the westbound A555 carriageway). The Pond outfall is downstream of the confluence and will be termed Lady Brook downstream from this point.
- Network C; Pond C at Mill Hill Hollows on the left bank (looking downstream) of Lady Brook (adjacent to the eastbound A555 carriageway).
- Network E;
    - Ponds E1 and E2 in cascade adjacent to the A555 westbound carriageway at the oil terminal gyratory junction to the A5149 Chester Road.
    - Storage pipework under the A555 westbound carriageway west of the A5102 Woodford Road bridge.
    - Existing below ground attenuation storage associated with the Network E pumping station adjacent to Hall Moss Lane bridge.

B.4 The drainage design

Detail of the design criteria and design calculation and drainage modelling has been hard to locate and the records are incomplete, however, 4 main documents have been referred to:

- Drainage Strategy Report, Aecom 1007/6.7/062 Rev 5 October 2013
- Flood Risk Assessment, Aecom 1007/6.7/061, Rev 5 October 2013 (supersedes Faber Maunsell A555 FRA, July 2006)
- Drainage Design Statement, Aecom/ Grontmij A6MARR-0-W-05-001-RE-002 Rev P0 March 2014
- 'As Built' drainage drawings.

The 2013 Drainage Strategy Report defines the principles for the development of the drainage design. The strategy report breaks the A555 scheme into a number of drainage networks and it defines the catchments and outfalls from each. The principle of attenuated discharge from impermeable catchments and unattenuated discharge from 'soft' landscape areas is established. Preliminary discharge restrictions for each catchment are tabulated and notional attenuation pond configurations given (but not storage volumes), Storm durations are not discussed. A lot of the detail has been changed in the as-built design so only the principles are relevant.

In terms of surface water drainage, the 2013 Flood Risk Assessment (FRA) refers extensively to the information within the Drainage Strategy Report and concludes surface water drainage is possible without increasing flood risk downstream. The FRA also concludes the A555 is itself robust to flooding and an appropriate development in the setting.

The following principles are surmised from the Drainage Design Statement, 2014:

- Section 3.1.1 suggests design storms are limited to 15 minute duration – this is much too short for drainage systems incorporating attenuation storage. Or is this only used for the 1 in 5 year design check; but no other durations are advised.
- Suggests earthworks (permeable) catchments are discharged un-attenuated to watercourses.
- Section 5.4 describes Network C as ‘pumped’; whereas only part of it is pumped.
- Indicates the principle that Network E is discharged to the existing A555 drainage at Hall Moss Lane. There is no validation that the existing system was/is capable of accepting the additional discharges.
- Section 5.5.1 describes Network E draining into the existing drainage network and states ‘previous correspondence with Cheshire County Council stated the existing pumping station (PS 4; Hall Moss Lane PS) was designed to accommodate an additional 700m of dual carriageway runoff’. This statement is not substantiated or expanded upon to indicate the capacity within the existing system.
- There is more than 700m of additional carriageway to be connected to the existing; however attenuation storage is proposed upstream of the connection to the existing (developed as Ponds E1/E2 and pipe storage).
- Discharge constraints are not given.
- Designed attenuation volumes are not given.

The ‘as built’ drawings indicate the following:

- Ponds A, B and C appear to have been designed to accommodate up to 1 in 100 year storm event(s) with some freeboard provision.
- Ponds E1 and E2, appear to have been designed to accommodate up to 1 in 30 year storm event(s) with some freeboard provision.
- Pond volumes are not given.
- Key data is summarised in Table B.1

Table B.1: Key attenuation storage data

Pond reference (Network)	Discharge restriction (l/s)	1 in 30 year storm storage level (mAOD)	1 in 100 year storm storage level (mAOD)	Freeboard to top of banks	Flow control chamber reference	Storage volume (m^3)
A	16.4	not given	94.354	165mm	A1/036	not given
B	35.4	not given	79.410	300mm	B1/068	not given
C	22.0	not given	77.500	300mm	C2/026	not given
E1	17.0	82.739	not given	not given	E/164	not given
E2	13.0	81.206	not given	not given	E/170	not given
E Storage pipes E/1.046-E/1.053 750/900mm diameter	200.0	Not applicable	Not applicable	Not applicable	E/Outfall	not given

Source: A555 'As built drawings'

With the information available, MM are unable to reconcile the values shown above for the as-built 'discharge restriction' with the 'green field' flow values given in the FRA. It is therefore assumed that the values for 'discharge restriction' for networks A, B and C are those agreed and consented with the EA through the planning and construction stages.

There are no calculations available to support the stated storage levels or to indicate the design assumptions with respect to storage volumes, storm duration etc.

B.5 A555 Flood incidents

The completed A555 was opened to traffic in October 2018 and the council record subsequent flooding event(s) as follows:

Incident Saturday 16th March 2019

- Heavy rain; original A555 pumps failing.
- All power off. Two of four pumps working.
- A555 flooding at Hall Moss Lane-Saturday Night.
- Road Closed from 20.00hrs 16th March.
- Reopened Monday 18th March at 20.00hrs.
- Attenuation Ponds damaged at Woodford Rd gyratory; these ponds drain to Spath Brook via the original A555 pumping station.

The March event exposed the original A555 pump station at Hall Moss Lane to be in a deteriorating condition and SMBC committed to replacing the pumps and controls. This work was planned to be undertaken in the first week of August 2019 but was delayed due to the impacts of the July 2019 flooding.

Incident Sunday 28th July 2019 (at this time drainage at the original A555 pumping station at Hall Moss Lane bridge was reliant on a temporary pump within the wet well pumping to Spath Brook; this temporary arrangement was pending installation of new permanent pumps).

- Heavy rain over several days.
- A555 flooding at Woodford Road (Poynton),
- Network C Pump alarm triggered,
- A555 flooding at Hall Moss Lane,
- Police call at 11.45 am, road closed 1.30pm.
- A555 closed both ways between A523 and A34 from 1.30pm 28th July 2019.
- Monday 29th July –A555 flooding at Woodford Rd cleared and road reopened between A523 and Woodford gyratory.
- Network C attenuation pond (discharge into Lady Brook) overflowing and damaged.
- Tuesday 30th July; A555 temporarily opened at 5pm but closed later due to more rain bringing levels in tanks back up over road level (at Hall Moss Lane).
- Wednesday 31st July; A555 closed again westbound from A523 before being closed from Woodford gyratory to A34.
- A555 closed westbound A34 to Woodford gyratory.
- A555 Manchester section (within the boundary of Cheshire East Council) also closed under Wilmslow Rd bridge (not SMBC responsibility).
- Friday 2nd August; A555 Eastbound carriageway open at 6pm.
- Monday 5th August- A555 Westbound carriageway open at 7pm. Remains one lane shut until 14th August to carry out fitment of new pumps and to desilt attenuation tank.

Clearly, within the SMBC area, in the July 2019 event the A555 carriageway flooded at 2 locations:

- At the Network C pump station, adjacent to Woodford Road, and
- At the original A555 pump station, Network E, adjacent to Hall Moss Lane.

On Sunday 28th July 2019 the pump maintenance contractor APS was called to site and whilst they could do nothing at Hall Moss Lane due to the depth of flooding they were able to access the Network C pump station and they noted the following:

- Attended Network C pump station on Sunday 29th July 2019 at 15:00hrs,
- A555 carriageway flooded; see Figure 2.9.
- Both pumps had tripped but tested ok and were re-started and the floodwater was cleared.
- The pumps were noted to be drawing 31 to 31.4 Amps across all phases with overload trips set at 32 Amps.
- At the time the water level in the Network C pond was 300mm below the delivery pipe.
- It was understood the pond level had been higher earlier in the day.
- Revisited site on Monday 29th July 2019 to investigate cause of pump tripping but no explanation found; pumps running at 29 to 30Amps.

On Wednesday 31st July 2019 APS were alerted at 15:00hrs that a pump had tripped again and proceeded to site to investigate and they reported:

- By the time they arrived both Network C pumps had tripped and the high-level alarm had activated.
- A555 carriageway starting to flood at Woodford Road bridge.
- Pumps were re-started but drawing 33A (over the 32A overload setting).
- APS visited the Network C pond and found it completely full and the delivery pipe submerged.

- Pond C then started overflowing (see Figure 2.10) and flowing overland to the river (Lady Brook) which was noted as being ‘very high’.
- Returning to the pump station the pumps had tripped on overload after 5 minutes.
- Re-starting a pump it then tripped on start-up (60A starter breaker).
- The pumps were re-set but not started. The engineers concluded the high pond level was increasing the pump duty’ leading to overload conditions.
- A555 carriageway completely flooded at Network C pump station.

APS concluded that the high Network C pond water level was increasing the pump duty’ leading to overload conditions and the pumps should not be re-started until water level drops.

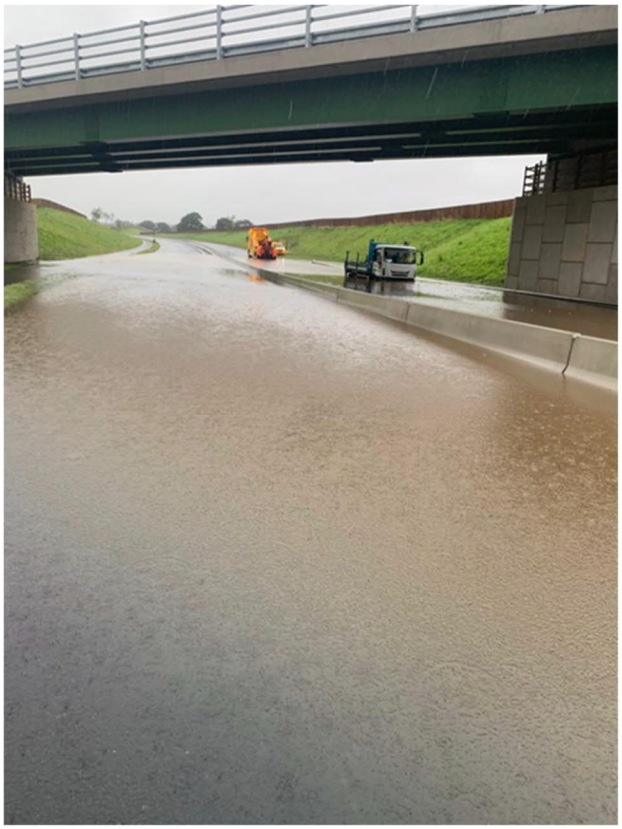
In retrospect it appears the conclusion the pump duty increased is probably correct, but this is not directly linked to the pond water level because there is a long section of gravity drain linking the pumped rising main to the pond. Nevertheless, in the severe rainfall events of 28th and 31st July 2019 the gravity drain is likely to have become surcharged and thereby increased the effective head the pumps were required to work against. In terms of the pumping station, actions to resolve appear to be:

- Check the rising main and receiving drain for obstructions/blockages.
- Review raising the overload settings if equipment is suitable,
- Review upgrading the pumps and/or electrical equipment for the higher ‘flood condition’ duty..

The Network E ponds and pumping station were overwhelmed on both 28th and 31st July 2019. At the start of this this period, it is understood only a single temporary pump was in operation, pending the installation of the new pumps. It is understood the temporary pump was operational throughout the period of flooding but was unable to cope with the runoff collected at Hall Moss Lane. As the event unfolded and as conditions permitted, supplementary temporary pumps were used to drain-down the flooded carriageway and drain the attenuation storage. It is also understood that the attenuation ponds E1 and E2 overflowed in the period. Overflow at these ponds was onto the A555 carriageway and along it in a westerly direction towards the original pump station. En-route some of the overfow will have been absorbed into the carriageway drainage. Carriageway drainage ultimately reaches another flow control device at the connection with the original road. At this point excess flow may have again overflowed and flowed above ground before reaching the original pump station where the carriageway became flooded. It is likely the overflowing, unattenuated flow from the new road was a contributory factor in the flooding at the pump station.

During the above incidents there are no reported issues in respect of Networks A or B.

Figure B.1: 28th July 2019 A555 carriageway flooded at Woodford bridge .



Source: APS

Figure B.2: Network C attenuation pond overflowing 31st July 2019



Source: APS

B.6 A555 post-flood investigations.

Investigations following the July 2019 flooding have identified the following:

Network B

- Vegetated or 'green' areas are drained directly, without attenuation, to Norbury Brook via several outfalls. It is difficult to justify this approach as meeting the intent of the FRA to limit discharge to the pre-existing condition, the act of providing the drains at top and base of slopes and routing these directly to watercourse is likely to increase the speed and volume of runoff to the watercourse. Discharge via some form of SuDS would have been appropriate. However, in the 2019 flooding it is likely the additional runoff was insignificant compared to the volume in Norbury Brook from upstream catchments. The total area drained by the A555 scheme to Lady Brook (including carriageway drained to attenuation ponds) is only approximately 5% of the total Lady Brook catchment to this point; so the A555 drainage is influencing only a small part of the total and the 'green' areas are only a part of the A555 drained area.
- Suspicion that attenuation pond B did not fill and accordingly may not have attenuated runoff flows as intended. Evidence from 3rd parties suggests there was no flattening down of grass around the margins of this pond that would have indicated an elevated water level. However, SMBC officials believe from their post-event site visits that there was evidence of filling and overflowing. There does not appear conclusive evidence one way or the other. Further investigation is warranted to prove the inlet drainage is not blocked leading to unattenuated spillage upstream of the pond.
- Upstream of the pond is an oil interceptor and upstream of that is a manhole sat very close to the steep bank of Norbury Brook. At this manhole the brook bank has slipped away partially exposing the manhole and taking with it the outfall headwall of an adjacent drain from 'soft' landscaping. It is possible the slippage has been caused by leakage/spilling from the surcharged carriageway drain.
- Large amount of debris located in the outlet pipe from Pond B trapped by the outlet grille. The origin of the debris is unknown as this is downstream of the pond flow control device; it is possible the debris was carried there prior to fitting of the flow control. This is a construction defect that is indicative of no maintenance by the contractor prior to handover. However, the outfall pipe is oversized for the duty downstream of the flow control and its partial blockage would likely only have a small effect on outflow. Presence of the flow control has been confirmed.
- The grating on the incoming pipe into the pond was more than 50% blocked with debris This could have lead to surcharge upstream and unplanned discharge to the watercourse.
- This pond, if functioning correctly, may also have overtopped, as pond C, and its design may be undersized; see discussion and actions below for Network C.
- A number of construction defects have been identified post the flood event and these are to be addressed by the construction contractor.

Network C

- As for Network B, within Network C vegetated or 'green' areas are drained directly, without attenuation, in this case to Lady Brook and the same comments apply.

- Attenuation pond C overtopped at several locations in the July 2019 flood event. The outlet flow control chamber is situated very close to the bank of Lady Brook and overtopping erosion/slippage has exposed the manhole construction. There is a risk of further bank erosion and potentially a breach of the pond into Lady Brook. This pond needs a robust overflow spillway and the flow control chamber needs to be made water-tight (it is of standard unsealed manhole rings without seals or concrete surround) to avoid saturating the riverbank. Bank slippage needs to be reinstated.
- Survey of Pond C has revealed that the outlet pipe has been installed 680mm higher than designed; thus reducing the flood storage volume available. This defect is to be corrected in 2020 by the construction contractor. See Figure B3.
- Because the outlet pipe has been installed too high, there is a suspicion that this pond is too small for the drained area to achieve the 1 in 100year flow control.
- Relevant design calculations should be sought and/or new calculations made to determine the as-built design standard using storm durations appropriate to the attenuated drainage arrangement.
- Network C pumping station; pumping discharge capacity appears adequate, but the pumps/pump controls need to be capable of sustaining the higher duty when pumping to a surcharged network. As a pre-cursor to this action the rising main should be surveyed to ensure it is free of blockage(s).

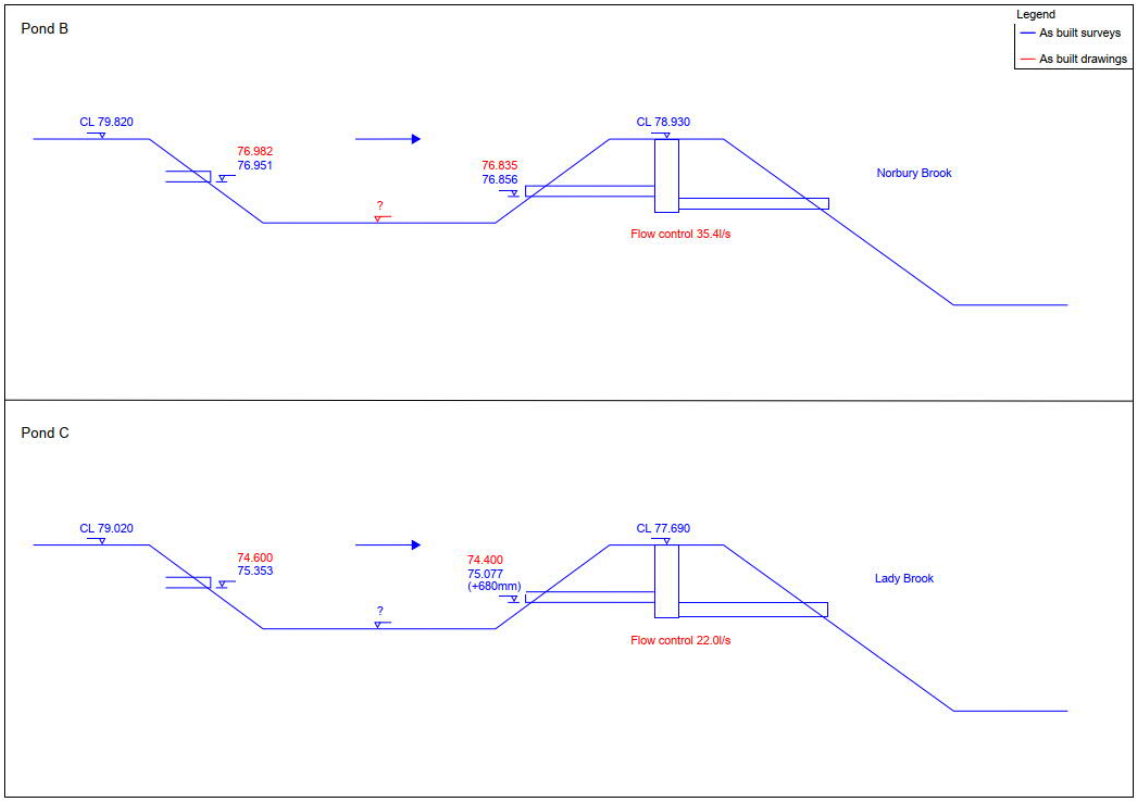
Network E

- Network E all drains into the original A555 drainage system and is all pumped to Spath Brook which flows to the River Dean and does not enter the borough. Flows that cannot be pumped are temporarily stored on or below the A555 carriageway. There are no calculations available to confirm the original A555 pump station at Hall Moss Lane together with the original below ground storage can support the additional flows from the new A555 Network E.
- In addition, this network has been expanded through design development to include what was a network D that was intended to drain to local watercourses at the Woodford gyratory. The impact is that in excess of 1300m of carriageway plus substantial ‘green areas’ are drained into the original A555 drainage network to the west. This compares to stated provision of capacity for 700m of carriageway in the original A555 design. There is therefore potential for increased peak flows and volumes to the existing storage and pumping station.
- Drainage from the new A555 Network E is connected to the original A555 via a ‘Hydrobrake ‘ to limit pass forward flow to circa 200 l/s and further upstream there are 2 attenuation ponds in cascade (E1 and E2) to hold back flows from the gyratory junction and east to the network boundary. Pond E1 has a design storage volume of 4527m^3 and discharge ’Hydrobrake’ with a pass forward flow of 17 l/s and Pond E2 has a design storage volume of 981m^3 and discharge ’Hydrobrake’ with a pass forward flow of 14.6 l/s
- Survey of Ponds E1 and E2 has revealed that the outlet pipes have been installed 700mm and 180mm respectively higher than designed; thus reducing the flood storage volume available; by up to 25% for pond E1. This defect is to be corrected by the construction contractor. See Figure B4.
- Based on the above pond volumes and pass forward flows the E1/E2 combination is likely to have an unusually long ‘drain-down’ time of between 4.5 days (no further inflow) and 2 weeks (steady inflow 10 l/s). This extended ‘drain-down’ time should have been investigated at design stage as it leaves

the scheme vulnerable to long duration events and to follow-on rainfalls after an initial event. DMRB makes suggestions to check these scenarios.

