

Hull City Council Flood Investigation Report

Section 19 – Prolonged Rain October/November 2019



29th February 2020
Investigation Ref No HCCFWMAS190005



Revision Schedule

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Contents

Executive Summary	4
1. Introduction	6
2. Drainage History – Previous Flood Incidents	9
3. Latest Flooding Incidents – Sunday 27 th October 2019.....	11
4. Risk Management Authorities operation response.....	20
5. Roles and Responsibilities	25
6. Recommendations	27
7. Conclusion	29
Abbreviations / Acronyms	30
Useful Links and Contacts	31

Executive Summary

In autumn 2019, Kingston upon Hull experienced flooded houses on two occasions. On the 27th October, over-topping of the Old Fleet Drain watercourse led to reports of five properties being flooded. Prolonged rainfall leading up to and including the 27th October 2019 saw the network of watercourses in and around the city exceed capacity. Following this, the drain over-topped on a number of occasions and further internal flooding was only prevented by the use of pumps at strategic locations.

Following heavy rain on Sunday the 10th November 2019, we received reports that in addition to repeat flooding at Bexhill Avenue, two further properties had experienced internal flooding, one on Paxdale, Sutton Park and one on Pilots Way, Victoria Dock. There was also several areas in the city where extensive roads and gardens were flooded although there were no confirmed internal properties flooded. The two most affected areas were Norland Avenue in Boothferry Ward and Cumbrian Way in North Carr Ward. The 3 surface water schemes in the west of the city were all operation, although the Cottingham and Orchard and Anlaby and East Ella Flood Alleviation Schemes were only 75% complete. **This S19 report will focus in Old Fleet Drain and Bexhill Avenue but will also look at the other areas in less detail and offer recommendations.**

A formal investigation under Section 19 of the Flood and Water Management Act (FWMA) was considered appropriate. This was led by Kingston upon Hull City Council as the Lead Local Flood Authority (LLFA). This report details the findings of the investigation. The cooperation of all partners was received and welcomed throughout.

Investigations have been carried out by Hull City Council (HCC), East Riding of Yorkshire Council (ERYC), the Environment Agency and Yorkshire Water as the Risk Management Authorities who operate numerous assets across the city and surrounding area. A range of findings have been reported in the investigation and measures are being put in place to improve the drainage network by both partners. Further works are being developed to deliver further improvements.

Flood Guidance Statements leading up to the event did not show any risk in Hull on the 27th, although yellow warnings for surface and river flooding had been issued covering the preceding days.

On the 27th October the residents of 34 Bexhill Avenue contacted the emergency services to report flooding, and Humberside Fire and Rescue responded. In order to maximise pumping capacity, they in turn contacted Hull City Council who provided two gully cleaners to assist with the pumping.

Hull City Council's Flood Risk Management team were made aware of the flooding on the morning of the 28th October 2019 and started a Section 19 investigation which was then extended to cover flooding in November.

On Sunday 10th November 2019 further flooding occurred. Old Fleet drain over-topped and internal flooding was only prevented through the use of pumps, and two other properties within the city were reported to have experienced minor internal flooding. The high levels in Old Fleet Drain continued for several days.

It is important to note that flooding following a sustained period of rainfall is always a possibility. The city of Hull is built on low lying land which prior to building was part of the natural floodplain. The city benefits from flood infrastructure, such as walls and pumping stations, to help manage water but a risk will always remain. Everyone has a role to play in helping to manage this risk. A recommendation is made to continue working with residents of the city to ensure they are aware of the risks of flooding and the ways in which a resident or community can help themselves.