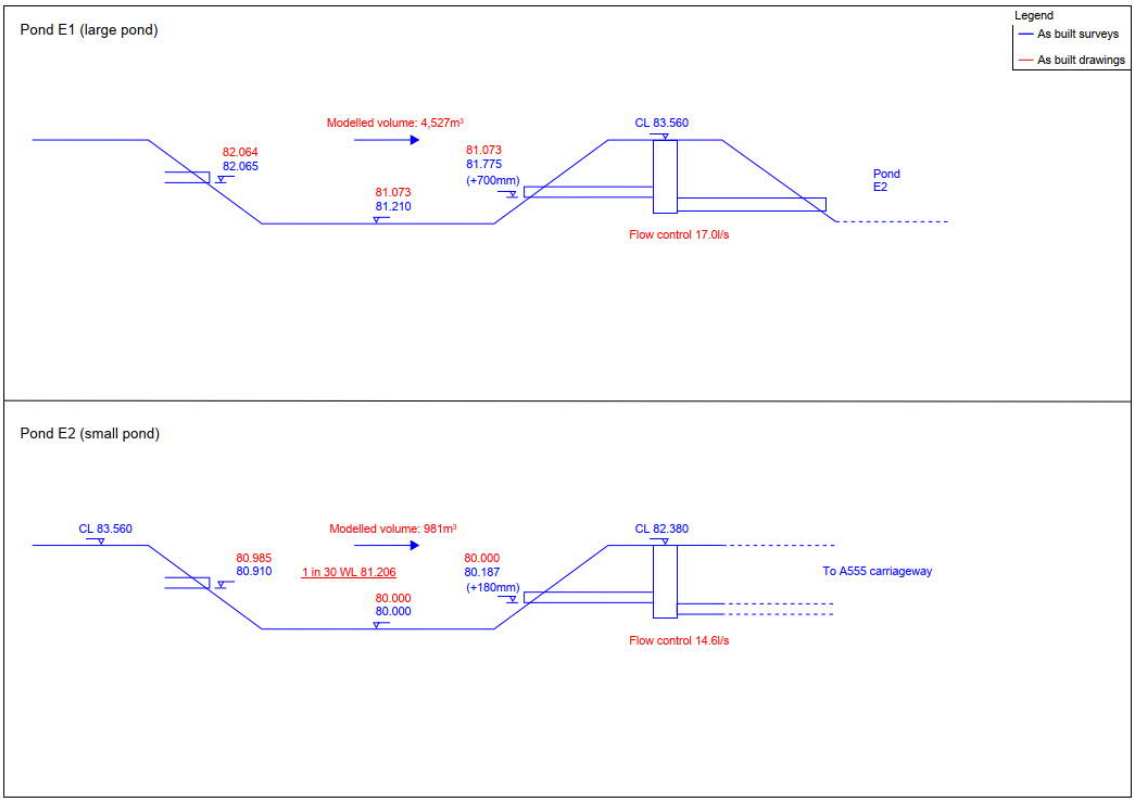
- From the history of flooding it is likely the original pump station is inadequate to drain the combination of the new road and the original to a reasonable standard. Accordingly, calculations should be sought and/or new calculations made to determine the as-built design standard using storm durations appropriate to the attenuated drainage arrangement and consideration of 'follow-on' events.
- It appears that the new components of Network E have been designed with a 1 in 30 year design flood capacity (on the grounds the exceedance flow is retained on the carriageway and not passed to downstream communities). This is acceptable for control of flood risk to downstream communities but leaves the highway vulnerable to flooding. Given the extended 'drain-down' times for the ponds and that it also appears the design did not consider extended duration rainfall events or 'follow-on' events, it is likely the design does not in practice provide a 1 in 30 year standard. There is no indication that the effect (e.g. the flooded extents of a 1 in 100year storm) has been considered.
- It is noted that there are significant inflows to the A555 drainage network from external catchments to the original A555 and to the new section; these inputs should be explicitly allowed for in the drainage calculations based on catchment areas and runoff characteristics or other appropriate means.
- To achieve the intended designed standard, it will be necessary to increase flood storage unless the consented release can be increased by negotiation with the EA. Accordingly, it is likely either one or both ponds E1 and E2 will need to be enlarged. The drainage calculations will indicate to what extent this is practical with the existing scheme layout, levels and boundaries and what design standard can be achieved.
- It is likely that storage drain-down will be longer than normal practice and there will be a residual risk that follow-on storms may have significant impact. This situation should be tested with the developed drainage model and if necessary a contingency plan developed for circumstances when significant flood storage is already occupied. This plan might incorporate some temporary emergency pumping in exceedance of consented discharge with the prior approval of the EA and limited to defined conditions.
- It is noted that the Hall Moss Lane pumping station is in a vulnerable location; being sited immediately below Spath Brook to which it discharges. The brook was noted as being of relatively small dimensions and somewhat overgrown. To minimise risk of the brook overflowing to the A555, due to natural runoff plus the A555 pumped discharges, the ownership and responsibilities for maintenance should be confirmed and actioned.

Figure B.3: Attenuation ponds B and C; key levels



Source: MM from SMBC data

Figure B.4: Attenuation ponds E1 and E2; key levels



Source: MM from SMBC data

C. Bramhall Green

A.1 General Situation.

Bramhall Green roundabout sits at the junction of Bramhall Lane South and Bridge Lane. Close to the roundabout, Lady Brook (Main River) flows approximately East to West parallel but off-set from Bridge Lane; flowing behind residential and commercial property on the north side of Bridge Lane. Upstream, Lady Brook turns and passes under Bridge Lane at Womanscroft Bridge. Downstream, Lady Brook passes under Bramhall Lane South at Bramhall Bridge and flows onwards through Bramall Hall Park.

The area has a history of flooding; events occurred in July 1973, June 2016, and July 2019, there are likely other events.

On the afternoon of 31st July 2019, 12 properties between Lady Brook and Bridge Lane from the roundabout up to Womanscroft Bridge, both residential and commercial, suffered internal flooding with a maximum internal depth of 2 feet (0.6m) reported. Maximum depth of external flooding was reported as 5 feet (1.5m). This flooding is directly linked to Lady Brook.

Additional properties east of Womanscroft Bridge on both sides of Bridge Lane and on Southern Crescent also reported flooding, some internal and some external; this flooding is linked to other sources of flooding and is reported separately at the end of this Appendix.

The rainfall events from 28th July to 31st July 2019 are discussed in the main S19 Flood Investigation Report.

Information of the event, of the flooding and background information has been extracted from the following sources:

- Flood reports recorded by SMBC and the EA
- Public drop-in meetings held in January/February 2020
- Follow-up communications with affected residents.

A.2 Flooding Timeline.

Sunday 28th July 2019

- No flooding reported, although surface water drainage systems in Bridge Lane noted as full.

Wednesday 31st July 2019

- 14:30hrs Lady Brook flow level approximately 0.3m below soffit level on downstream side of car park bridge at rear of Brookdale Club. Ponding commences at rear of Brookdale Club
- 15:20hrs Bridge Lane is partially flooded as is front door of Brookdale Club. No evidence at this time of flow from Lady Brook. It is like
- 15:40hrs Lady Brook flow level at soffit level on downstream side of car park bridge at rear of Brookdale Club. Rainwater pipes discharging to surface (drains surcharged).
- 15:50hrs Flow from drains filling yard at rear of Brookdale Club.

- 16:00hrs Muddy water from Lady Brook starts to flow onto access at rear of Brookdale Club.
- 16:10hrs Muddy water from Lady Brook streaming through ‘gateway in river wall’ and flowing around building to access road.
- 16:30hrs Flooding on Bridge Lane reported as 4feet (1.2m) deep.
- 16:37hrs Lady Brook now just spilling over river wall.
- 16:47hrs Lady Brook now wiering over river wall.
- 16:57hrs Lady Brook flood level still rising; not quite over bridge deck.
- 17:00hrs Detailed evidence from Brookdale CCTV cameras ends (power loss?).
- Maximum flood level reported as between 17:00 and 18:00hrs.

A.3 Flooding Mechanism(s).

Interpretation of the flooding mechanism, from the above timeline and the photographs and video records available, indicates:

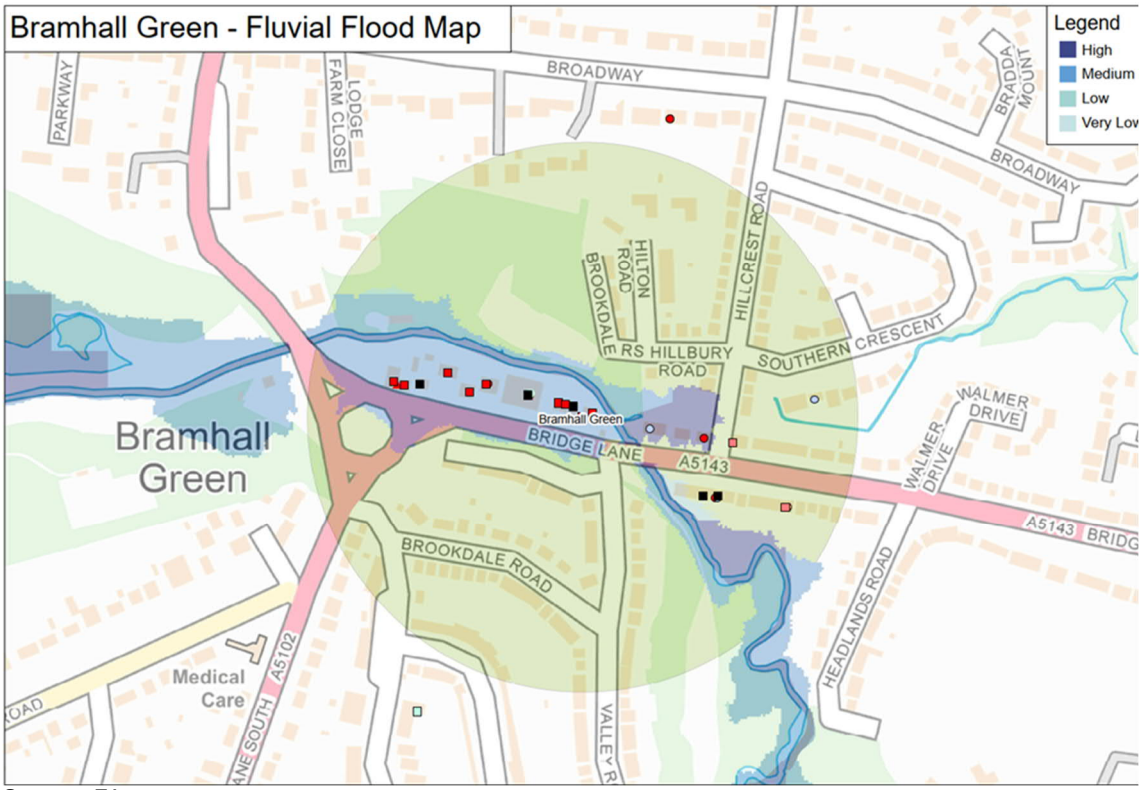
- Initially Bridge Lane begins flooding from surface water runoff that exceeds the capacity of the highway drainage available to discharge this to Lady Brook via 2 outfalls (1 just upstream of Brookdale Club and the other adjacent to the Nisa local shop at the roundabout. Drainage capacity is likely at this time to have been restricted as Lady Brook was already at a high level.
- Subsequently, Lady Brook breaks its banks and flows into the rear of properties upstream of the roundabout; particularly Brookdale Club and neighbouring property (possibly others but evidence has not been seen). Floodwater from Lady Brook flows from the rear of properties onto Bridge Lane and flows towards the roundabout.
- At the roundabout floodwater ponds initially until flood depth rises rapidly to commence overland flow across Bramhall Lane South and into Bramall Hall Park.

Based on the flood mechanism above the main source of flooding is the Main River, Lady Brook and accordingly the EA have responsibility for investigating the circumstances and considering practicable mitigation measures. The initial stages of flooding do appear to stem from the inability of highway drains to remove local surface water when Lady Brook is also in flood. It is possible that there is a transient condition as Lady Brook flood level rises that there may be back-flow in the highway drains as these do not appear to be protected by non-return (or flap) valves. However, the magnitude of the flood flows and their timing seen from evidence suggests the majority of floodwater on/at Bramhall Green roundabout has overflowed from the banks on Lady Brook. Had the brook not overflowed there may still have been flooding but the depth and extents would have been much less.

A.4 EA Flood mapping.

The EA produces flood mapping for main rivers (Fluvial flood mapping) based upon numerical hydraulic modelling using local topography and surveyed dimensions of structures. The relevant flood mapping is shown in Figure C.5.

Figure C.5: EA, Bramhall Green, Fluvial Flood Map



Source: EA

This map indicates locations of reported flooding and shows:

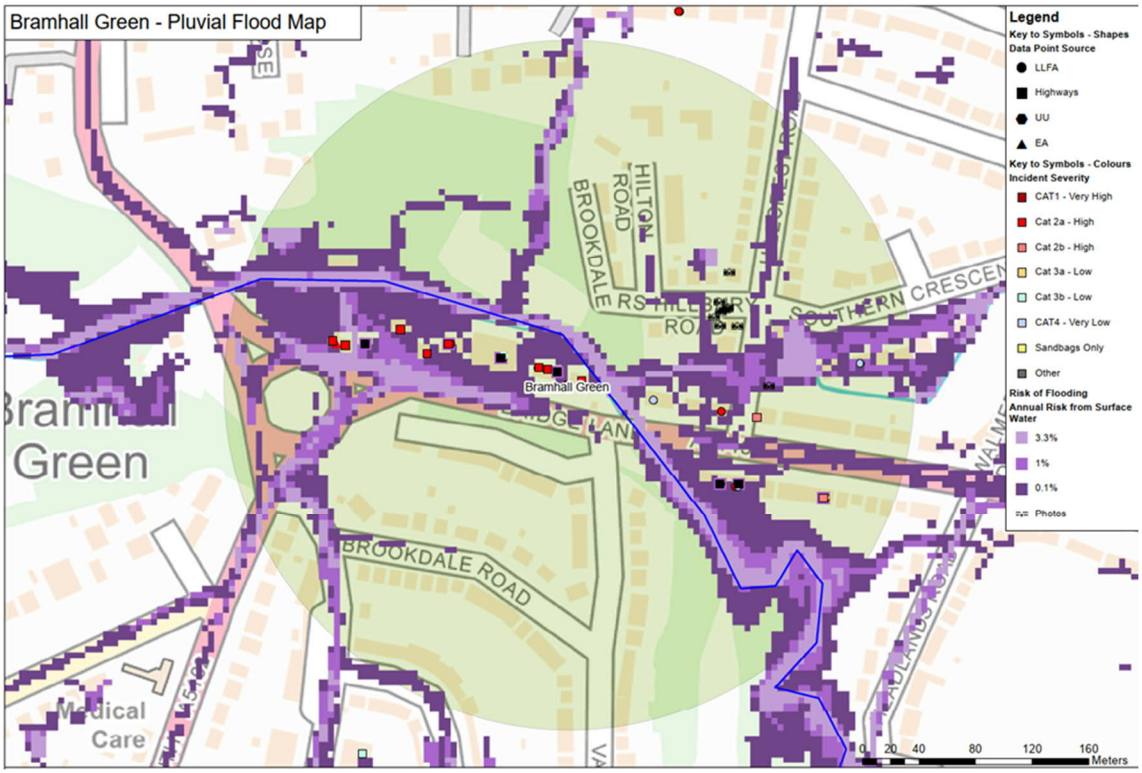
- Properties flooded between Womanscroft Bridge and the roundabout all lie within the 'Medium' risk area; that is to say they are forecast to have between a 1% and 3.3% risk of flooding each year.
- Bramhall Lane South is not shown to flood.

It should be noted that the flood extent of 31st July 2019 extended over Bramhall Lane South and it may be concluded that to do so the flood depths upstream must have been greater than forecast.

Similarly, the EA produces flood mapping from 'Pluvial' sources; this is shown in Figure C.6 and shows:

- Flood risk to properties between Womanscroft Bridge and the roundabout is very similar to the fluvial case (note some property footprints show as no risk but are surrounded by flooding; this is a feature of the method of mapping that requires floodwater to flow around the buildings).
- Localised flooding on Bramhall Lane South.

Figure C.6: EA, Bramhall Green, Pluvial Flood Map



Source: EA

A.5 Significant factors/structures affecting Flood levels on Lady Brook.

- Access bridge at rear of Brookdale Club
- Access bridge to Guide hut.
- Bramhall Lane South road bridge(s)

There are 3 bridges across Lady Brook downstream of Womanscroft Bridge (Bridge Lane); there is no report or evidence that flood flow exceeded the capacity under Womanscroft Bridge so this is the upstream limit of consideration.

Photographic and video evidence indicates that The Brookdale access bridge and Bramhall Lane South bridges became surcharged during the 31st July 2019 event. The guide hut bridge may have also, but we have seen no evidence. Under surcharged conditions, i.e. when the flow depth upstream exceeds the soffit of the bridge opening, flow depth increases rapidly for relatively small increase in discharge and there will be increased energy losses in the flow upstream to downstream. Accordingly, there are level changes upstream to downstream at each bridge. These level changes combine with the overall flow gradient on the brook to produce a hydraulic profile that is higher at Womanscroft Bridge than at Bramhall Bridge.

At each bridge, and indeed at all cross-sections along the brook, flood flow encounters restriction due to the available flow area and flow depth generally has to increase to increase flow discharged. Looking at the sectional areas available to flow there appears an obvious constriction at the downstream side of the Bramhall Lane South bridge. This bridge is in effect 2 structures, an original downstream masonry arch bridge from c.1929 and a steel beam and

concrete slab bridge from c.1995. Having the same roadway level and span, means the old arch bridge has a significantly smaller opening for flow. Review of photographs and field inspection shows there to be a build-up of silt upstream of the old bridge.

Each of these hydraulic constraints should have been incorporated into the EA's fluvial flooding model and the flow depths should thereby be representative of the situation. However, given that there was extensive flood flow over Bramhall Lane South which is not indicated in the model results, this suggests the components of the hydraulic model should be checked/reviewed and amended/updated appropriately and if necessary the flood mapping updated. Note this action is linked to similar actions in relation to flooding at Sandringham Road, Queens Road and The Demmings and Wilmslow Road which are all part of the same river model. Where considered necessary or critical channel sections should be re-surveyed to capture existing (silted) conditions.

Similarly, the hydrology of the Lady Brook catchment should be reviewed to confirm or refine the appropriate runoff hydrographs. As is discussed in Appendix A, the new A555 dual carriageway has been cited as a contributor to increasing flood flow to Bramhall Green. The conclusions drawn are that whilst features of the A555 drainage did not work entirely as designed or intended the presence of the road is not the main driver behind the flooding experienced. In this regard it should be noted that there were significant flood damages in the upper reaches of the Lady Brook catchment and the flood flows responsible subsequently combine to Lady Brook e.g. at Lyme Park and Poynton.

A.6 Flood Warning.

Yellow 'be prepared' weather warnings were issued for heavy rainfall for areas of Greater Manchester, Cheshire and Derbyshire. The EA issued 'Flood Alerts' for the Bramhall area on 28/7/2019 at 10:23 and on 31/7/2019 at 08:57 however no 'Flood Warnings' were given for the area. It is noted that flood warnings for Bramhall are linked to measured trigger levels on the River Mersey. Reliance on flood levels on the Mersey will not be able to spot flood events on the much smaller and faster to respond Lady Brook. As such the warning system is insensitive to localised intense rainfall on the Micker Brook (including Norbury, Poynton and Lady Brook) catchments.

A.7 Conclusions and Recommended Actions.

The primary driver for flooding at Bramhall Green in July 2019 is Fluvial Flooding from Lady Brook. Unplanned drainage runoff from the A555 is not considered to be significant in the overall event.

Flood mitigation measures need to be proportionate to the damages and frequency of occurrence, to be cost effective and affordable. Following confirmation/modification of the flood modelling, consideration should be given to the identification of an appropriate raft of measures from:

- Fitting of non-return valves to highway drainage outfalls.
- Establish measures for discharge of highway runoff in 'tide lock' conditions e.g. pumped drainage or extend outfalls further downstream.
- Property Level Defences (PLP).
- Removal/relief of hydraulic constraint at Bramhall Bridge.
- Linear defences upstream of Bramhall Bridge

- Catchment runoff control measures; slow the flow in upper reaches of the catchment.
- Upstream flood attenuation reservoir(s).
- Develop Micker Brook catchment specific flood warning system based on local rainfall and gauged flows.

Some of the above measures could have impacts at the other downstream flood risk areas along Micker Brook. Accordingly, they should be developed and reviewed in unison.

A.8 Additional Flooding Bramhall Green Area.

Additional properties east of Womanscroft Bridge on both sides of Bridge Lane and on Southern Crescent also reported flooding. The sources of this flooding are considered to be separate from the lower section of Bridge Lane described earlier.

Properties on Bridge Lane, east of Womanscroft Bridge, appear to have been flooded from surcharging of the highway and/or UU surface water drainage network. Many of these properties are below the level of the road and drainage gullies and other connections are likely to spill in storm conditions. It is recommended the owners consider fitting non-return valves to their connections with the UU combined drainage network. Where highway runoff could enter private land e.g. via drop kerbs for access the owners should consider reprofiling the access to keep the highway flows on highway land.

Several properties on Southern Crescent reported flooding to their gardens; some front and rear. An ordinary watercourse, a tributary of Lady Brook flows to the south of the properties but during the flooding of 31st July 2019 an upstream bridge on Fred Perry Way is reported to have become choked with debris and floodwater was temporarily stored upstream. At some point the blockage was breached and a flood surge flowed downstream that overwhelmed the natural channel such that some flow passed onto southern Crescent and thence to front gardens on the low side of the road. Accordingly, this flooding may not have taken place had the flows not ponded in the first place due to the debris. This incidence highlights the need for the LLFA and riparian owners to be alert to potential blockage locations and carry out periodic inspections and inspection of key locations upon notice of severe rainfall forecasts. A ‘Local Flood warden’ might have been able to intervene before the blockage became too severe and potentially too dangerous to clear.

D. Bramhall Moor

D.1 Background

Figure D.7 indicates the extent of this flooding hotspot and the relevant street names. The hot spot comprises the residential streets of Corfe Crescent and Mostyn Road from where multiple flood reports have been submitted. Several properties on Corfe Crescent report internal flooding and 1 property on Mostyn Road reports flooding below floorboards and floodwater in their garden up to 600mm deep.

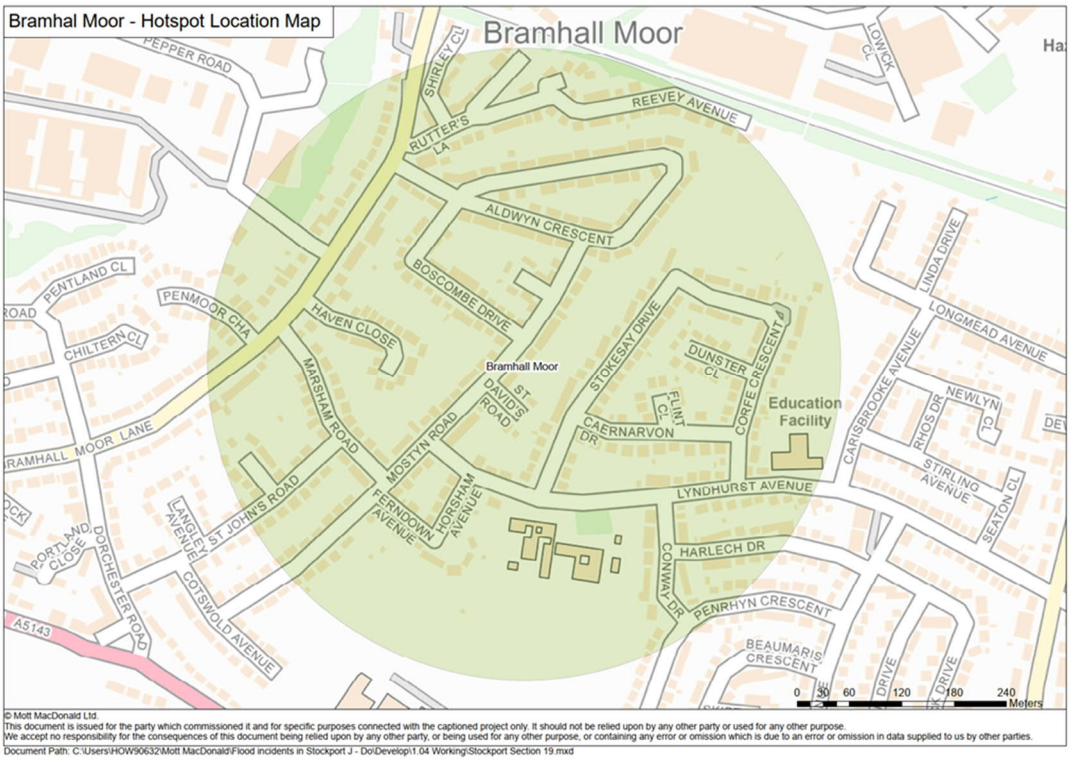
At Corfe Crescent the road and front gardens of many houses was completely flooded. Residents report this has happened many times before (2016?). Reports suggest that SW runoff from the school field to the east and runoff from Lyndhurst Avenue to the South contributes to the ponded volume.

Drains and gullies were surcharged in the locale and there were reports of some sewage contamination.

D.2 Flooding Timeline

Flood reports for Corfe Crescent indicate external flooding and flooding of garages took place on Sunday 28th July 2019 and this was followed by a greater depth of flooding on Wednesday 31st July 2019.

Figure D.7: Hot Spot Location Plan, Bramhall Moor



Source: Reference mapping.

D.3 EA Flood mapping

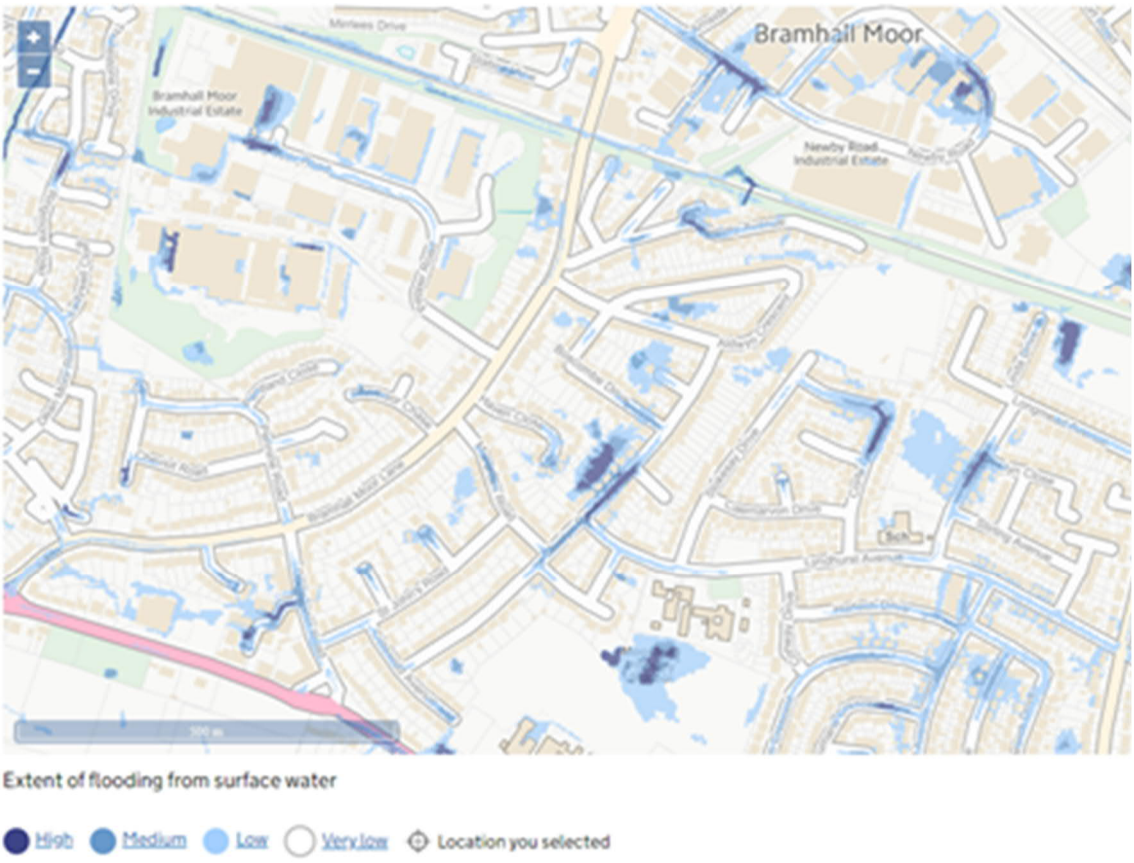
The EA produces flood mapping from 'Pluvial' sources; this is shown in Figure D.8. In this case the pluvial flood map shows:

- An area of flooding on Corfe Crescent that has the potential to impact property.
- An area of flooding on the school field to the east of Corfe Crescent.
- An area of flooding on Moystyn Road and to the rear of properties.

The pluvial mapping provides indicates there is risk of SW flooding at the bend in Corfe Crescent.

Note a fluvial flood map is not considered here because there are no 'Main' Rivers within this hot spot and hence no mapped flood extents.

Figure D.8: Bramhall Moor; EA Pluvial Flood Map



Source: Environment Agency

D.4 Flood Warning

Yellow 'be prepared' weather warnings were issued for heavy rainfall for areas of Greater Manchester, Cheshire and Derbyshire. This warning is indicative of possible surface water flooding.

D.5 Conclusions

From the flood reporting it is not clear if floodwater at Mostyn Road and Corfe Crescent is solely attributed to SW runoff from adjacent roads and fields or if the flooding is in part fed by surcharge from the local drainage system. Some investigation of the drainage network is required, however this is a small area of flooding so the time and expense needs to be proportionate to the relatively small gains achievable.

Recommended actions:

- Investigate the performance of the local drainage network and try to eliminate inflow to the flood locations, eliminate obvious defects.
- Residents at risk should consider property level protection measures.

E. Sandringham Road

A.9 General Situation.

Six recently constructed (circa. 2014) houses were flooded on the north side of Sandringham Road, Cheadle Hulme on the evening of 31st July 2019. The properties back onto the flood plain of Lady Brook/ Micker Brook.

Impacted residents report contaminated flood water 1ft deep (0.3m) inside their homes and foul water 'pumping' out of their sinks.

The properties are located on the low-side of Sandringham Road and have been developed following a 'Flood Risk Assessment'. The properties lie outwith the EA's current mapped fluvial flood risk and outside mapped flood zones 2 and 3.

Information of the event, of the flooding and background information has been extracted from the following sources:

- Flood reports recorded by SMBC and the EA
- Public drop-in meetings held in January/February 2020

A.10 Flooding Timeline.

Wednesday 31st July 2019

- 17:00 Floodwater approaching homes from rear (Lady Brook).
- 20:00 Homes are already flooded at this time.

A.11 Flooding Mechanism(s).

Interpretation of the flooding mechanism, from the above timeline and the photographs and video records available, indicates:

- Flooding appears to have progressed from the rear of the properties as the flood extent of Lady Brook expanded from the watercourse.
- There is evidence of foul flooding within the properties as UU's foul and combined networks became surcharged by the surrounding fluvial flood water.

Based on the flood mechanism above the main source of flooding is the Main River, Lady Brook, and accordingly the EA have responsibility for investigating the circumstances and considering practicable mitigation measures.

A.12 EA Flood mapping.

The EA produces flood mapping for main rivers (Fluvial flood mapping) based upon numerical hydraulic modelling using local topography and surveyed dimensions of structures. The relevant flood mapping is shown in Figure E.9.

Figure E.9: Sandringham Road; EA Fluvial Flood Map



Source: EA

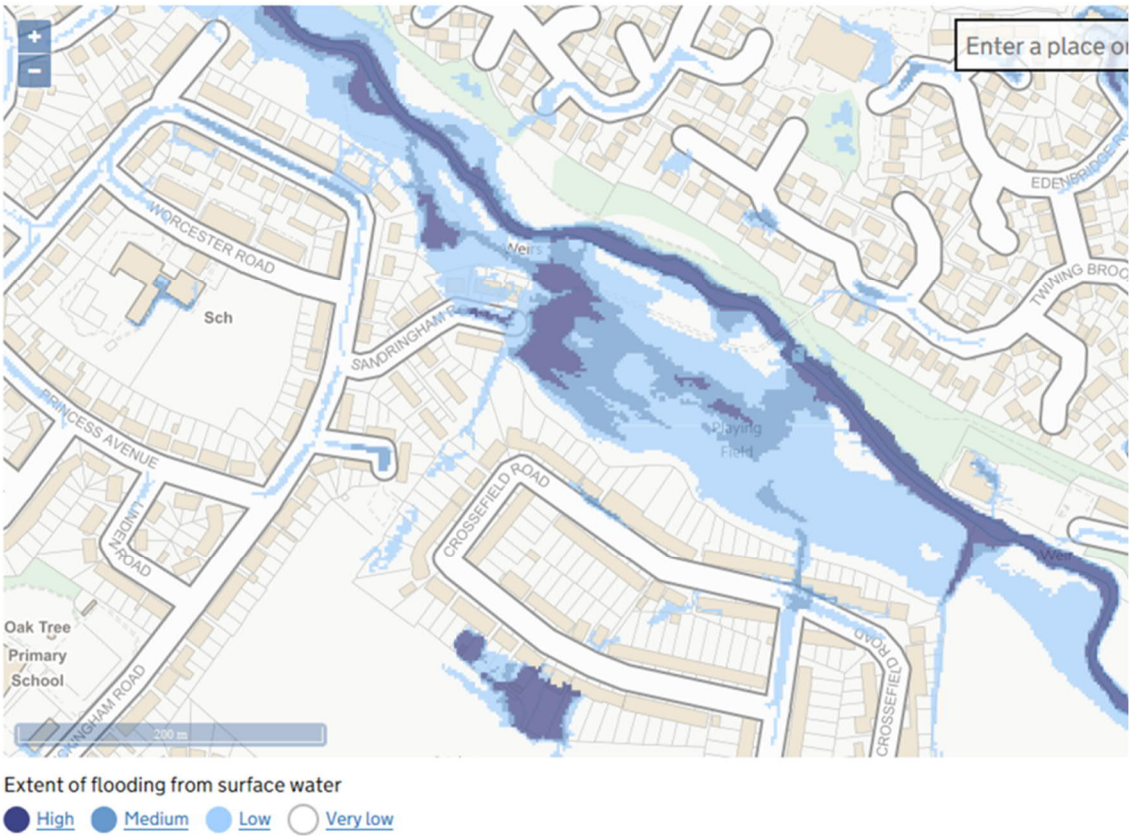
This map indicates that Sandringham Road lies in an area considered to be at very low flood risk (from fluvial sources) and this conflicts with the flooding mechanism observed from the July 2019 flood event. Accordingly, it is possible the flood modelling is in error or the watercourse was partially blocked by debris causing elevated flood levels, or possibly both. We have no evidence of blockage but note the presence of 'weirs' on the watercourse at the rear of the properties; which may have some bearing upon flood flow levels. Based on the fluvial flood mapping the Sandringham Road properties would not have been expected to flood in the July 2019 event and accordingly the modelling and mapping should be reviewed to establish whether the mapping needs to be amended. Amended flood levels may indicate a requirement to provide some flood mitigation measures to Sandringham Road.

The EA also produces flood mapping from 'Pluvial' sources; this is shown in Figure E.10 and shows:

- Food extents for 'Low' flood risk appear to closely match July 2019 flooded extents in Sandringham Road.

Given the methodology of modelling, the underlying assumptions and the topographic data source used for the production of the 'pluvial' or surface water flood maps it is surprising that this map replicates the July 2019 flood flow in Micker Brook. The hydraulics of the main river channel will dominate flood water levels and these should be much better represented in the fluvial modelling.

Figure E.10: EA, Sandringham Road; Pluvial Flood Map



Source: EA

A.13 Significant factors/structures affecting Flood levels locally on Lady Brook

- Channel width and depth
- Weirs at rear of Sandringham Road
- Flood plain adjacent to watercourse.

A.14 Flood Warning.

Yellow ‘be prepared’ weather warnings were issued for heavy rainfall for areas of Greater Manchester, Cheshire and Derbyshire. The EA issued ‘Flood Alerts’ for the Middle Mersey catchment area on 28/7/2019 at 10:23 and on 31/7/2019 at 08:57 however no ‘Flood Warnings’ were given for the area. It is noted that based on current mapped flood risk Sandringham Road would be unlikely to be affected.

Flood warnings for the Middle Mersey catchment are linked to measured trigger levels on the River Mersey. Reliance on flood levels on the Mersey will not be able to spot flood events on the much smaller and faster to respond Lady Brook. As such the warning system is insensitive to localised intense rainfall on the Micker Brook (including Norbury, Poynton and Lady Brook) catchments.

A.15 Conclusions.

The primary driver for flooding at Sandringham Road in July 2019 is Fluvial Flooding from Lady/Micker Brook.

A.16 Recommended actions.

Flood mitigation measures need to be proportionate to the damages and frequency of occurrence, to be cost effective and affordable. Following confirmation/modification of the flood modelling, consideration should be given to the identification of an appropriate raft of measures from:

- Fitting of non-return valves to foul water connections.
- Property Level Defences (PLP).
- Removal/relief of local hydraulic constraints on Lady Brook.
- Linear defences to rear and upstream of affected properties
- Develop Micker Brook catchment specific flood warning system based on local rainfall and gauged flows.

Some of the above measures could have impacts at the other downstream flood risk areas along Micker Brook. Accordingly, they should be developed and reviewed in unison.

F. Queens Road

A.17 General Situation

Localised flooding was experienced at Queens Road and the Demmings Road Industrial Estate and local streets (including Pickmere Gardens) on the evening of 31st July 2019. At this location Micker Brook (upstream it is Lady Brook) passes under Queens Road and flows in a walled-in channel alongside Old Wool Lane before entering a culvert under the lane and then immediately under Brook House. Reports of internal flooding up to 1.3m deep have been recorded for 10 residential properties and 9 commercial properties; it is likely all flooding has not been reported.

Downstream of Brook House, Micker Brook flows in a channel confined by industrial buildings on the right bank and a new, elevated, housing development (Wentworth Drive). Many of the ground floor industrial units of Brook House and Brookfield Business Park have floor levels below the external ground levels and were consequently quickly flooded.

Local residents suggest there is no history of flooding at this location for 30years or more.

Information of the event, of the flooding and background information has been extracted from the following sources:

- Flood reports recorded by SMBC and the EA
- Public drop-in meetings held in January/February 2020
- Follow-up communications with affected residents.

A.18 Flooding Timeline

Wednesday 31st July 2019

18:00hrs	Floodwater reaching Brook House car park approximately 3 inches (75mm) deep.
18:15hrs	Floodwater depth increased by approximately 4 inches (100mm), half of car park covered.
18:30hrs	Approximately ¾ of Brook House car park covered, Approximately 6 inches (150mm) deep.
19:00hrs	Brook House car park completely covered approximately 1 foot (300mm) deep.
20:00hrs	Brook House car park completely covered approximately 2.5 feet (750mm) deep.
Not known	Wall adjacent to Brook House collapses; releasing water ponded on car park into brook downstream.
Not known	Depth of ponded water on car park and within adjacent property reduces rapidly to lower level.

A.19 Flooding Mechanism(s)

Interpretation of the flooding mechanism, from the above timeline and the photographs and video records available, indicates:

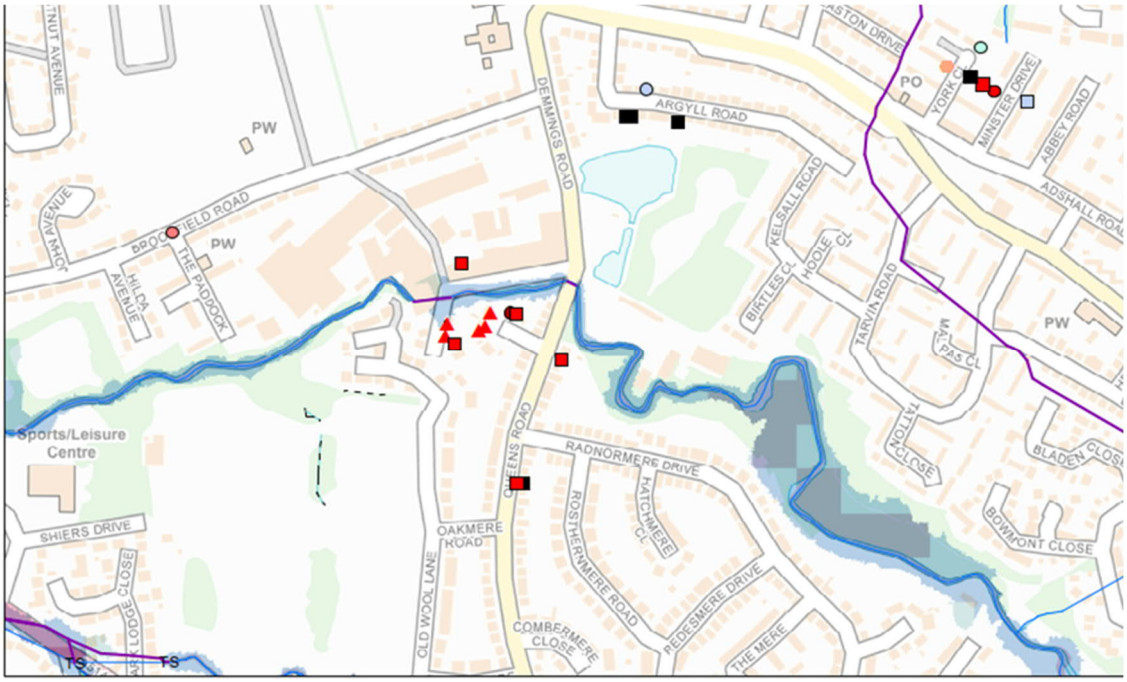
- It appears that out of channel flow occurs at several locations in the vicinity; i.e from the left bank upstream of Queens Road (flooding Queens Road and local properties), from the left bank between Queens Road and Old Wool Lane bridge (flooding properties on Pickmere Gardens and The Demmings) and from the right bank onto Old Wool Lane (flooding mostly industrial properties on Old Wool Lane and Brook House). The relative timing of each overflow is not known.
- It appears that out of channel flows on the left bank largely ponded, whereas out of channel flows initially ponded on Old Wool Lane and in the low lying areas adjacent to industrial units until ponding depth was sufficient to flow around Brook House to the south and eventually return to the watercourse channel downstream of Brook House.
- Depth of flooding rapidly increased adjacent to Brook House as the flow return path was restricted by a brickwork boundary wall (circa 0.9m high) at the downstream end of the Brook house car park. At some point this wall collapsed into the watercourse and flood depth thereafter reduced rapidly to a lower level.
- Video evidence shows that the downstream channel was full and overtopping a footway bridge deck. Floodwater was also draining from cracks in the buildings on the right-bank indicating these properties were internally flooded.