1. Introduction

1.1 LLFA Investigation

HCC as the LLFA has a responsibility to record and report flood incidents as detailed within Section 19 of the FWMA:

Section 19

(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:

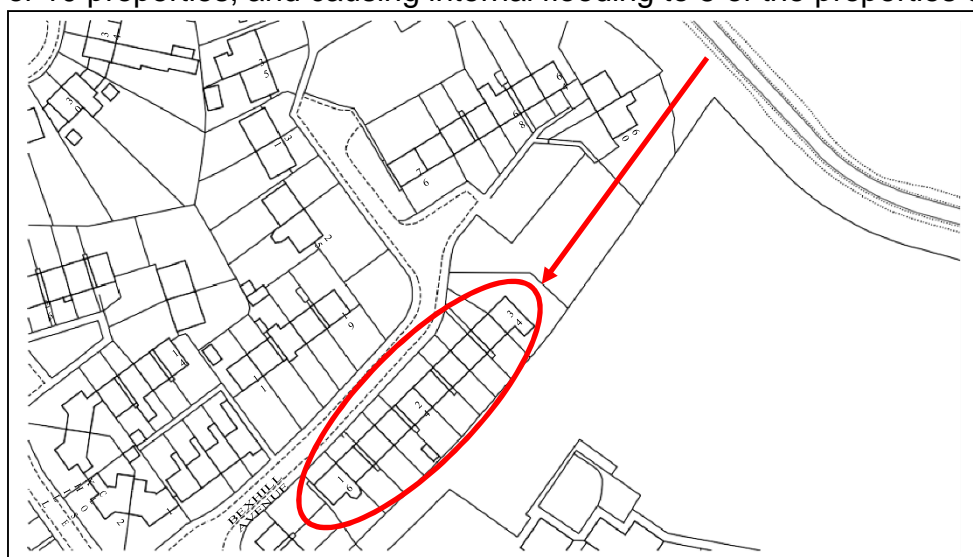
- (a) Publish the results of its investigation, and
- (b) Notify any relevant risk management authorities.

It was deemed necessary to complete an investigation into the flood incidents which occurred on the 27th October 2019 and around the 10th November 2019 as 7 properties were reported to have flooded internally.

This report provides the details of the conditions leading to the flooding, the impacts of the flooding and the roles and responsibilities of all operating authorities in the area. Investigations have been carried out and recommendations and conclusions are given.

1.2 Site Location- Old Fleet Drain, Bexhill Avenue

On the 27th October 2019, flood water crossed the garden of number 60 and entered the gardens of 10 properties, and causing internal flooding to 5 of the properties on Bexhill Avenue, Hull.



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Figure 1: Affected Area

On Sunday 10th November 2019, the Old Fleet Drain again over topped causing more flooding and in addition, we received reports at two further properties in the city:

- One on Victoria Dock, where water appears to have flowed down a slope in the garden to the back of the house. Despite making enquiries, we have not been able to confirm the reports of flooding here or how much damage was caused, and
 - One on Sutton Park, where water flowed from a footpath which was higher than a front garden which had an impervious surface, leading to slight internal flooding via an air brick.
 - There was also reports of extensive road flooding at Cumbrian Way, North Carr
 - Road and gardens submerged in Norland Avenue
 - Record high levels on the Holderness Drain which caused some flooding to property outside of the city boundary
-
-

1.3 Local Drainage System

The city of Hull is built on former marshland which would have formed the natural floodplain of the River Hull at its mouth with the Humber estuary. It is this location that provided the trade, wealth and employment that a port city brings but with this location comes the challenges of managing water. This is particularly apparent with the impact of climate change. Along the frontage of the Humber estuary and the River Hull the land has been raised to defend the city from the tide, however this has then caused issues with surface water and smaller watercourses unable to naturally outfall into the estuary. This means there is a reliance on pumps to help lift water into the estuary, particularly when the tide is high and with sea level rise the reliance on pumps is becoming more frequent. The drainage system which carries the water from surrounding land to the north, east and west of the city is a complex interaction of rivers, streams, ditches, dykes and sewers. Some of these are Main Rivers permissively managed by the Environment Agency (EA) and some are open drains and streams (Ordinary Watercourses permissively managed by local authorities, or often the responsibility of riparian landowners) but much of the system is culverted below ground.

The majority of the drains do not remain open and have been either filled in or piped in to become the public sewer system. This system for the majority of the city is combined surface water and foul and flows to the Saltend Waste Water Treatment Works where the flows are treated and discharged to the Humber estuary. Pumping stations at West Hull and East Hull help manage the flows from these sewer systems. There is also pumping at East Hull to lift water out of Holderness Drain and into the estuary. The Bransholme area of the city is served by a separate surface water drainage system which discharges flows into a storage lagoon before outfalling to the River Hull. Yorkshire Water is responsible for the city's sewerage system.