Based on the flood mechanism above, the main source of flooding is the Main River, Micker Brook and accordingly the EA have primary responsibility for investigating the circumstances and considering practicable mitigation measures.

A.20 EA Flood mapping

The EA produces flood mapping for main rivers (Fluvial flood mapping) based upon numerical hydraulic modelling using local topography and surveyed dimensions of structures. The relevant flood mapping is shown in Figure F.11.

Figure F.11: EA, Queens Road; Fluvial Flood Map



Source: Environment Agency

This map indicates locations of reported flooding and shows:

- Properties flooded on Queens Road, Old Wool Lane and The Demmings all appear to lie outwith the 'very low' risk area; that is to say they are forecast to have less than a 0.1% risk of flooding each year.
- Queens Road is not shown to flood.

It is not clear from the evidence seen whether Queens Road flooded as a consequence of restricted discharge at the Old Wool Lane bridge/culvert or due to the flood flow and hydraulic constrictions of the watercourse and Queens Road bridge.

It is however considered that the EA flood map is inconsistent with the flooded extents of 31 July 2019 because the flood event is not thought to have been a 0.1% event. Also, the flood map does not indicate an exceedance flow route around the industrial buildings that bridge over the watercourse. This appears erroneous given the restricted culvert capacity under the buildings.

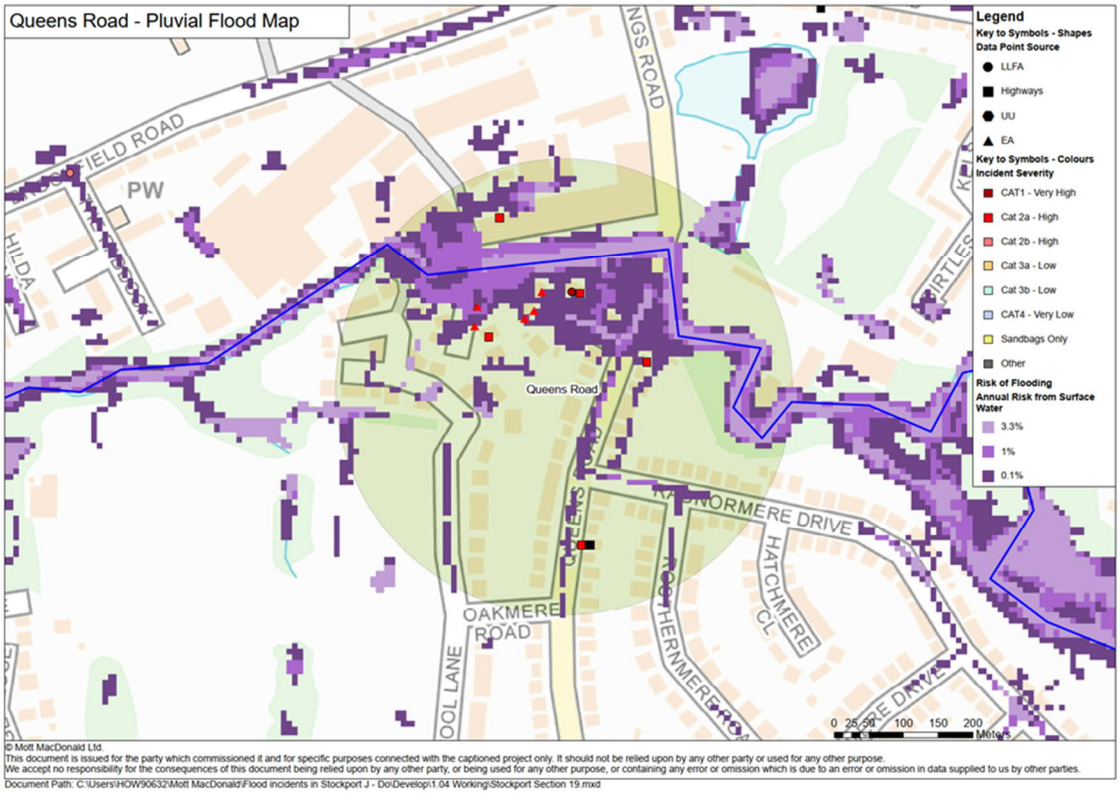
Similarly, the EA produces flood mapping from 'Pluvial' sources; this is shown in Figure F.12:

- The pluvial flood map shows flooded extents that are more in line with the observed extents of 31 July 2019.
- There appears an overland flow path around the southern side of the industrial buildings and Brook House, see overhead view and overland flow path marked in red on Fig F.13.

The pluvial flood map would normally be considered to be less reliable than the fluvial mapping for a watercourse as the pluvial mapping is done without details of channel and culvert

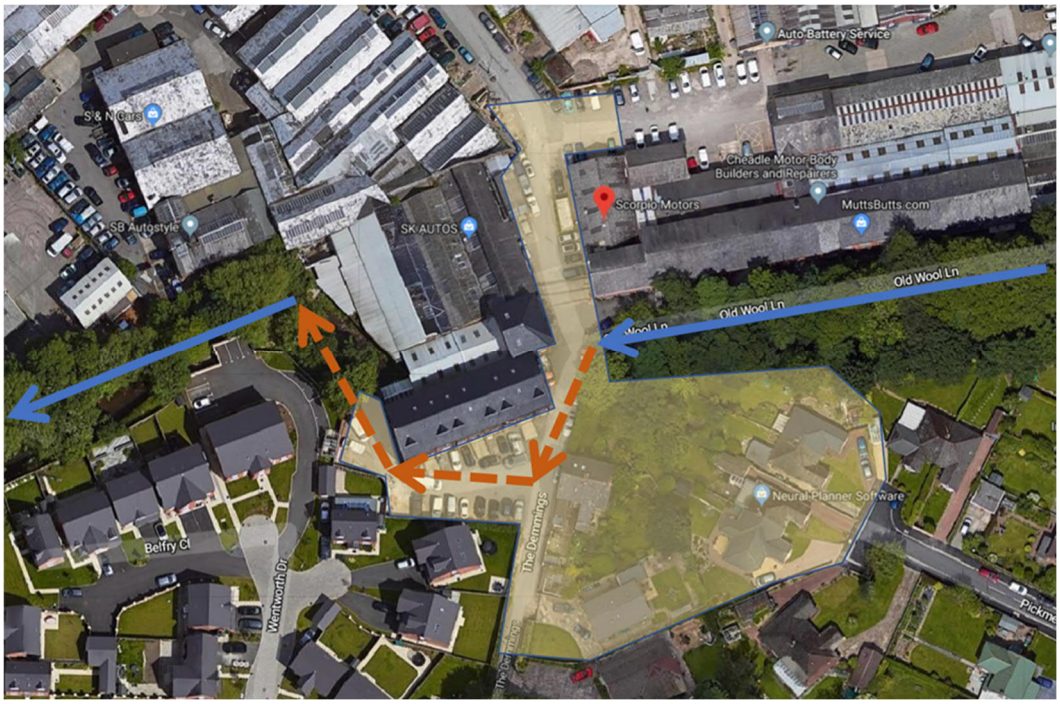
dimensions. In this case there is a suspicion there is some inconsistency in the fluvial mapping. This needs to be rectified so that the local flood risk is better understood.

Figure F.12: EA, Queens Road; Pluvial Flood Map



Source: Environment Agency

Figure F.13: Queens Road; Overhead view showing overland flow path in red.



A.21 Significant factors/structures affecting Flood levels on Micker Brook local to Queens Road

- Queens Road bridge and services supported below it.
- Old Wool Lane bridge.
- Culvert below Brook House.
- Debris and blockages

At each structure, and indeed at all cross-sections along the brook, flood flow encounters restriction due to the available flow area and flow depth generally has to increase to increase flow discharged. Looking at the sectional areas available to flow there appears an obvious constriction at the Old Wool Lane bridge and the Brook House culvert.

Each of these hydraulic constraints should have been incorporated into the EA's fluvial flooding model and the flood extents should thereby be representative of the situation. However, given that there was extensive flood flow around the buildings which is not indicated in the model results, this suggests the components of the hydraulic model should be checked/reviewed and amended/updated appropriately and if necessary the flood mapping updated. Note; this action is linked to similar actions in relation to flooding at Bramhall Green roundabout, Sandringham Road, and Wilmslow Road which are all part of the same river model. Where considered necessary or critical, channel sections should be re-surveyed to capture existing (silted) conditions.

Residents have advised us that a number of reports have been made to the council and to the EA about debris and fallen trees within the river corridor that do not appear to have been actioned prior to the event. What impact this debris had on the flood levels is difficult to understand. EA acknowledge that debris and fallen trees were removed from the watercourse in

the days following the 31st July 2019 event. In particular, there was a fallen tree spanning across the watercourse a short distance upstream of the Old Wool Lane bridge at below bank top level. This tree, together with an accumulation of water-bourne debris could easily be responsible for increased water levels upstream sending flow out of channel onto Old Wool Lane on the right bank and causing back-up leading to the out of bank flow on the left bank upstream of Queens Road. This fallen tree and other debris has subsequently been removed. In addition, EA have inspected the Brook House culvert and have reported this clear of obstructions.

At 31st July 2019, EA's maintenance strategy was 'reactive' but this has subsequently been changed to include regular inspections. This flood event should serve as a reminder of the depth of flow that should be allowed to pass without hinderance. Upstream of Queens Road the watercourse channel banks are heavily wooded which may have significant impact upon flood depths and which should be incorporated in the modelling.

Similarly, the hydrology of the Lady Brook catchment should be reviewed to confirm or refine the appropriate runoff hydrographs. As is discussed in Appendix A, the new A555 dual carriageway has been cited as a contributor to increasing flood flow to Queens Road. The conclusions drawn are that whilst features of the A555 drainage did not work entirely as designed or intended the presence of the road is not the main driver behind the flooding experienced. In this regard it should be noted that there were significant flood damages in the upper reaches of Micker Brook catchment and the flood flows responsible subsequently combine to Micker Brook e.g. at Lyme Park and Poynton.

The recent and raised development of Wentworth Drive did not flood in July 2019 and this development does not intrinsically increase the flood risk of the area compared to the pre-development condition when there were old industrial buildings on the south side of the Brook House car park. Based on the current fluvial flood mapping the new development would have shown to have no impact; however, given the uncertainty of the local flood modelling this may not be the case. At the very least an 'open' exceedance flow route via the Brook House car park and return to the watercourse should be preserved. This will not reduce the incidence of flooding but will minimise the flood depth.

A.22 Flood Warning

Yellow 'be prepared' weather warnings were issued for heavy rainfall for areas of Greater Manchester, Cheshire and Derbyshire. The EA issued 'Flood Alerts' for the Bramhall area on 28/7/2019 at 10:23 and on 31/7/2019 at 08:57 however no 'Flood Warnings' were given for the area. It is noted that flood warnings for Bramhall are linked to measured trigger levels on the River Mersey. Reliance on flood levels on the Mersey will not be able to spot flood events on the much smaller and faster to respond Micker Brook. As such the warning system is insensitive to localised intense rainfall on the Micker Brook (including Norbury, Poynton and Lady Brook) catchments.

A.23 Conclusions

The primary driver for flooding at Queens Road and The Demmings area in July 2019 is Fluvial Flooding from Micker Brook.

Recommended actions.

Flood mitigation measures need to be proportionate to the damages and frequency of occurrence, to be cost effective and affordable. Following confirmation/modification of the fluvial

flood modelling, consideration should be given to the identification of an appropriate raft of measures from:

- Removal of all redundant service pipes/ducts from within the watercourse cross-section.
- Removal of woody debris capable of forming blockage within Brook House culvert.
- Fitting of non-return valves to drainage outfalls.
- Property Level Defences (PLP).
- Linear defences upstream of Old Wool Lane Bridge
- Catchment runoff control measures; slow the flow in upper reaches of the catchment.
- Upstream flood attenuation reservoir(s).
- Develop Micker Brook catchment specific flood warning system based on local rainfall and gauged flows.

Some of the above measures could have impacts at the other downstream flood risk areas along Micker Brook. Accordingly, they should be developed and reviewed in unison.

G. Wilmslow Road

G.1 General Situation

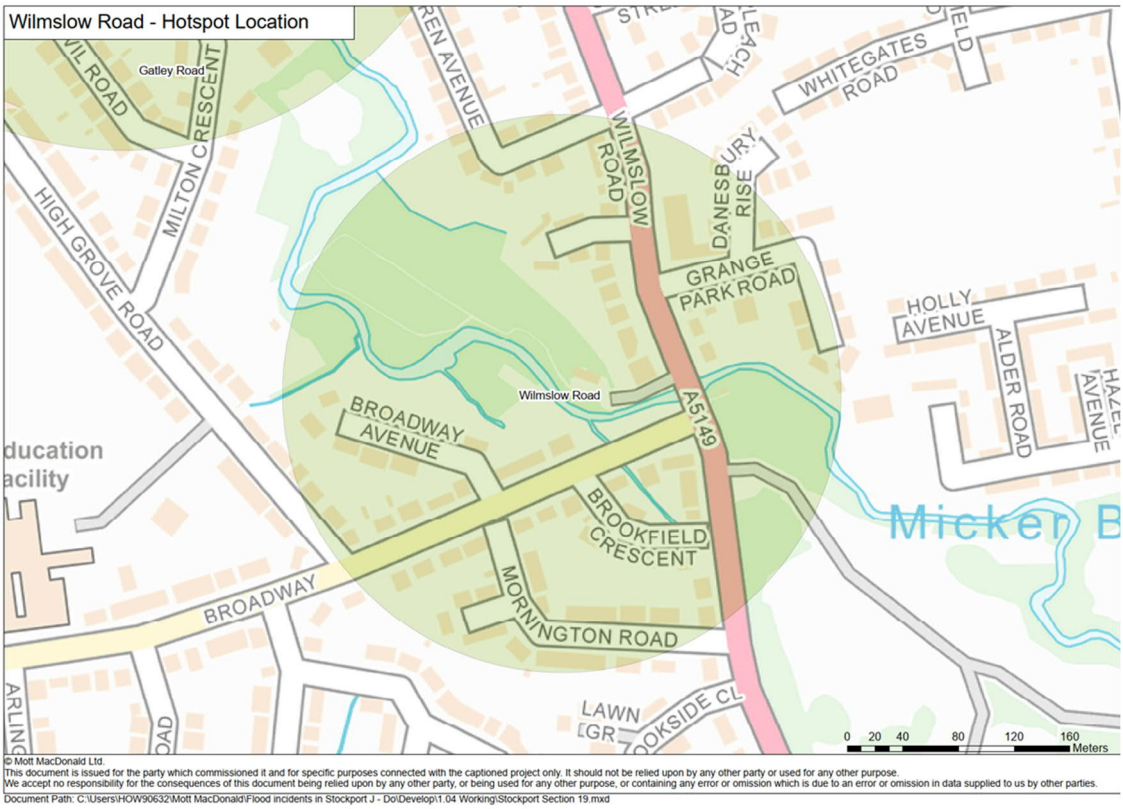
At this location Micker Brook flows approximately East – West and passes under Wilmslow Road before being joined by 2 local tributaries. Residential property surrounds the watercourses with small areas of open flood plain.

Flooding was experienced at Wilmslow Road and local streets (including Broadway, Broadway Avenue, Brookfield Cresent and Grange Park Road and Grange Park Avenue) on the evening of 31st July 2019.

Information of the event, of the flooding and background information has been extracted from the following sources:

- Flood reports recorded by SMBC and the EA
- Public drop-in meetings held in January/February 2020
- Follow-up communications with affected residents.

Figure G.14: Hot Spot Location Plan, Wilmslow Road



Source: Reference mapping.

G.2 Flooding Timeline

A detailed flood timeline is not available for this area. From flood reports it appears flooding first appears from gullies at about 17:00hrs on Wednesday 31st July 2019. At 20:00hrs there are reports of overland flow from Micker Brook across Wilmslow Road, with flow passing to Broadway before returning to watercourse. There is suggestion that downstream of Wilmslow Road there was a rapid rise in floodwater level which has been linked to the release of ponded water at The Demmings Industrial Estate. There may also be linkage to the start of overland flow at Wilmslow Road.

There is suggestion that floodwater started to retreat around 22:30hrs.

G.3 Flooding Mechanism(s)

Interpretation of the flooding mechanisms, from the above timeline, the photographs resident reports available suggests that out of channel flow occurred at several locations in the vicinity; i.e.:

- From the left bank of Micker Brook upstream of Wilmslow Road (flooding Wilmslow Road and local properties), flow returning to Micker Brook via property on Wilmslow Road and Broadway.
- From the right bank of Micker Brook upstream of Wilmslow Road; flow ponds into gardens of Laurel Avenue, Grange Park Avenue and Grange Park Road.
- From the left bank of Micker Brook at the rear of properties on Broadway and Broadway Avenue.
- From the 2 local culverted tributaries to Micker Brook passing through Brookfield Cresent.

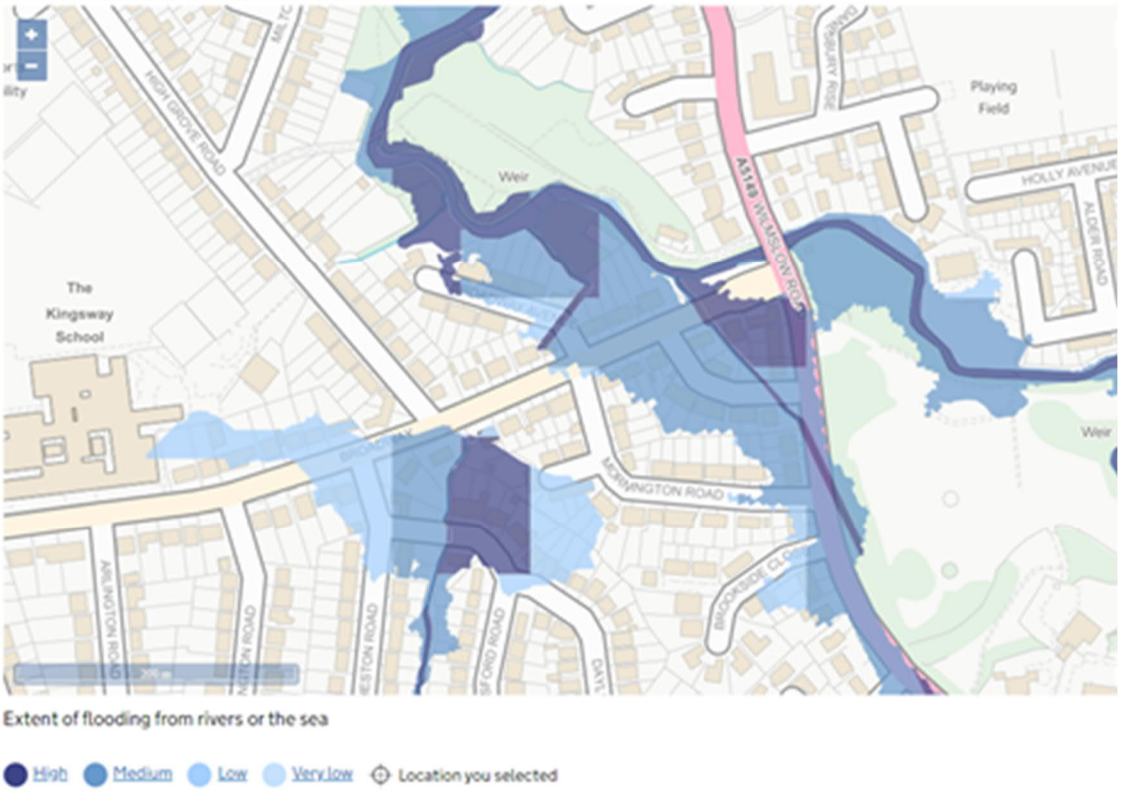
Based on the flood mechanism above, the main source of flooding is the Main River, Micker Brook and accordingly the EA have primary responsibility for investigating the circumstances and to consider practicable mitigation measures. Secondary sources of flooding are the 2 local culverted watercourses which are Ordinary Watercourses over which the LLFA have some powers but riparian owners are primarily responsible. It would appear that the hydraulic capacity of Wilmslow Road bridge over Micker Brook was exceeded by the flow on 31st July. Whether or not the capacity was significantly affected by debris is unclear.

Downstream of Wilmslow Road it appears that Micker Brook broke its banks and flood levels rose to flood gardens and basements of properties along Broadway Avenue. There is suggestion this may have been exacerbated by accumulated silt and/or debris.

G.4 EA Flood mapping

The EA produces flood mapping for main rivers (Fluvial flood mapping) based upon numerical hydraulic modelling using local topography and surveyed dimensions of structures. The relevant flood mapping is shown in Figure F.15.

Figure G.15: EA Wilmslow Road; Fluvial Flood Map



Source: Environment Agency

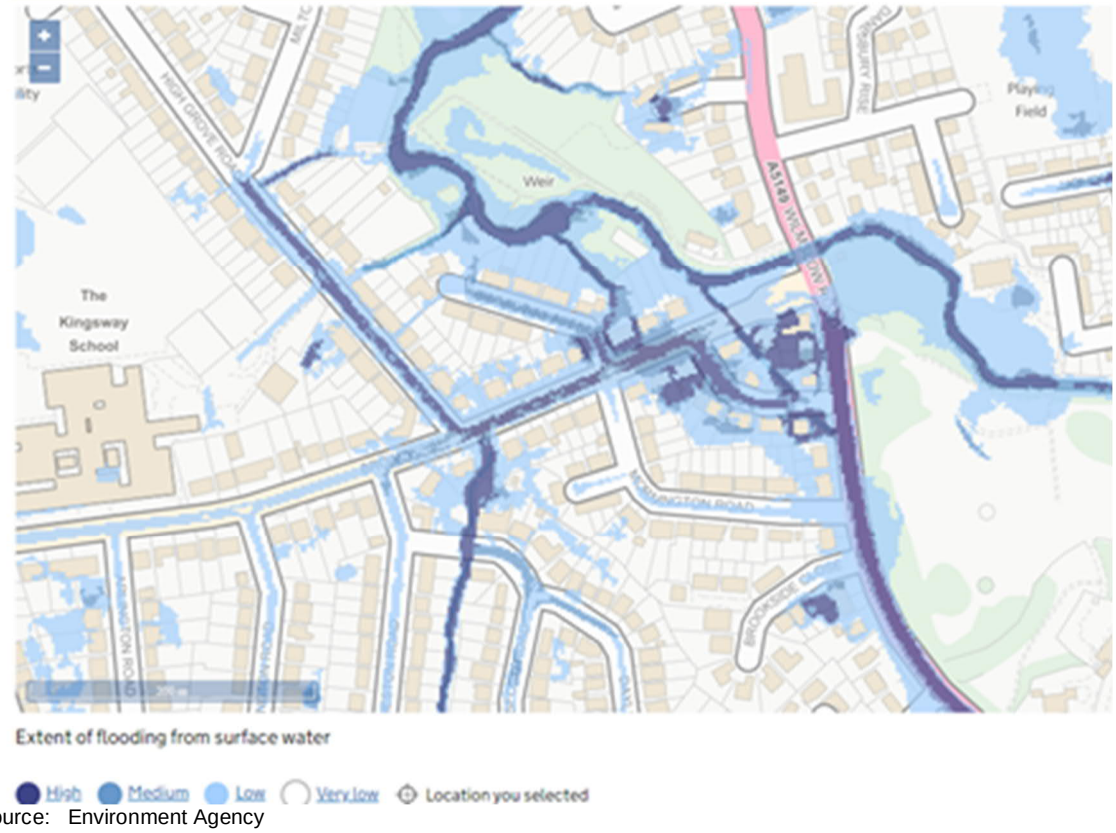
This map indicates that depending upon the severity of the event the following locations may experience flooding:

- Properties on Wilmslow Road just south of Micker Brook.
- Properties on Brookfield Crescent
- Properties on Braodway and Broadway Avenue.

The mapped flood extents are broadly consistent with the flooding reported from 31st July 2019.

Similarly, the EA produces flood mapping from 'Pluvial' sources; this is shown in Figure F.16. The pluvial flood map shows flooded extents that are generally consistent with the fluvial flood map; except that the pluvial flood mapping shows flooding or flow paths along some of the roads; notably Broadway and High Grove Road. This mapped flooding is likely a consequence of the modelling methodology because the culverted tributary will not have been modelled and hence all runoff from it has been modelled as progressing to Micker Brook via overland flow routes, along the roads.

Figure G.16: EA Wilmslow Road; Pluvial Flood Map



Source: Environment Agency

G.5 Significant factors/structures affecting Flood levels on Micker Brook local to Wilmslow Road

- Wilmslow Road bridge.
- Possible debris accumulations upstream of Wilmslow Road bridge.
- Possible debris and siltation downstream of Wilmslow Road bridge.
- Culverted tributaries.
- Debris and blockages at culvert entrances.

G.6 Flood Warning

Yellow ‘be prepared’ weather warnings were issued for heavy rainfall for areas of Greater Manchester, Cheshire and Derbyshire. The EA issued ‘Flood Alerts’ for the Cheadle area on 28/7/2019 at 10:23 and on 31/7/2019 at 08:57 however no ‘Flood Warnings’ were given for the area. It is noted that flood warnings for Cheadle are linked to measured trigger levels on the River Mersey. Reliance on flood levels on the Mersey will not be able to spot flood events on the much smaller and faster to respond Micker Brook. As such the warning system is insensitive to localised intense rainfall on the Micker Brook (including Norbury, Poynton and Lady Brook) catchments.

G.7 Conclusions

The primary driver for flooding in the Wilmslow Road area in July 2019 is Fluvial Flooding from Micker Brook. There is also evidence of secondary flooding from the 2 local tributaries which are in-part culverted..

Recommended actions.

Flood mitigation measures need to be proportionate to the damages and frequency of occurrence, to be cost effective and affordable. Consideration should be given to the identification of an appropriate raft of measures from:

- Review of updated fluvial flood model (as recommended for upstream reaches of Micker /Lady Brook).
- Removal of siltation and woody debris capable of forming significant blockages.
- Fitting of non-return valves to drainage outfalls.
- Property Level Defences (PLP).

Some of the above measures could have impacts at the other downstream flood risk areas along Micker Brook. Accordingly, they should be developed and reviewed in unison.

H. Borrowdale Avenue

H.1 General Situation

Borrowdale Avenue was identified as a flooding hot spot based on evidence submitted to the council and representations at public consultation meetings; however, there are no flood reports logged by LLFA, EA, UU or Highways for the July 2019 flood event. Repeated flooding of the road and up to house floor level was reported from a few properties. There is no mention of this flooding in either of the 2016 S19 flood reports.

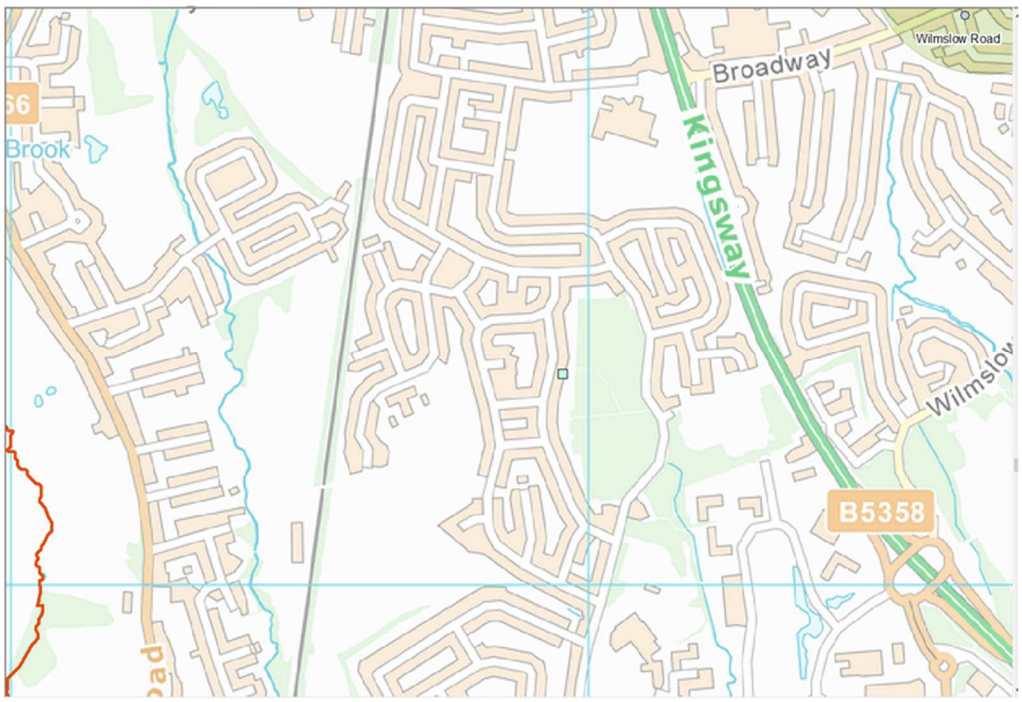
This area is remote from watercourses and is drained by UU combined sewers (and highway drainage?). Some foul contamination has been noted in the floodwater. It is not known if highway drainage is connected to UU systems or independently drained.

At the rear of properties on the west side of Borrowdale Avenue lies the Manchester to Crewe railway line. To the south this railway is in cutting and falls northwards towards Borrowdale Avenue. At Borrowdale Avenue the railway is on embankment and cuts off natural drainage.

Information of the event, of the flooding and background information has been extracted from the following sources:

- Flood reports recorded by SMBC and UU
- Public drop-in meetings held in January/February 2020
- Follow-up communications with affected residents.

Figure H.17: Hot Spot Location Plan, Borrowdale Avenue

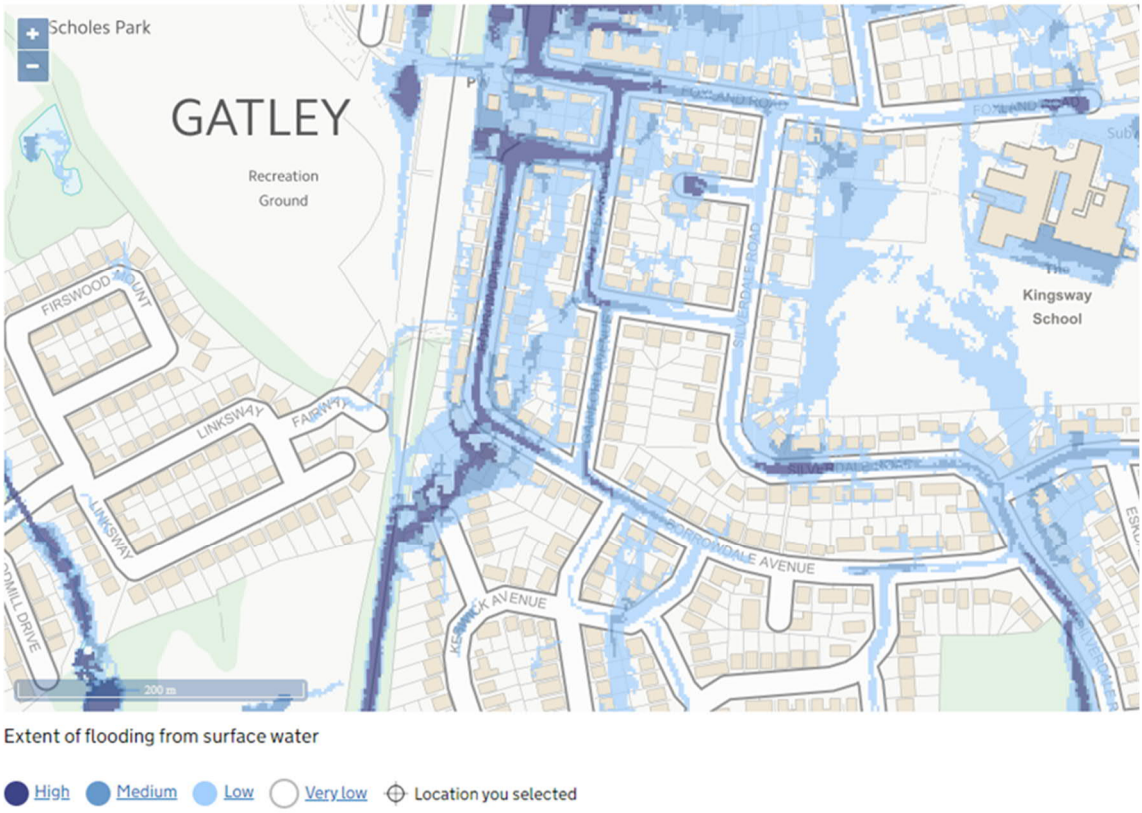


Source: Reference mapping.

H.2 EA Flood mapping

The EA produces flood mapping from 'Pluvial' sources; this is shown in Figure H.18. The pluvial flood map shows widespread SW flooding due to the absence of clearly defined watercourses and the blockage of drainage routes by the railway. A flow path is shown for SW runoff northwards from the railway to Borrowdale Avenue and ponding at the bend in the road at its north end. Further flooding is shown to the north but this does not appear to have manifest in the July 2019 event. Ponding of overland flows at the bend in Borrowdale Avenue is likely to overwhelm the UU combined sewers draining the area.

Figure H.18: Borrowdale Avenue; EA Pluvial Flood Map



Source: Environment Agency

H.3 Conclusions

Looking at old mapping there is a culvert under the railway to the north opposite the end of Burnside Road (west of railway) which is/was a tributary of Gatley Brook. Our hunch would be that is where the railway drainage is headed and its route along the east-side toe of the railway embankment (at the rear of properties on Borrowdale Avenue) has possibly become blocked and this pushes flow out onto Borrowdale Avenue where it overwhelms the UU combined sewer ; hence the foul flooding.

Recommended actions:

Investigation is required to confirm what the Network Rail drainage arrangements are intended to be, their current state and to remediate if necessary. UU may have an input due to the foul flooding reported. LLFA should coordinate.

I. High Lane

I.1 General Situation

Cromley Road and Woodside Drive were identified as a flooding hot spot based on local internal flooding of 8 residential properties. Some of these properties also report having been flooded in the June and September events of 2016; although not specifically reported in the relevant S19 reports.

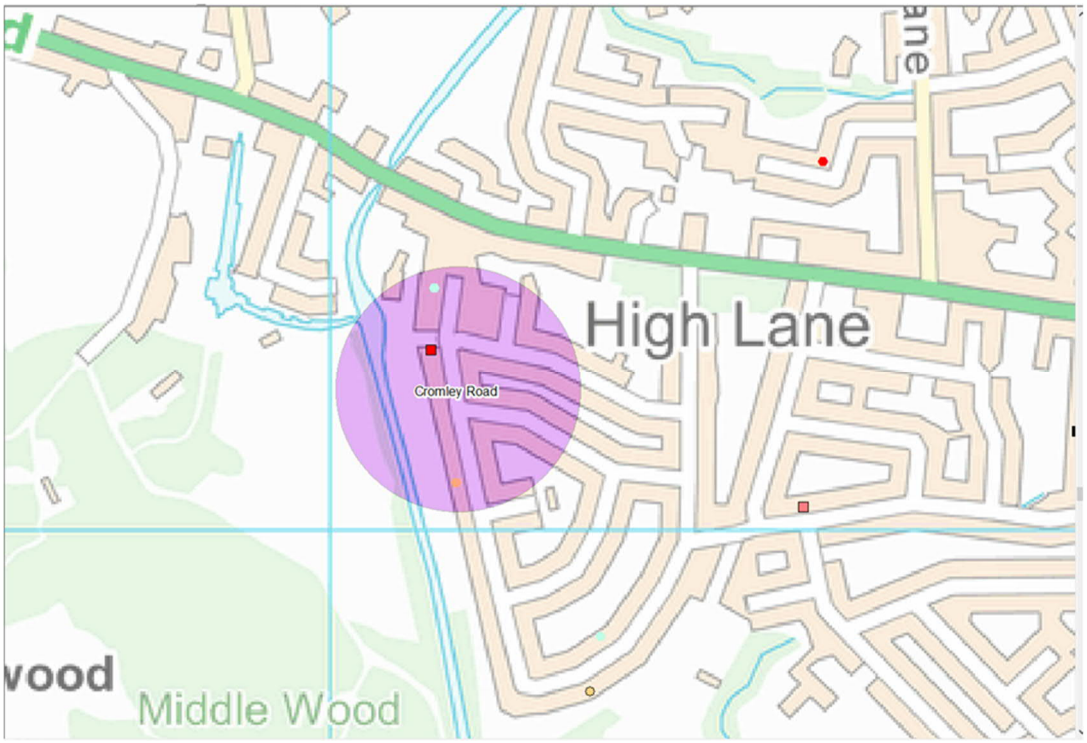
This area is remote from watercourses and is drained by UU surface water sewers. Some foul contamination has been noted in the floodwater, but this is likely a consequence of the SW flooding entering the foul system. It is not known if highway drainage is connected to UU SW systems or independently drained.

The area of residential housing falls generally east to west towards Cromley Road and onwards to the Macclesfield Canal. SW appears to be drained to the canal.

Information of the event, of the flooding and background information has been extracted from the following sources:

- Flood reports recorded by SMBC and UU
- Public drop-in meetings held in January/February 2020
- Follow-up communications with affected residents.

Figure I.19: Hot Spot Location Plan, High Lane

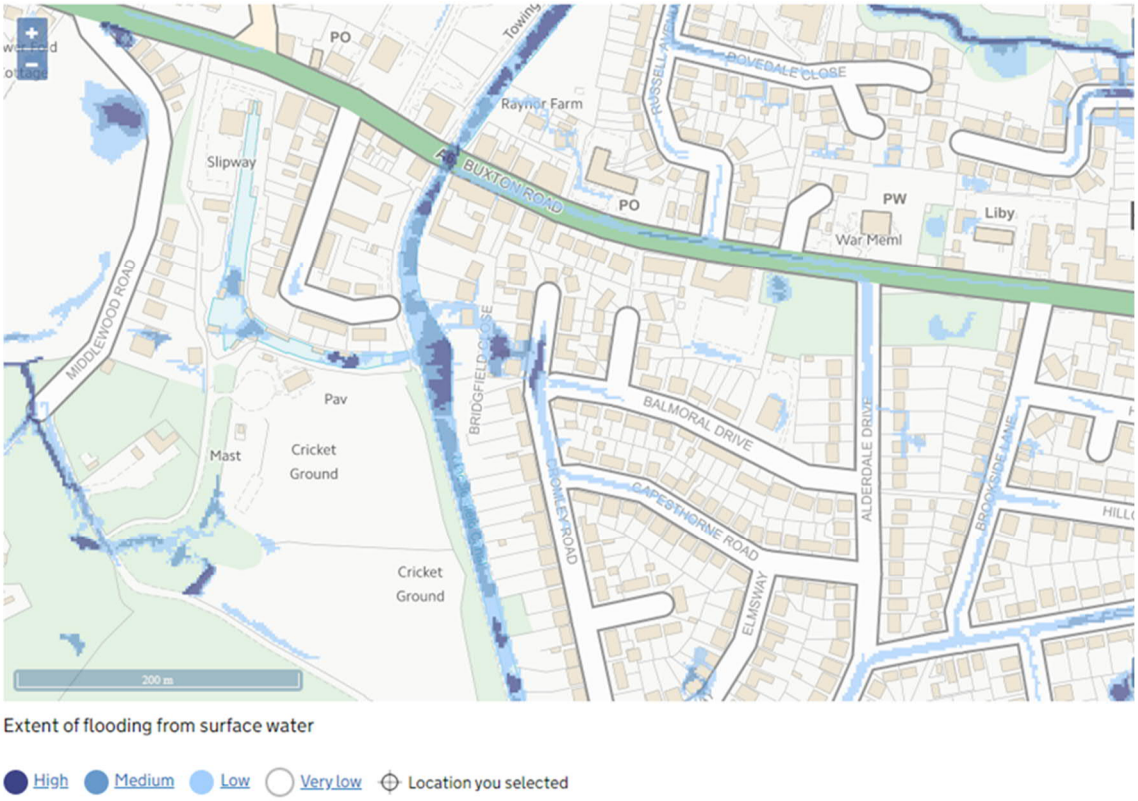


Source: Reference mapping.

I.2 EA Flood mapping

The EA produces flood mapping from 'Pluvial' sources; this is shown in Figure I.20. The pluvial flood map shows flooding of Cromley Road at the junction with Balmoral Drive and an overland flowpath to Bridgefield Close and onwards to the canal. Some of the runoff volume will be drained by UU (and Highway?) drainage systems but the map serves to indicate the area at risk.

Figure I.20: High Lane; EA Pluvial Flood Map



Source: Environment Agency

I.3 Conclusions

The primary driver for flooding in the High Lane, Cromley Road area in July 2019 was SW flooding from overland flow and UU SW sewers. Given the magnitude of the July 2019 event some flooding may be expected from UU SW sewers even if these are compliant with current design standards and fully operational (no blockages). However, given that this area also flooded in the lesser events of 2016, some investigation is warranted to confirm the adequacy of the SW drainage system and its outfall to the canal.

Recommended actions.

Review and report on SW drainage network and capacity.

J. Torkington and Hazel Grove

J.1 General Situation

This 'Hot Spot' was identified early-on in the S19 investigation based upon mapped clusters of internal flood reports from residential property on Hazelwood Road and on Highfield Road. Upon investigation the flood reports on Highfield Road have been incorrectly assigned a Hazel Grove post code by the council and the reported flooding actually relates to Highfield Road, Cheadle Hulme.

Accordingly, only the flood reports on Hazelwood Road, Hazel Grove have been reviewed in this hot spot.

Torkington Brook flows south to north through Torkington Park and is culverted below Torkington Road; the entrance to this culvert is protected by a large debris screen that has been refurbished/modified by the EA following overflowing from this location onto Torkington Road in the June and September flood events of 2016. It appears that there was not any overflow at this location in July 2019.