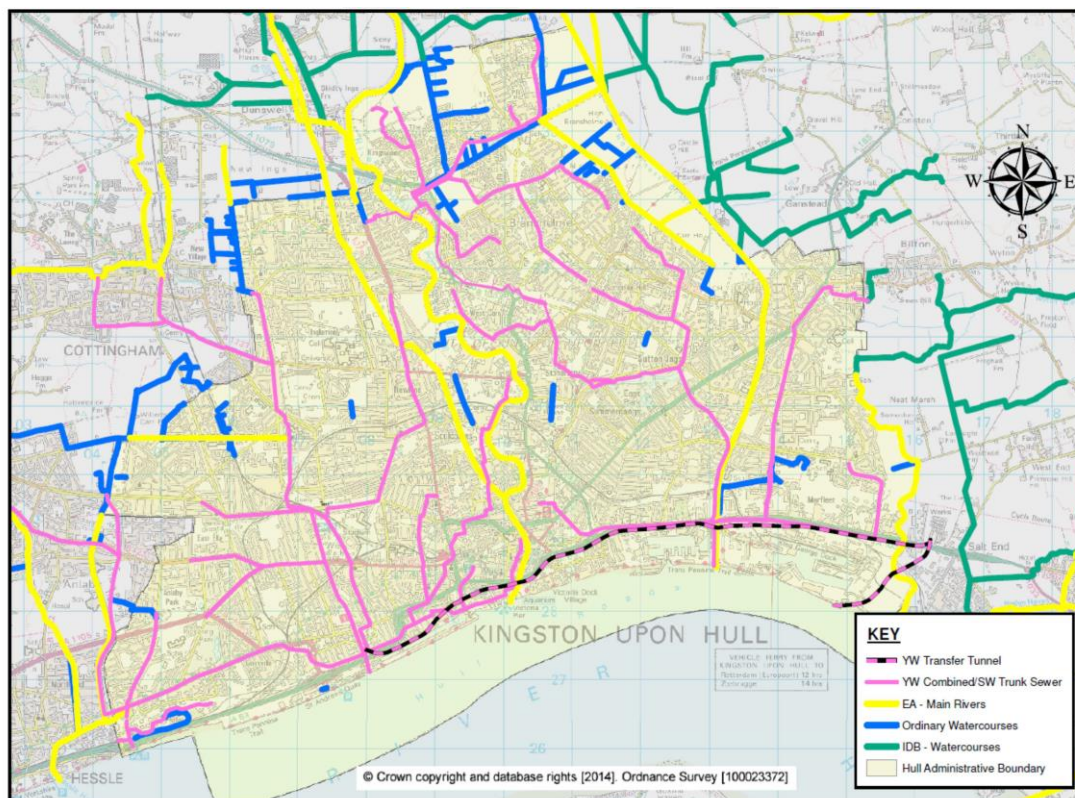


Figure 2: Hull City Drainage Systems

2. Drainage History – Previous Flood Incidents

2.1 June 2007

The floods of 2007 followed some of the highest rainfall on record across many parts of the region, and many drains, ditches and watercourses were overwhelmed. Many streams and ditches flowing through the East Riding of Yorkshire Council (ERYC) villages of Anlaby, Cottingham and Willerby were overwhelmed and flood flows came out of bank and caused significant flooding through these towns, these flows then passed onto the west of the city of Hull where the flooding of Anlaby Park, Orchard Park and Derringham followed. The flooding of these areas was caused by the capacity of the integrated drainage system being unable to pass flood flows. Similar flooding extended across large areas of the east of the city where drainage systems were unable to cope with excessive rainfall, flooding again extended outside of the city boundary with many villages east of the city suffering from flooding.

Flooding in the North East area of the city was exacerbated due to infrastructure failure at the Bransholme Pumping Station; significant areas of Bransholme and Kingswood were affected.

More than 1300 businesses and 8600 residential properties were flooded in the city; many more were affected in the ERYC villages.