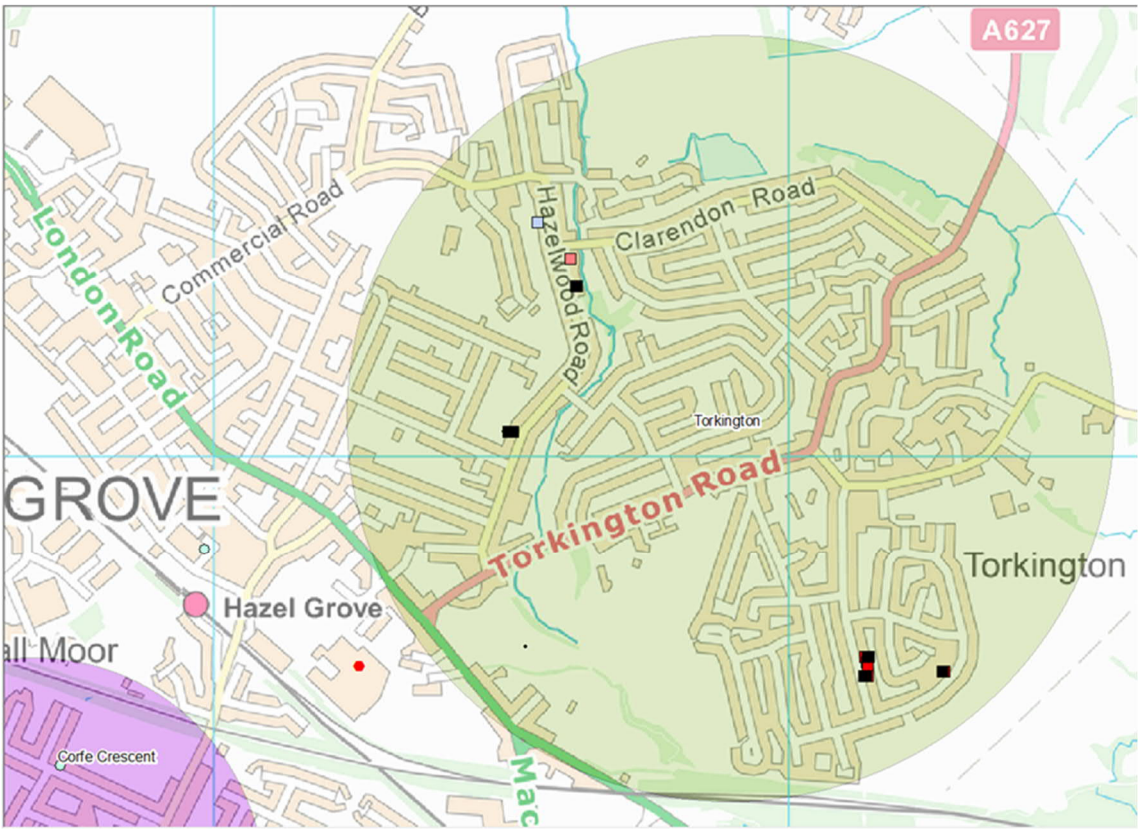
Downstream of Torkington Road the brook flows in open channel to the rear of properties on Hazelwood Road. 3 properties are reported as flooding from the stream at the rear on 31st July 2019. These properties are upstream of Clarendon Road where Torkington Brook is again culverted below the road (refer to Figure J.21). At this location, if the capacity of the culvert were to be exceeded, excess flow would due to the topography flow out westwards onto Hazelwood Road and flow along the road until finding a return path to the brook.

In addition, 1 property further south on Hazelwood Road, near to the junction with Douglas Road, reported internal flooding and their neighbours reported flooding to their gardens.

Information of the event, of the flooding and background information has been extracted from the following sources:

- Flood reports recorded by SMBC and the EA
- Public drop-in meetings held in January/February 2020
- Follow-up communications with affected residents.

Figure J.21: Hot Spot Location Plan, Torkington Road



Source: Reference mapping.

J.2 Flooding Mechanism(s)

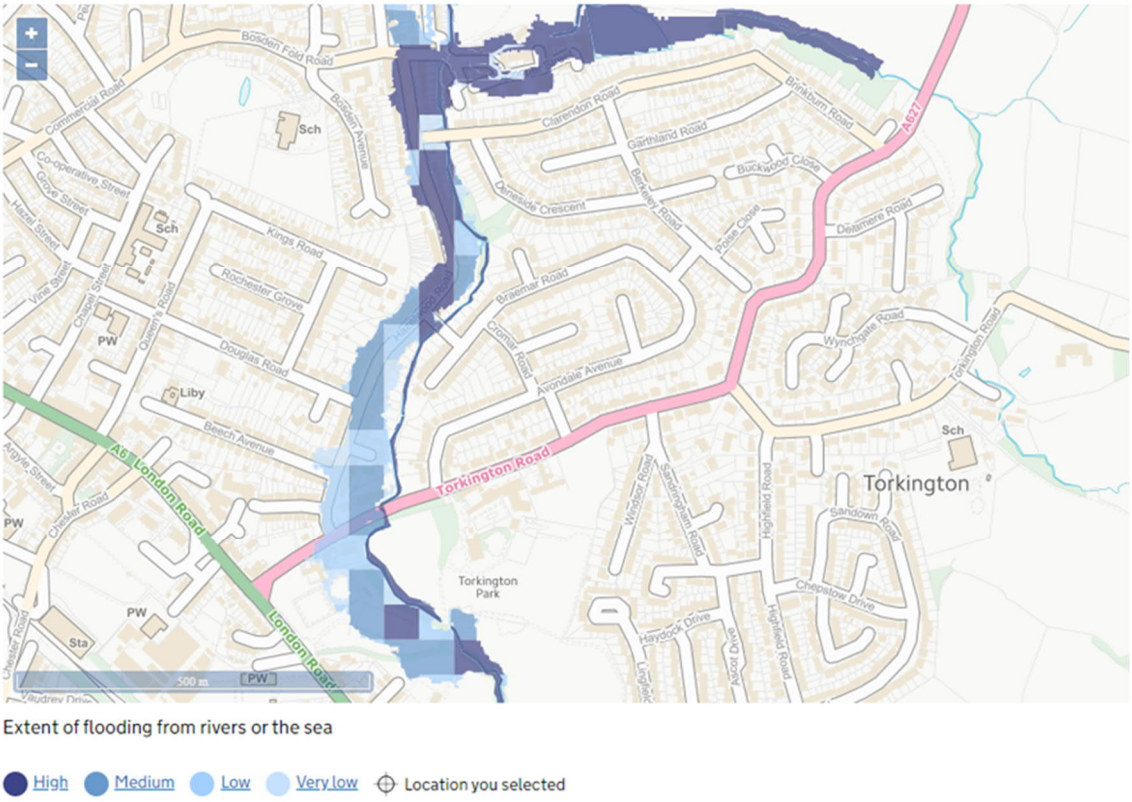
It is considered likely that the main source of flooding on Hazelwood Road originated from Torkington Brook and a surcharged condition at the entrance to the culvert below Clarendon Road. It appears the surcharge was insufficient to initiate flow along Hazelwood Road and flooding was therefore localised.

Secondary flooding to the south on Hazelwood Road was likely caused by surcharge of surface water sewers.

J.3 EA Flood mapping

The EA produces flood mapping for main rivers (Fluvial flood mapping) based upon numerical hydraulic modelling using local topography and surveyed dimensions of structures. The relevant flood mapping is shown in Figure J.22.

Figure J.22: Torkington Road; EA Fluvial Flood Map



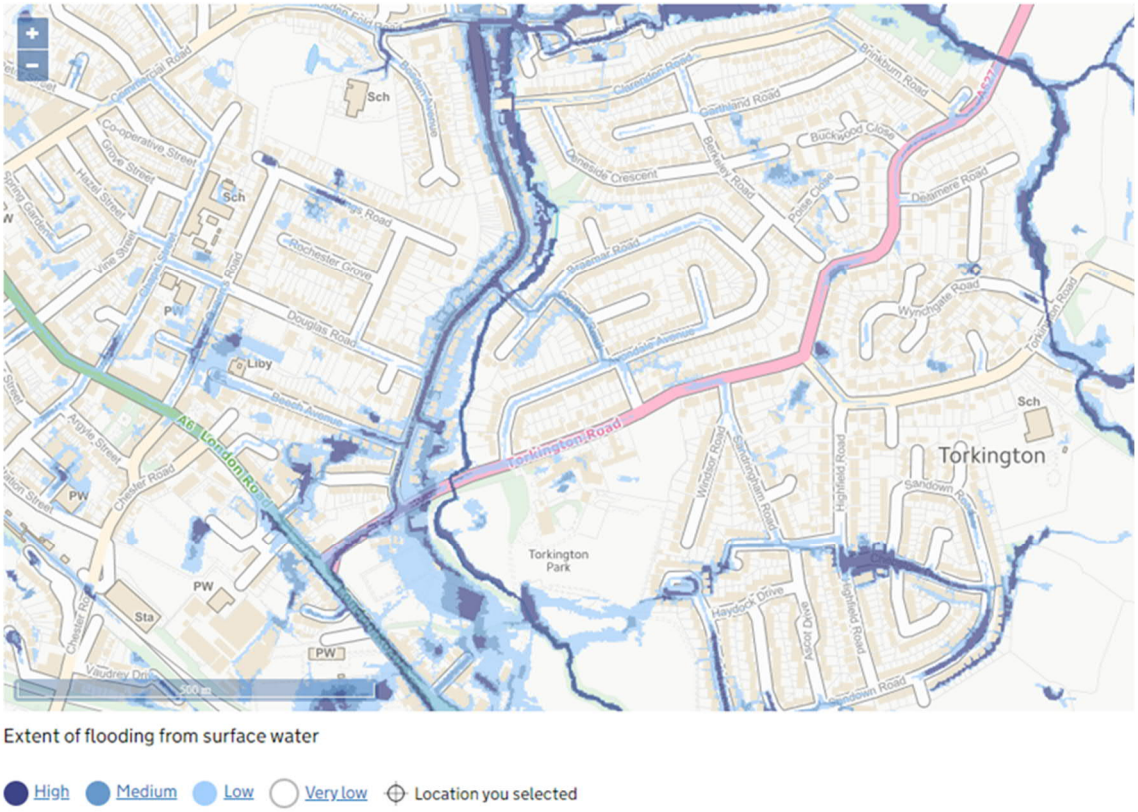
Source: Environment Agency

This map indicates that overflowing from the culvert entrance at Torkington Road is anticipated to form an overland flow route along Hazelwood Road and return to the main river downstream as far as Bosden Fold Road and the confluence with poise Brook.

The mapped flood extents are not inconsistent with the flooding reported from 31st July 2019 but are much more extensive as extents up to 1 in 1,000 year events are mapped.

Similarly, the EA produces flood mapping from 'Pluvial' sources; this is shown in Figure J.23. The pluvial flood map shows flooded extents that are generally consistent with the fluvial flood map.

Figure J.23: Torkington Road; EA Pluvial Flood Map



Source: Environment Agency

J.4 Conclusions

The primary driver for flooding in the Torkington area in July 2019 was Fluvial Flooding from Torkington Brook. The extent of flooding in this area was much reduced compared to the 2016 events largely due to improvements to the screen and culvert inlet improvements and maintenance carried out by the EA in Torkington Park

There is also evidence of localised secondary flooding from surface water flooding.

Recommended actions.

Flood mitigation measures need to be proportionate to the damages and frequency of occurrence, to be cost effective and affordable. In this case the inlet to the culvert and the culvert under Clarendon Road should be inspected to ensure debris and blockages are removed in a timely manner.

K. Bean Leach Road (Poise Brook)

K.1 General Situation

This location appears to be affected by a combination of fluvial and pluvial flooding. Flooding of Bean Leach Road, Minsmere Walks, Shearwater Road and Siskin Drive has been reported for the flood event of 31st July 2019.

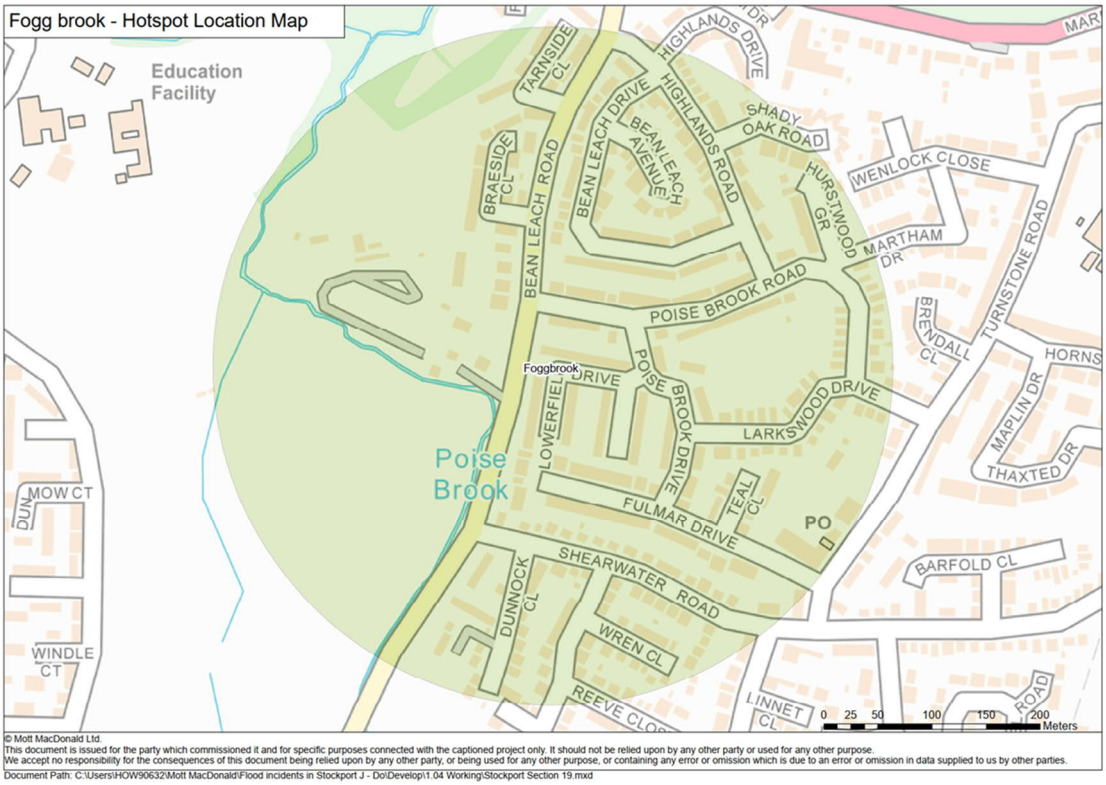
At this location Poise Brook flows approximately South to North and passes under Bean Leach Road under a small road bridge/culvert. Immediately downstream of the bridge the brook turns sharply to closely follow the road; refer to Figure K.24 for location and street names.

Poise Brook catchment extends upstream through Hazel Grove to High Lane in the east.

Information of the event, of the flooding and background information has been extracted from the following sources:

- Flood reports recorded by SMBC and the EA
- Public drop-in meetings held in January/February 2020
- Follow-up communications with affected residents.

Figure K.24: Hot Spot Location Plan, Bean Leach Road



Source: Reference mapping.

K.2 Flooding Timeline

A detailed flood timeline is not available for this area. From flood reports it appears flooding first appears at about 16:00hrs on Wednesday 31st July 2019. By 19:00hrs the flood water was receding.

K.3 Flooding Mechanism(s)

Interpretation of the flooding mechanisms, from the above timeline, the photographs resident reports available suggests the following:

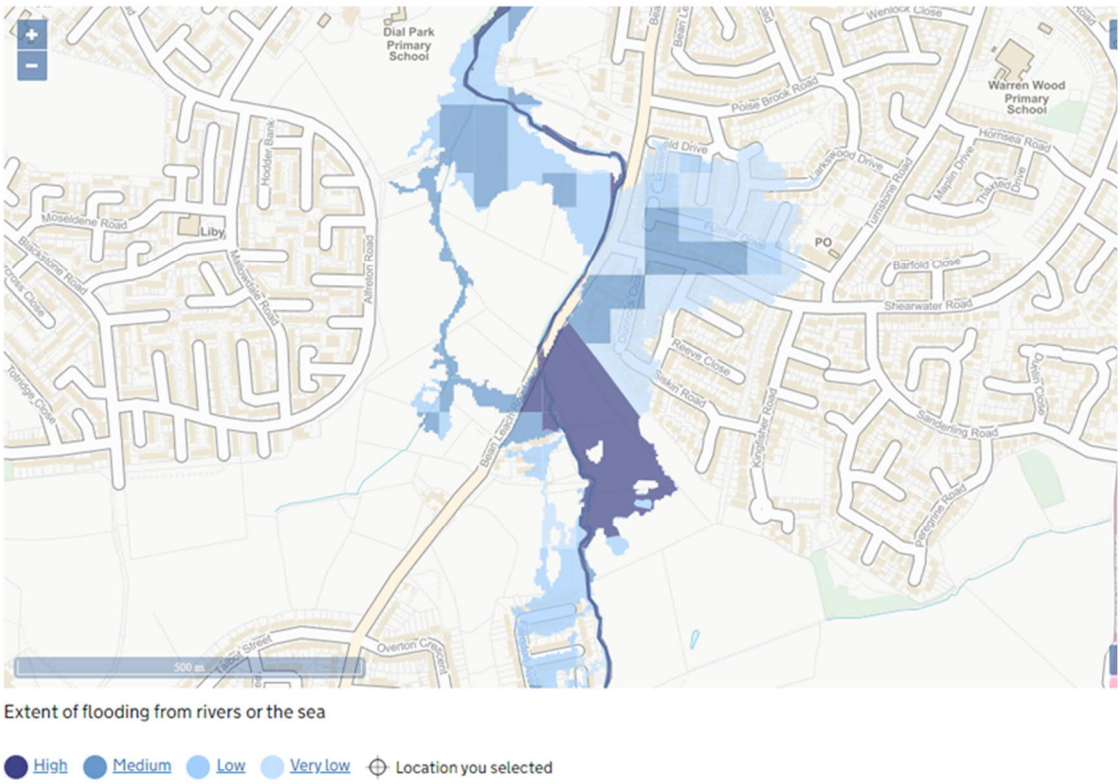
- Surface Water (SW) sewers in the low-spots in Shearwater Road and adjacent streets overflowed via gullies and ponded on the road before spreading into adjacent properties.
- Flow in Poise Brook exceeded capacity of bridge/culvert below Bean Leach Road and flood depth and extent built up to overtop onto Bean Leach Road. Overland flow flowed along the road to the North. At Minsmere Walks some of the flow along the road spilled off the road towards Minsmere walks and eventually flooded several properties internally. Overland flow remaining on Bean Leach Road may have flowed into Shearwater Road adding to flooding there.

Based on the flood mechanism above, the main source of flooding is the Main River, Poise Brook and accordingly the EA have primary responsibility for investigating the circumstances and to consider practicable mitigation measures. A secondary source of flooding is the UU SW network draining the local estate via Shearwater Road and discharging to Poise Brook. Previously in 2016 flood events the SW sewer outfall has been identified as a potential constraint to discharge of surface water. Indeed, on 8 August 2019 Shearwater Road flooded again, this time without flood flow in Poise Brook, so there does appear to be some issue here.

K.4 EA Flood mapping

The EA produces flood mapping for main rivers (Fluvial flood mapping) based upon numerical hydraulic modelling using local topography and surveyed dimensions of structures. The relevant flood mapping is shown in Figure K.25.

Figure K.25: Bean Leach Road; EA Fluvial Flood Map



Source: Environment Agency

This map indicates that depending upon the severity of the event the following locations may experience flooding:

- Greenspace upstream of Bean Leach Road and spreading NE towards the housing estate. Flood propogation directly NE into the housing is prevented by an earth embankment. This embankment is not a formal defence but does form a barrier to floodwater.
- The map does not show Bean Leach Road to flood which is contrary to the eyewitness reports.
- A large are of the estate is shown to be at Low to Medium flood risk.
- The flood extents map shows a spill route over Bean Leach Road that flows westwards to join a tributary channel that joins with Poise Brook downstream and west of Bean Leach Road

The mapped flood extents are inconsistent with the flooding reported from 31st July 2019 i.e. Bean Leach Road is not shown to flood whereas it has been seen to be a significant overland flood route.