2.2 25th August 2012

The flood event of 25th August 2012 was caused by an intense storm localised to the city, surrounding areas have not reported similar incidents from this event and similarly many of the other events which caused problems in surrounding areas did not impact significantly on the city. Problems were reported across the city but are broadly concentrated in a 'central belt'. 19 residential and 2 commercial properties have been recorded as flooded and many other roads.

2.3 5th December 2013 Tidal Flooding

On the 5th December 2013, a tidal surge breached the city's Humber flood defences causing flooding to 264 properties and businesses predominantly in the Anchorage, Porter St and English St areas of the city

2.4 10th August 2014

From Sunday 10th to Monday 11th August 2014, the UK experienced some unseasonably windy and very wet weather from the remnants of ex-hurricane Bertha. Bringing strong winds and heavy rain, with parts of eastern England and north-east Scotland worst affected. This led to the flooding of 3 properties and numerous roads in Hull

Environment Agency data showed that water levels in the River Hull and smaller watercourses within the city were normal and able to receive flows. The tidal levels were also at a lower extent so there were no recorded issues with water discharging to the Humber. This shows that the incident was purely based around a pluvial event, flooding from surface water and sewers.

2.5 2nd April 2018

On the evening of the 2nd April, a property in Bexhill Avenue, near to the city's eastern boundary flooded. The nearby Old Fleet Drain had over-topped, causing water to run through a garden, across an area of public open space and then flooding a single property.

3. Latest Flooding Incidents – Sunday 27th October 2019

3.1 Bexhill Avenue Flooding

On the evening of the 27th October, residents in Bexhill Avenue, near to the city's eastern boundary noticed rising flood water rising around their house. The fire service attended along with Hull City Council.

On investigation, it became apparent that the nearby Old Fleet Drain had over-topped in the same place as in April 2018, but the larger volume this time caused water to run through a garden, across an area of public open space and then flooding five properties internally.

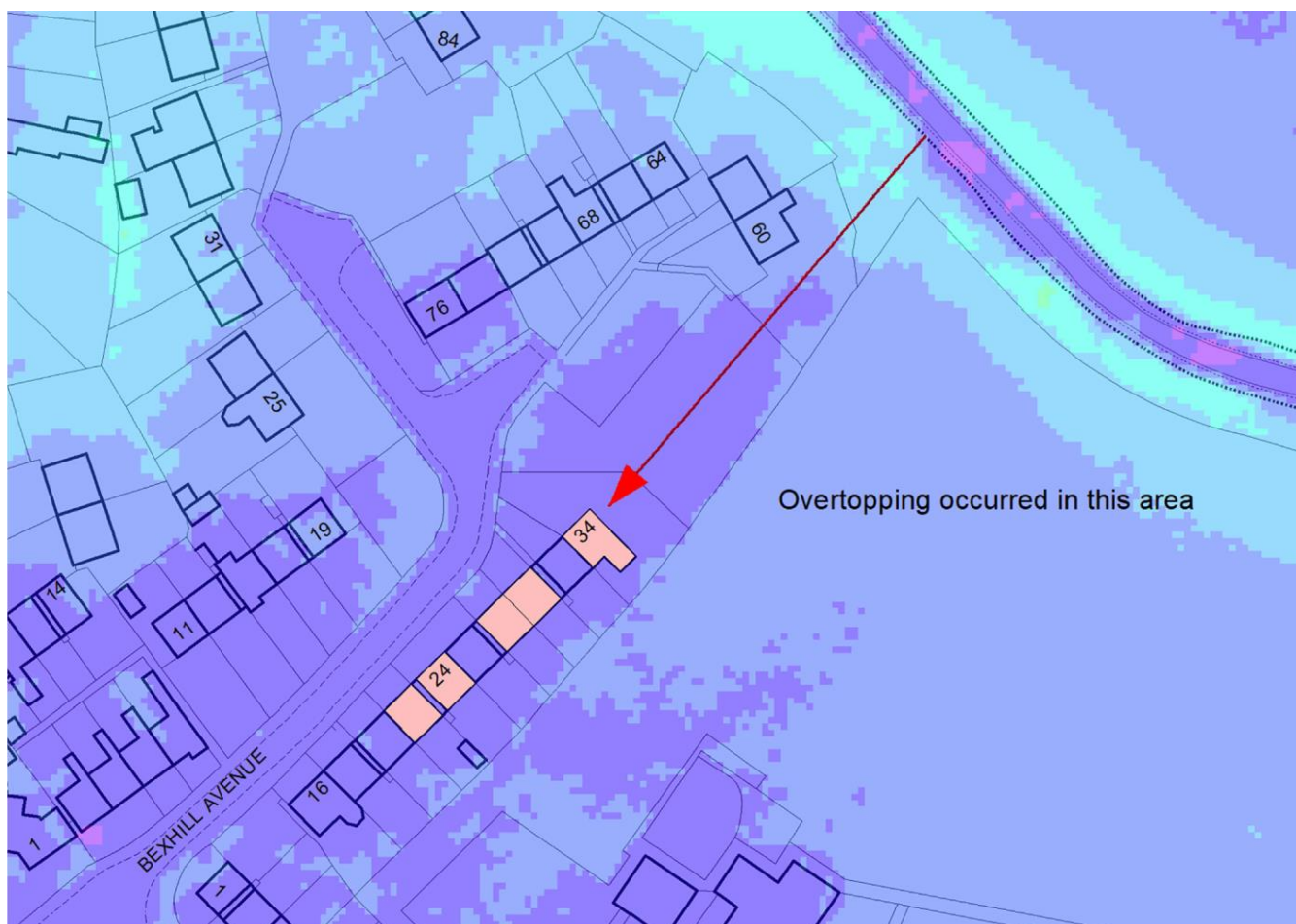


Figure 3: Bexhill Avenue LiDAR

3.2 Bexhill Avenue, Sutton Park, Victoria Dock - Sunday 10th November 2019

On Monday 11th November the residents at one of the properties on Bexhill Avenue rang to say they had flooded again. On investigation this was found to be contained to the garden and no internal flooding had occurred. Details of the rainfall and operational response can be found in the next sections.

3.3 Cumbrian way, Bransholme

Flooding was reported on roads in Bransholme around Cumbrian Way and Lothian Way. Initial reports to Humberside Fire and Rescue suggested internal property flooding but the flood water remained on the roads and in gardens. There were no watercourses overtopping so issue was linked to surface water unable to discharge into the gullies and sewers and must have been localised as a housing estate on the same trunk sewer system which is lower did not report any issues.

3.4 Norland Avenue

Humber Fire and Rescue Service crews were called to Norland Avenue and proceeded to pump flood water away on the evening of the 14th November. There were no reports of properties within the Hull side of Norland Avenue flooding but it appeared to mostly affect properties in the East Riding.

Following on from the reports of external flooding in Anlaby Common, Yorkshire Water carried out a visual inspection of the public sewer network on Norland Avenue and Kendall Way and reported that there were no signs of operational issues or blockages on the network.

The water levels receded rapidly on the 14th and remained stable once weather conditions improved.

Background Information

The sewer network, from parts of the East Riding and the west of Hull City, discharge into the YWS Trunk Sewers and into the Hull Tunnel adjacent to the West Hull Pumping Station (WHPS).