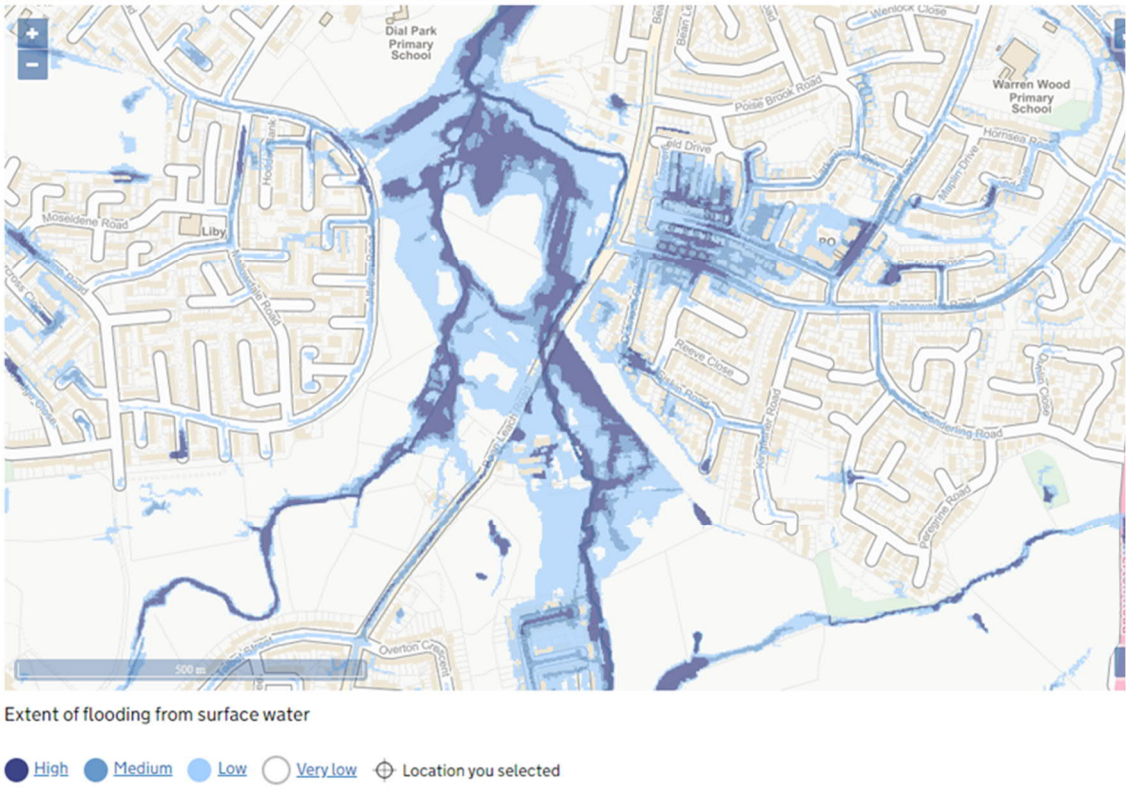
Similarly, the EA produces flood mapping from 'Pluvial' sources; this is shown in Figure K.26. The pluvial flood map shows:

- No flooding along Bean Leach Road from Poise Brook bridge to Shearwater Road.

- The estate 'flood embankment' appears to prevent Poise Brook runoff entering the estate.
- Shearwater Road and many estate roads show flooding which is deemed to be local runoff that is 'tide locked' by elevated flood levels in Poise Brook at the western end of Shearwater Road.
- Downstream of Poise Brook bridge 2 overland flow paths are mapped that take flow away from the main channel adjacent to Bean Leach Road.

Accordingly, the fluvial and pluvial mapping are also inconsistent with one another. As stated for other locations, the pluvial flood map should normally provide the more reliable forecast of flow routes and flooding but in this case it does not. There is a suspicion that assumptions in the modelling of the estate flood embankment may be confusing the picture.

Figure K.26: Bean Leach Road; EA Pluvial Flood Map



Source: Environment Agency

K.5 Significant factors/structures affecting Flooding at Bean Leach Road

- Bean Leach Road bridge.
- Estate flood embankment.
- Possible debris and siltation downstream of Bean Leach Road bridge.
- Detail of topography of Bean Leach Road and its verges that will control what spills where.

- Topography of farmland downstream of Bean Leach Road bridge that will control secondary flow routes.

K.6 Flood Warning

Yellow ‘be prepared’ weather warnings were issued for heavy rainfall for areas of Greater Manchester, Cheshire and Derbyshire. However, the EA did not issue ‘Flood Alerts’ for Poise Brook ahead of the July 2019 flooding. EA have in 2020 revised downward the trigger level of the Poise Brook flow gauge to try to ensure appropriate flood warning may be given in future.

K.7 Conclusions

EA flood mapping inconsistent with 2019 flood extents. When capacity of Bean Leach Road bridge over Poise Brook is exceeded, excess flow runs along the road (bypassing 3rd party defences) and spills off the road into Minsmere Walks and adjacent property. Exceedance flow surcharges highway and SW drainage systems leading to flooding of properties on Shearwater and adjacent roads.

Recommended actions.

Flood mitigation measures need to be proportionate to the damages and frequency of occurrence, to be cost effective and affordable. Consideration should be given to the identification of an appropriate raft of measures from:

- Consider fitting non return valve(s) to UU SW outfall(s) to Poise Brook and confirmation the outfall has free discharge without silt blockage.
- As possible ‘quick win’ install raised kerb or bund on Bean Leach Road to prevent Poise Brook exceedance flow from flowing towards properties on Minsmere Walks.
- As possible 'quick win' consider highway surface modification (speed table?) to ensure Poise Brook exceedance flow is tipped to the downstream brook and the speed table links with 3rd party informal defence structure (estate flood embankment). This action benefits Minsmere Walks and takes pressure off SW drainage in Shearwater Road.
- Update hydraulic model of this reach (including re-survey as appropriate to monitor siltation); validate against 2019 event.
- Update flood mapping for this reach, formalise the flood embankment if necessary.
- Review options for Flood Risk Management Scheme in reach and/or upstream flood management.
- Promote appropriate FRMS.
- Residents in low spots of Shearwater and adjacent roads should consider Property Level Defences (PLP) to protect against SW flooding.

L. Adswood Road

L.1 Background

Historic development in this area (Adswood Road, Clover Avenue and Culver Road) has built over an original watercourse. A short section of the original watercourse was culverted when the Stockport to Crewe railway line was constructed and the culverting of the upstream watercourse came later with housing development. Upstream of the railway culvert the drainage system has become part of UU's surface water drainage network. Downstream of the railway culvert, the watercourse is part in culvert under land recently developed for housing and then in open channel in council ownership in greenspace until culverting again under another railway line (referred to as the Midland Line).

The developed area upstream of the Stockport to Crewe railway line area has combined and surface water drainage and has over many years experienced flooding as a consequence of heavy and persistent rainfall events. All surface water draining from the local catchment is required to discharge through the railway culvert.

Internal property flooding occurred in the September 2016 flood event and in response SMBC compiled the 'Adswood Road, Flood Mitigation Action Plan (FMAP)'; the plan covers Clover Avenue, Culver Road and Adswood Road. The Plan indicates the following history of flooding and actions:

- July 2009 flood incident resulted from a blockage at the outlet to the open watercourse, which was cleared of vegetation and debris in July 2009.
- March 2010, culvert investigated by Stockport Council Drainage Team – investigations highlighted a reduction in capacity of culverted watercourse, due to a solid layer of grout throughout the culvert.
- December 2010 – Network Rail (NR) told of culvert blockage.
- September 2011 – security screen fitted to outlet.
- January 2012 – grout removal works successful for 50m upstream of outlet, works abandoned from there as pipe diameter reduces from 1200mm to 1000m, confined spaces meant works were suspended subject to culvert survey report from NR.
- October 2012 – NR attempt CCTV survey, abandoned due to lack of access.
- December 2012 – 2nd CCTV survey attempt, abandoned at 5m due to 10% silt invert of brick arch culvert, NR to progress cleaning and resurvey.
- April 2016 – Stockport Council contract work to clear downstream watercourse.
- May 2016 – CCTV survey, abandoned due to silt debris.
- June 2016 – no reported flooding in surrounding roads.
- 13th September 2016 – extensive flooding to properties on Clover, Culver and Adswood, UU report no operational issues within their system upstream of the railway that would have been a factor in flooding.
- January 2017 – culvert rehabilitation works resumed to break out grout, works abandoned after 3 days due to constant water flow.

- 9th March 2017 – central area committee meeting, waiting for report from NR once they've completed the works on the culvert.
- 5th May 2017 – NR and council met at rear of property on Hyacinth Close to determine access manholes, NR states that NR urgently need to survey to trace and locate access chamber.
- 4th July 2017 – NR initial works order to minor works team not carried out due to lack of budget.
- 25th September 2017 – internal condition survey of culvert by NR, commenced from rear garden of 11 Hyacinth Close, survey abandoned at 23m due to water level – condition of culvert directly underneath live railway is in deteriorated state, deformation of cross sectional area, infiltration, open joints, displaced brickwork.
- Summer 2020; NR advise SMBC that a contractor is in place to complete grout removal from culvert as a precursor to condition survey of the culvert.

Information of the event, of the flooding and background information has been extracted from the following sources:

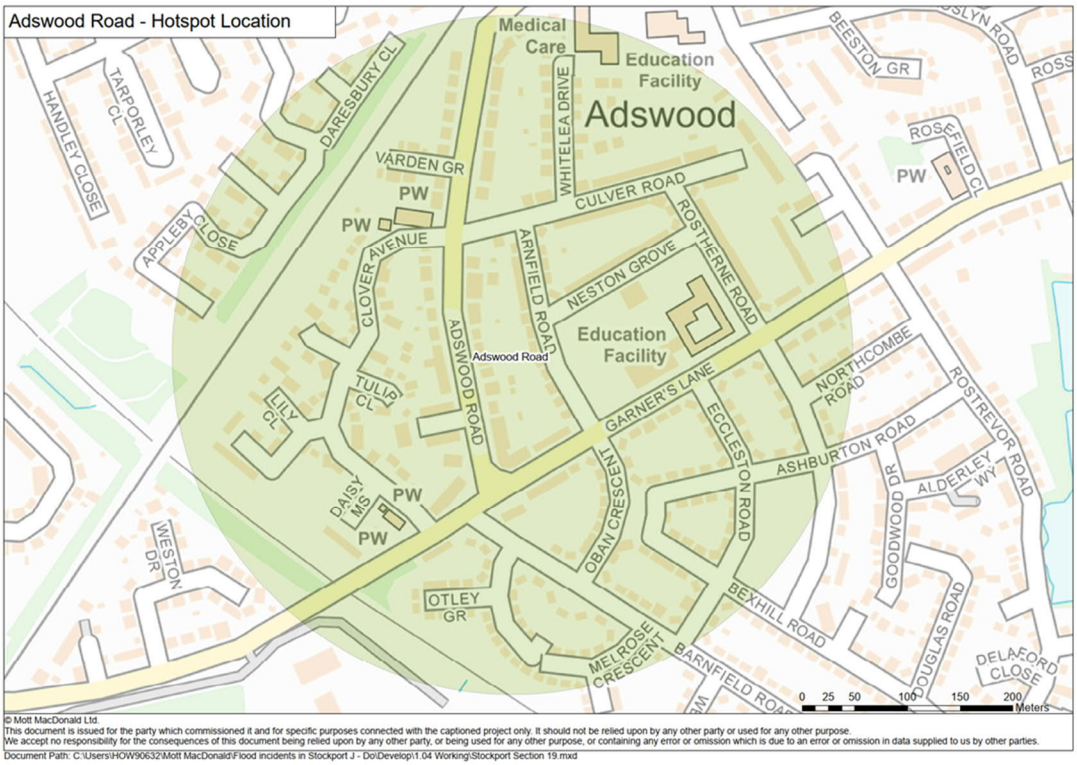
- Flood reports recorded by SMBC and the EA
- Public drop-in meetings held in January/February 2020
- Follow-up communications with affected residents.

Based upon the above, a great deal of the drainage and flooding problems of the area are likely to be linked to the restricted capacity of the culver below the Stockport – Crewe railway line. It is known that where the UU SW sewer enters railway land that there is a significant drop in the invert level and UU have proven their system to be clear to this point. It is also known that, working from the downstream portal of the railway culvert, that the whole length of culvert upstream to the railway was filled to half bore with solidified grout. This grout has been cleared by the relevant riparian owners, except only now for the section in railway ownership.

L.2 Flooding Mechanism(s)

In time of heavy rainfall, it is expected the reduced cross-sectional area for flow under the railway presents a hydraulic constraint and causes flood water to be stored upstream. The flooding of the roads and properties of Clover Avenue, Adswood Road and Culver Road is likely a direct consequence of the constraint under the railway. UU's SW sewers become surcharged and eventually spill out of highway gullies that are connected to the SW system and on occasions manhole covers have been lifted by the pressure of air trapped in the system. With the SW system surcharged many highway gullies may appear blocked as they are unable to admit flow. Solving the railway culvert constraint will likely significantly reduce the incidence of flooding in this area and it should be a priority of the LLFA to verify that NR completes this task.

Figure L.27: Hot Spot Location Plan, Adswood Road



Source: Reference mapping.

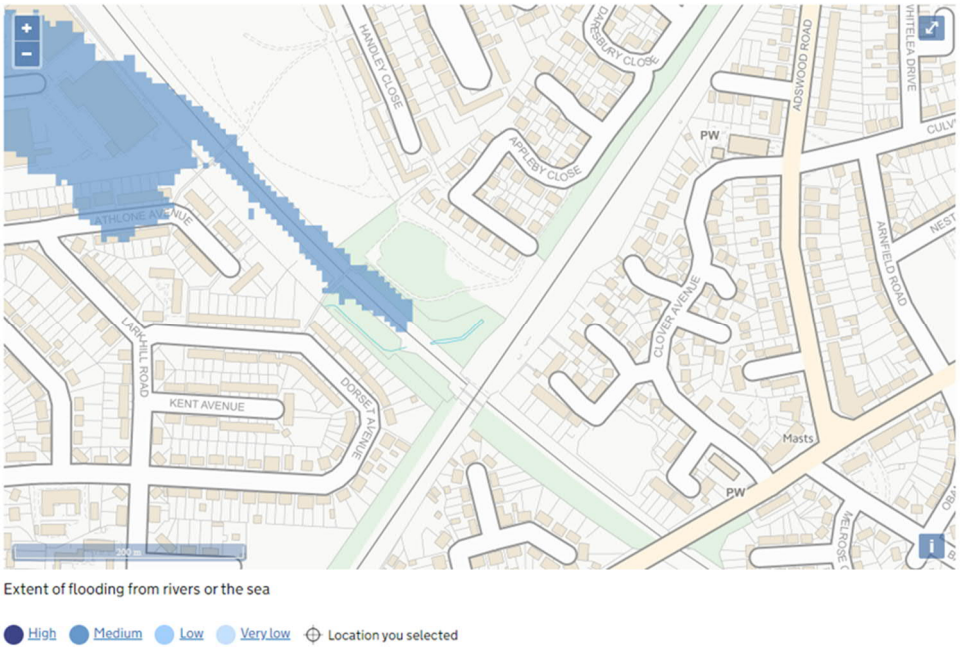
L.3 EA Flood mapping

The EA produces flood mapping for main rivers (Fluvial flood mapping) based upon numerical hydraulic modelling using local topography and surveyed dimensions of structures. The relevant flood mapping is shown in Figure L.28. This map suggests there is no fluvial flooding in the area because there are no Main Rivers present and only shows some flooding downstream of the Stockport – Crewe railway line.

Similarly, the EA produces flood mapping from 'Pluvial' sources; this is shown in Figure L.29. In this case the pluvial flood map shows an unrealistic flooded extent upstream of the railway line because the flood mapping methodology does not recognise that there is a culvert under the embankment (note, there is no flow path across the embankment).

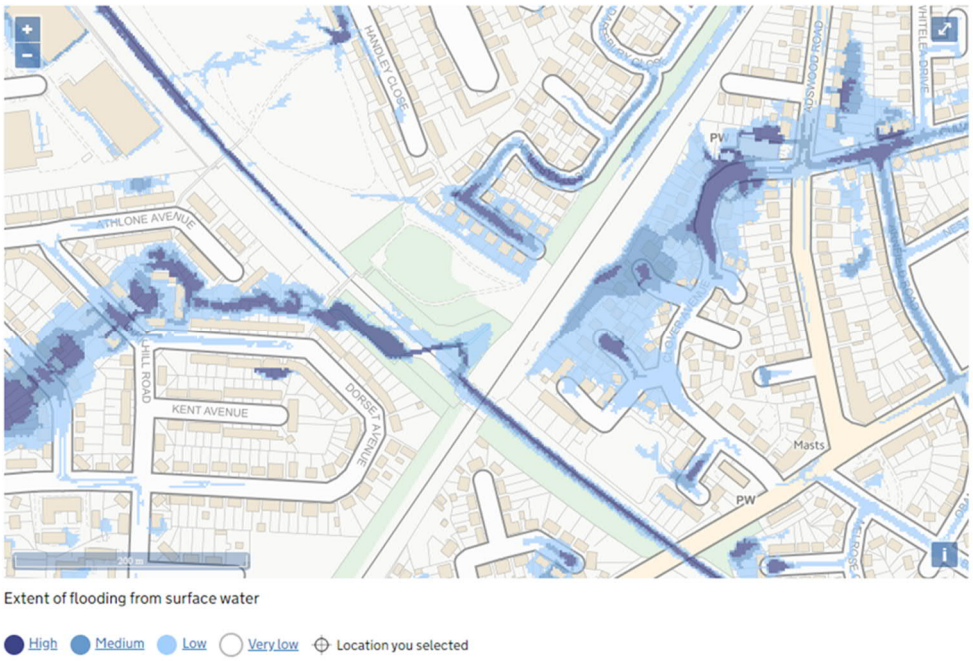
Accordingly, the pluvial mapping is only an indication of the flooded extent if the railway culvert were to become completely blocked. Nevertheless, the areas of highest flood risk are indicative of the areas flooded in July 2019 and earlier events.

Figure L.28: Adswood Road; EA Fluvial Flood Map



Source: Environment Agency

Figure L.29: Adswood Road; EA Pluvial Flood Map



Source: Environment Agency

L.4 Flood Warning

Yellow ‘be prepared’ weather warnings were issued for heavy rainfall for areas of Greater Manchester, Cheshire and Derbyshire. This warning is indicative of possible surface water flooding.

L.5 Conclusions

The known blockage in the culverted watercourse under NR land appears crucial to the incidence of flooding in this area. As a result of this blockage, UU SW network surcharges and directly floods roads and property, but also highway drains are affected, and it is likely there is some linkage to the UU combined system.

Recommended actions:

- LLFA should continue to push for remediation by NR and use available powers to enforce action.
- SMBC Highways should ensure critical gullies are cleared regularly and, in particular, in springtime ahead of the summer storm season.
- UU should monitor effectiveness of NR clearance on the incidence of surcharge in their SW system to ensure there is no other problem.

M. Councillor Lane

M.1 General Situation

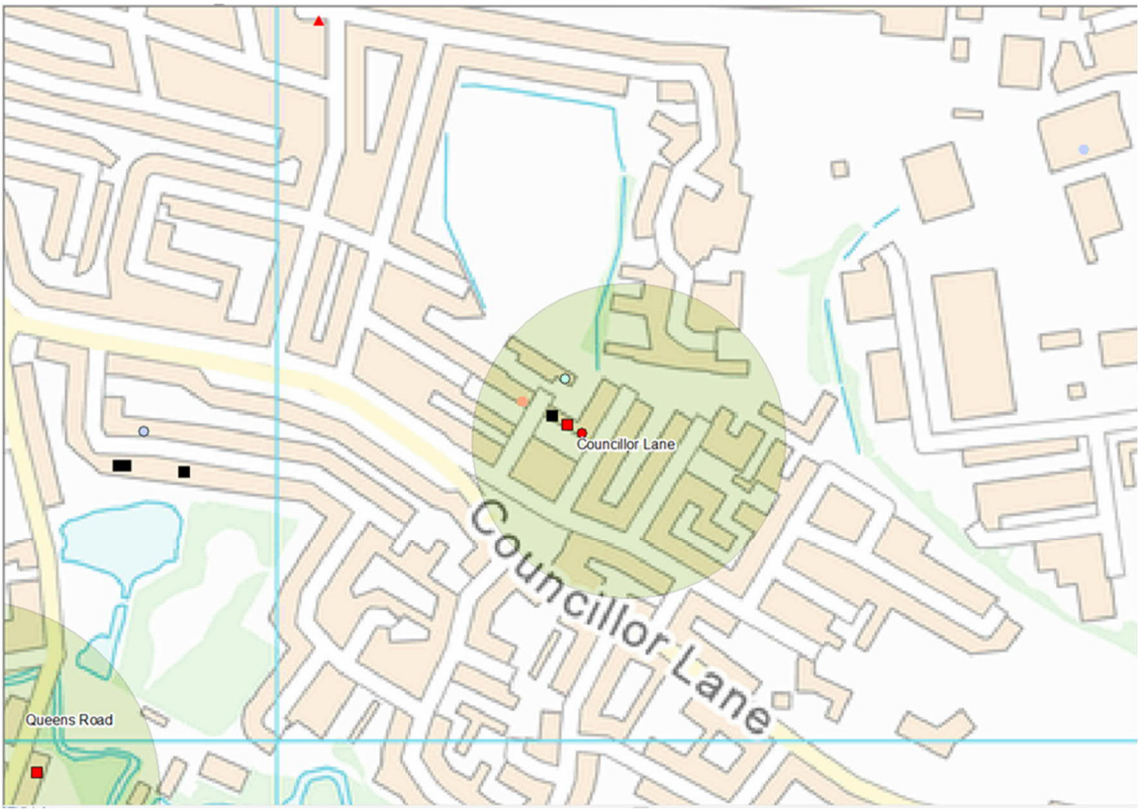
Councillor Lane was identified as a flooding hot spot based on reports of internal flooding to 7 residential properties on York Close. There is little background available to this incidence but the LLFA record that there was an overloaded UU SW sewer and '03/10/2019 Report from UU to confirm drainage running clear following jetting and root removal works'.