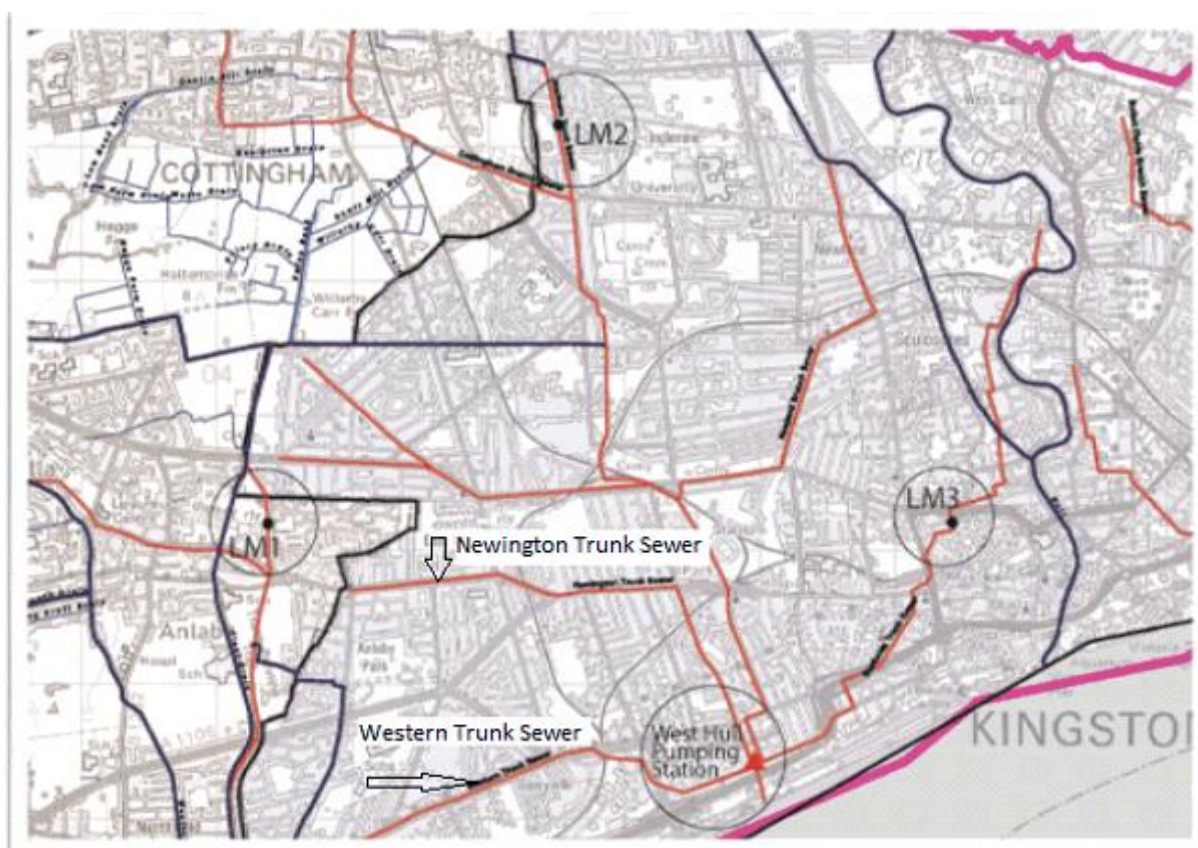


Figure 4: Yorkshire Water Sewer Network with Level Monitor (LM) Locations

In figure 2 the trunk sewers are labelled and the locations of the sewer level monitors, LM1, LM2 and LM3 in the sewer network are also indicated. The local sewer networks serving the properties in the area discharge into the trunk sewers.

Anlaby and Cottingham and much of the Haltemprice area in East Riding drain into the YWS sewer network in Hull City, largely into the trunk sewer network. There are two trunk sewers which serve the area of Anlaby: one in Anlaby Road, the Newington Trunk, and the other runs down Springhead Lane into the Western Trunk. (See figure 2 above).

The trunk sewers discharge into the Tunnel sewer, constructed as part of the Humbercare Scheme, which carries flows to the Saltend Treatment Works, the Tunnel also takes flows from the east of the city, adjacent to East Hull Pumping Station on Hedon Road. The Tunnel is designed to act as storage during high flows. When the tunnel capacity is exceeded the West Hull Pumping Station can act as an overflow and is used to discharge excess flows directly into the estuary.

The probable cause at Anlaby Common was the intense rainfall on the catchment upstream overwhelming the trunk sewer network which flows from west to east through the affected area. Therefore it is likely the flooding experienced was as a result of the exceptionally heavy rainfall events resulting in inability of the local sewer system to discharge quickly enough into the trunk sewers.

The trunk sewers discharge into the Hull Tunnel at West Hull Pumping Station. The sewer system started to drain down once the intensity of the rainfall eased and pumping operations were able to catch up with flows in the system.