This area is close to watercourses to the north and local drainage may have become surcharged by high levels in these watercourses.

Information of the event, of the flooding and background information has been extracted from the following sources:

- Flood reports recorded by SMBC and UU
- Public drop-in meetings held in January/February 2020
- Follow-up communications with affected residents.

Figure M.30: Hot Spot Location Plan, Councillor Lane

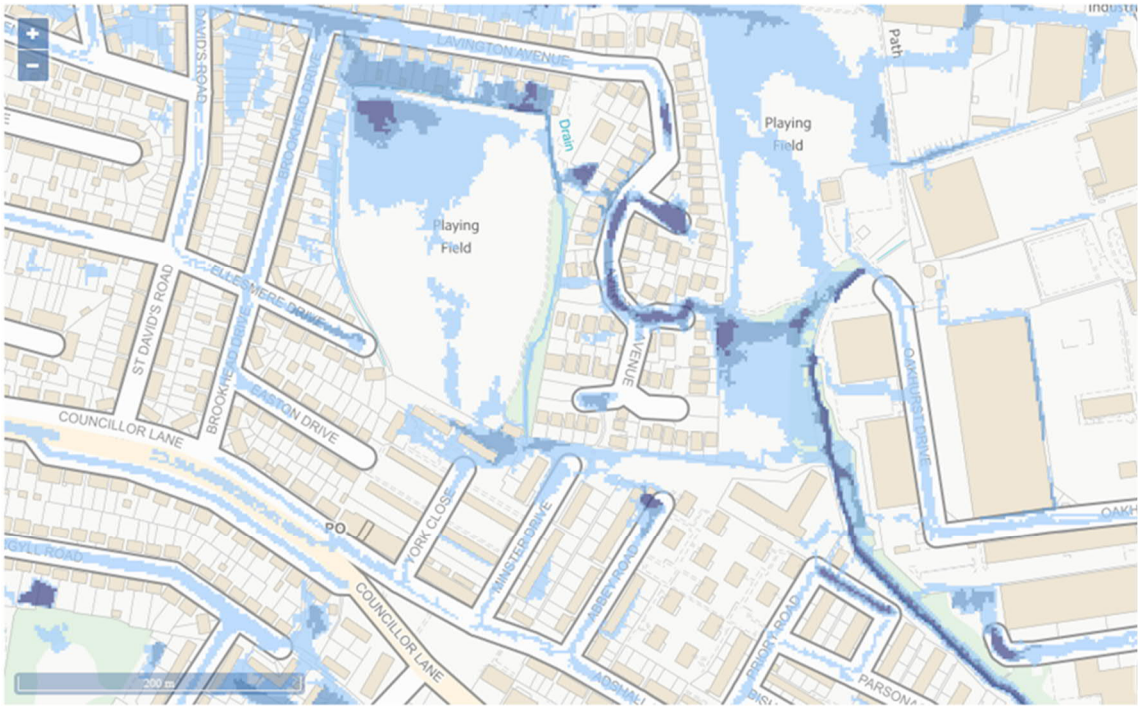


Source: Reference mapping.

M.2 EA Flood mapping

The EA produces flood mapping from 'Pluvial' sources; this is shown in Figure M.31. The pluvial flood map shows property at the north end of York Avenue to be at low to medium flood risk from local SW runoff.

Figure M.31: Councillor Lane; EA Pluvial Flood Map



Source: Environment Agency

M.3 Conclusions

It appears likely the clearance of the UU network should have improved the local situation and given the local nature of the flooding reported no further action appears warranted at this time.

Recommended actions.

No further action required unless repeat incidence of flooding.

N. Gatley Brook

N.1 General Situation

Gatley Brook was identified as a flood risk area but there are no records of flood reports to any of the RMA's. A concerned resident attended the Gatley consultation session and reported that in the July 2019 event Gatley Brook was very full but not flooding property the opinion expressed was that due to siltation in the brook (Styal road area) it was only a matter of time before property flooding occurred. Clearance of silt build-up by riparian owners was considered futile as any improvement was quickly negated by infilling from upstream.

No further considerations warranted at this time.

O. Glenside Drive and Werneth Road, Woodley

O.1 Background

Figure O.23 indicates the extent of this flooding hotspot and the relevant street names. The hot spot comprises locations of property flooding linked to overland flows along Werneth Road. The eastern end of Werneth Road receives surface water runoff from steep rural land and the steep Werneth Low Road. In storm conditions these overland flows exceed the capacity of highway drainage gullies and flow down Werneth Road adjacent to both kerbs. At various locations where drop kerbs and low pavement heights exist some flow is spilled to adjacent property. At Glenside Drive the road profile is such that much of the exceedance flow against the southern kerb flows off to the low spot at the bend in Glenside Drive; causing flooding to gardens and garages.

The secondary effect of the exceedance flows is that UU drainage systems become overloaded and there are reports of sewage contamination.

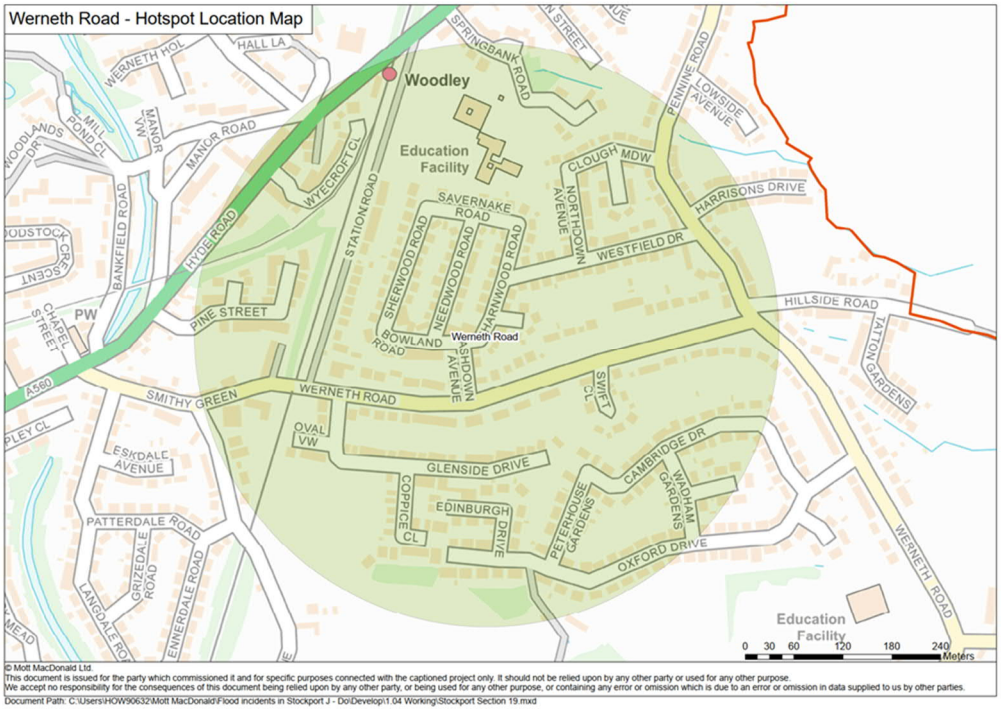
Information of the event, of the flooding and background information has been extracted from the following sources:

- Flood reports recorded by SMBC and the EA
- Public drop-in meetings held in January/February 2020
- Follow-up communications with affected residents.

Flooding Timeline

Glenside Drive reported flooding of gardens and garages on 31/07/2019 and 09/08/2019 and overflows from manhole in garden that contained sewage. Similar flooding has been experienced many times and has been reported again in July 2020.

Figure O.32: Hot Spot Location Plan, Glenside Drive and Werneth Road



Source: Reference mapping.

O.2 EA Flood mapping

The EA produces flood mapping from 'Pluvial' sources; this is shown in Figure O.33. In this case the pluvial flood map shows:

- A narrow strip of SW flooding alongside Glenside Drive.
- Little forecast flooding along Werneth Road
- No flooding from Werneth Road into Glenside Drive.

Accordingly, the pluvial mapping provides little indication of the flood mechanism evident at Glenside Drive and Werneth Road.

Note a fluvial flood map is not considered here because there are no 'Main' Rivers within this hot spot and hence no mapped flood extents.

Figure O.33: Glenside Drive and Werneth Road; EA Pluvial Flood Map



Source: Environment Agency

O.3 Flood Warning

Yellow ‘be prepared’ weather warnings were issued for heavy rainfall for areas of Greater Manchester, Cheshire and Derbyshire. This warning is indicative of possible surface water flooding.

O.4 Conclusions

Uncontrolled surface runoff from permeable and impermeable surfaces runs off rural areas of Werneth Low and Werneth Low Road and overwhelms highway drainage in Werneth Road. The runoff brings with it sand, silt and other debris causing blockages.

Recommended actions:

- Explore possible 'slow the flow' approaches in permeable areas.
- Prioritise maintenance of gullies and drainage along Werneth Road to ensure runoff is captured; add gullies if required.
- Maximise discharge to local watercourses.

- Review possibility of local highway surface level adjustments to prevent exceedance flows tipping into Glenside Drive.
- Residents with low-height pavement crossings should explore independent measures to prevent flows on the road spilling to their property.

P. Romiley

P.1 Background

Figure P.34 indicates the extent of this flooding hotspot and the relevant street names. The area comprises a mix of old property with infilling by newer development. The flood location lies in a flat area at the foot of rising ground that is agricultural at the highest locations. Newer development has gradually extended to higher elevations.

Reported flooding is principally to roads and adjacent property on:

- Guywood Lane
- Central Avenue
- Sandy Lane
- Leyfield Avenue
- Compstall Road and the precinct

Information of the event, of the flooding and background information has been extracted from the following sources:

- Flood reports recorded by SMBC and the EA
- Public drop-in meetings held in January/February 2020
- Follow-up communications with affected residents.

P.2 Flooding Timeline

Sunday 28th July; a few reports of flooding to basement dwellings.

Wednesday 31st July; several reports of flooding; timing variously reported between 1500hrs and 20:00hrs.

Thursday 1st August; many reports of flooding (but there is a suspicion this date is incorrect and should have been recorded as the 31st July). There does not appear evidence for 2 successive days of significant flooding and the 1st August does not correspond with significant recorded rainfall.

Friday 9th August; isolated reports of flooding.

P.3 Flooding Mechanism(s)

UU SW and combined sewer networks appear to have overflowed onto roads (Guywood Lane, Central Drive and Sandy Lane). Manhole covers have been reported to have ‘blown off’ and fountains of water discharged. Residents replaced some covers to try to reduce the flows released to local roads. These exceedance flows combined with direct runoff have flowed along roads to reach the local low-spot at Leyfield Avenue where ponding occurred. Exceedance flows were unable to drain via highway gullies because these were either surcharged or blocked with debris.

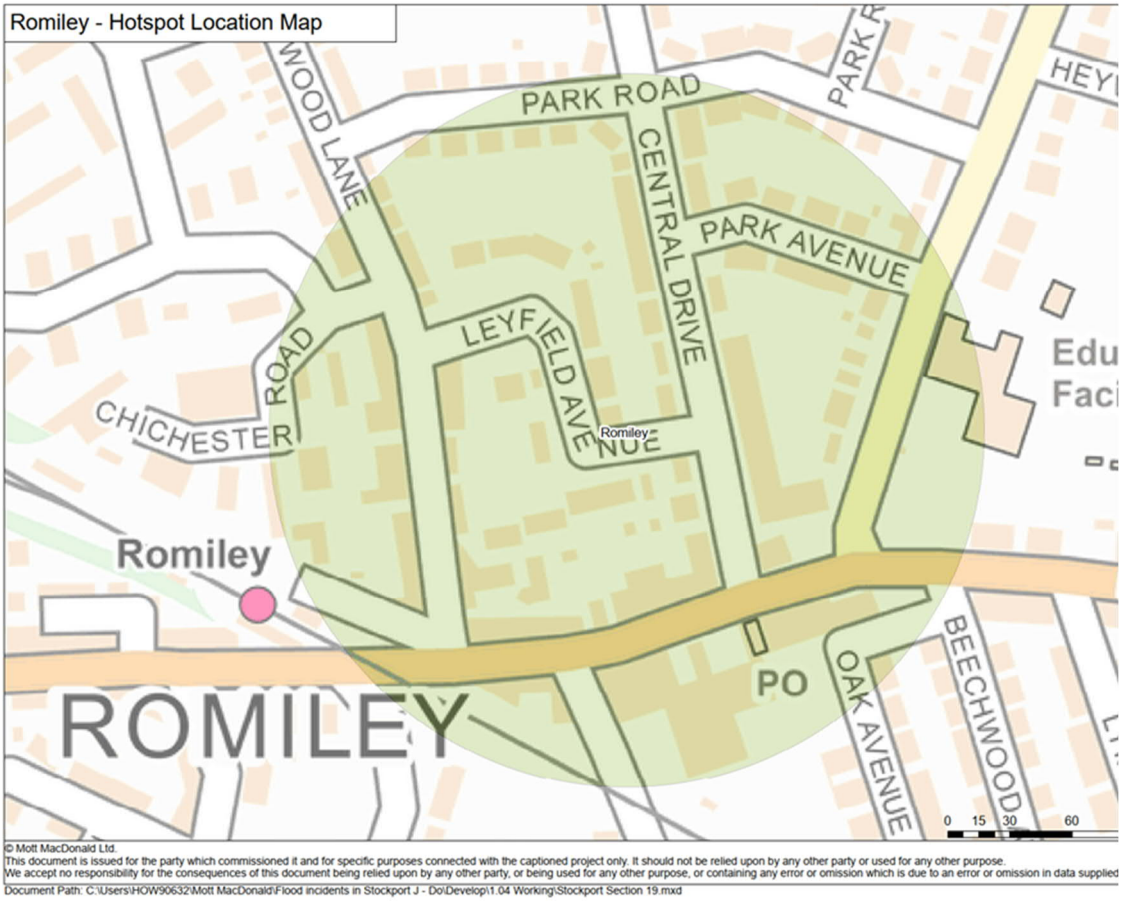
Video evidence and resident descriptions shows that exceedance flows on Sandy Lane flowed to Compstall Road, along Compstall Road and at least some of the flow then flowed from

Compstall Road onto Central Drive and thence to the low-spot at Leyfield Avenue. Several shops in the precinct were flooded by the ponded water which was unable to drain because gullies and drainage channels were blocked.

Many residents indicate the floodwater to have been contaminated with sewage so the UU combined network may also have become surcharged and spilled at some locations.

Accordingly, although exceedance flows are along the highways a significant contribution to the floodwater came from overflowing of UU's surface water drainage system.

Figure P.34: Hot Spot Location Plan, Romiley



Source: Reference mapping.

P.4 EA Flood mapping

The EA produces flood mapping from 'Pluvial' sources; this is shown in Figure P.35. In this case the pluvial flood map shows:

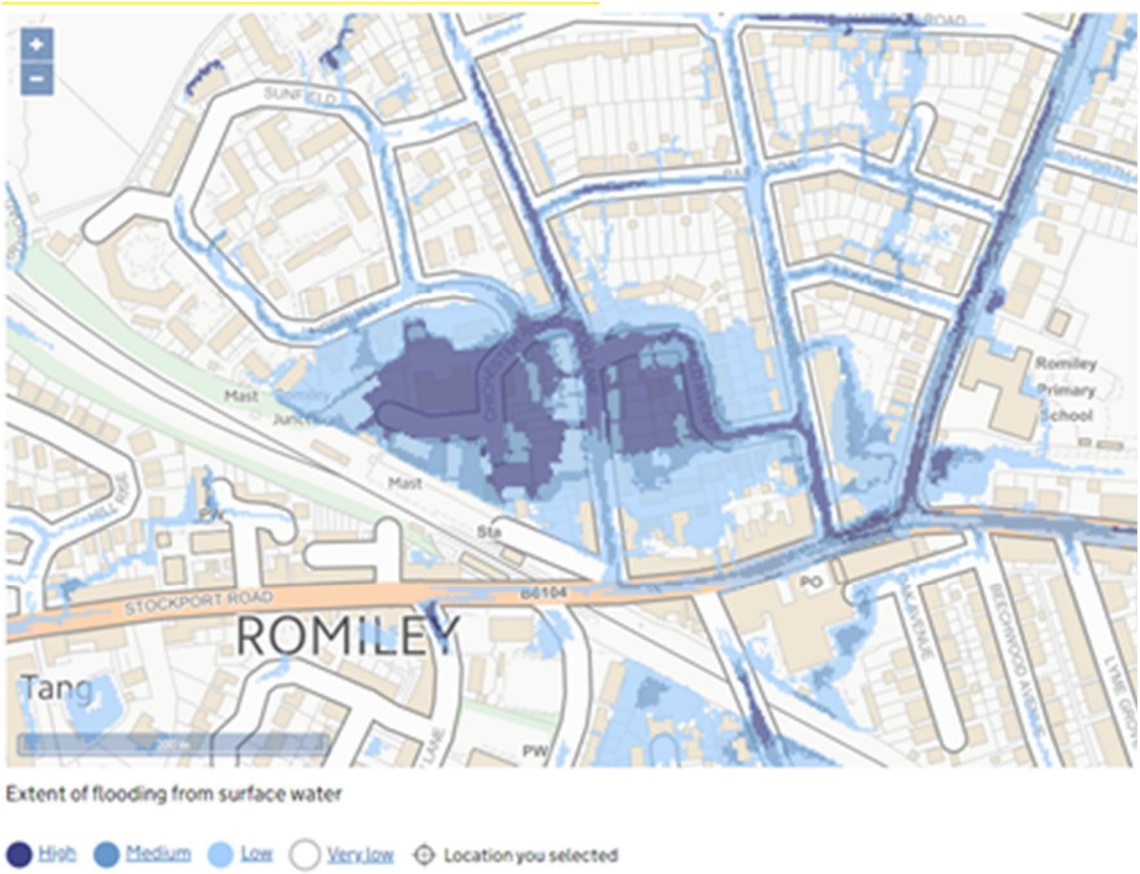
- An unrealistic flooded extent upstream (North) of the railway line because the flood mapping methodology does not recognise that there are culverted discharge routes under the railway embankment.

- Significant SW flooding is shown for Leyfield Avenue and Chichester Road.

Accordingly, the pluvial mapping is only an indication of the flooded extent if the drainage system were to become completely blocked. Nevertheless, the areas of highest flood risk are indicative of the areas flooded in July 2019 and earlier events. However, flooding was not reported on Chichester Road following the July 2019 rainfall event.

Note a fluvial flood map is not considered here because there are no 'Main' Rivers within this hot spot and hence no mapped flood extents.

Figure P.35: Romiley; EA Pluvial Flood Map



Source: Environment Agency

P.5 Flood Warning

Yellow 'be prepared' weather warnings were issued for heavy rainfall for areas of Greater Manchester, Cheshire and Derbyshire. This warning is indicative of possible surface water flooding.

P.6 Conclusions

Surface water drainage is a major issue in this area of Romiley (Guywood Lane, Central Avenue, Sandy Lane, Compstall Road and linking roads). The SW drainage is in large part a UU system although there are isolated sections of watercourse under riparian ownership. The

drainage system is predominantly culverted and is therefore difficult to understand, difficult to inspect, difficult to maintain and difficult to improve.

Flood affected residents in this area are frustrated at being passed between UU and the council as neither body appears to take responsibility for the issues. Whilst the council (as LLFA) may not be directly responsible for much of the SW network it should provide a lead as to where responsibility lies and to support residents in seeking some mitigation to the frequent flood events in the area. Given that UU sewers have been repeatedly reported to have lifted manhole covers and discharging SW flows onto roads, it is surprising that UU do not have a single flood report in this area; the likely consequence of residents being told it is not a UU problem and being directed to report the incident to the council.

The rainfall depth and intensity of the July 28th to July 31st event has been assessed (refer to main report) and it is likely even modern well designed and well performing SW networks could have flooded. So, it is no surprise that the old SW drainage of this area was overwhelmed. However, residents report repeated flood events going back many years that are not associated with the severity of the July 2019 rainfall and are in need of some mitigations.

Flooding in Guywood Lane, Central Drive, Sandy Lane, Compstall Road and Leyfield Avenue are all interlinked; some SW flows overland from high ground and SW exceedance flows on for example Sandy Lane flow along Compstall Road and off into Central Drive and compound the problems there. The UU surface water network was clearly overwhelmed and frequently spills to roads. Road gullies are reported blocked by debris which is not surprising given the frequency of exceedance conditions that bring silt and debris onto the road surface. All exceedance flows focus on Leyfield Avenue.

Recommended actions:

- Develop area-wide understanding of drainage networks and overland flow routes and identify all discharge routes to Main River (R. Etherow). Joint action LLFA and UU.
- Develop area-wide integrated above-ground and below-ground drainage network model as basis for evaluation of improvement actions. Joint action LLFA and UU.
- Promote appropriate FRMS for the area; prioritise actions giving benefit for Leyfield Avenue.