3.5 Holderness Drain

On 27th October the pumps at East Hull Pumping station which work to lift water from the drain into the Humber estuary when the tide is high were not operated. This resulted in high water levels in the Holderness Drain, although no properties were flooded in Hull. A business premises in the East Riding did suffer flooding in this event and subsequently has flooded several times since. <https://www.hulldailymail.co.uk/news/hull-east-yorkshire-news/flash-flooding-hull-golf-club-3475190>

3.6 Weather Guidance

Flood Guidance Statements were received from the Environment Agency in the days up to the 27th October 2019. The flood guidance statement from the Flood Forecasting Centre on Thursday 24th October suggested risk would have passed by Sunday, and that overall likelihood in Hull was low with only minor impacts.

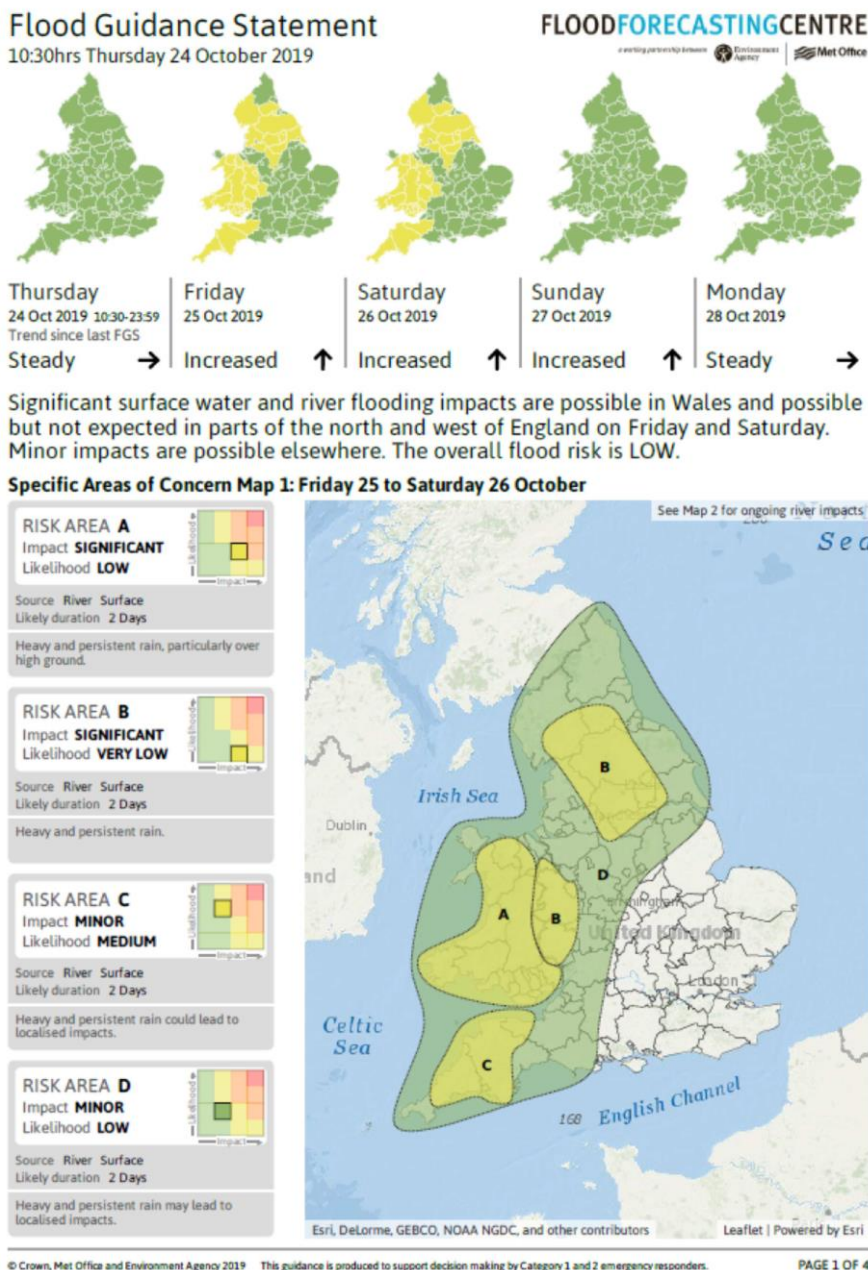
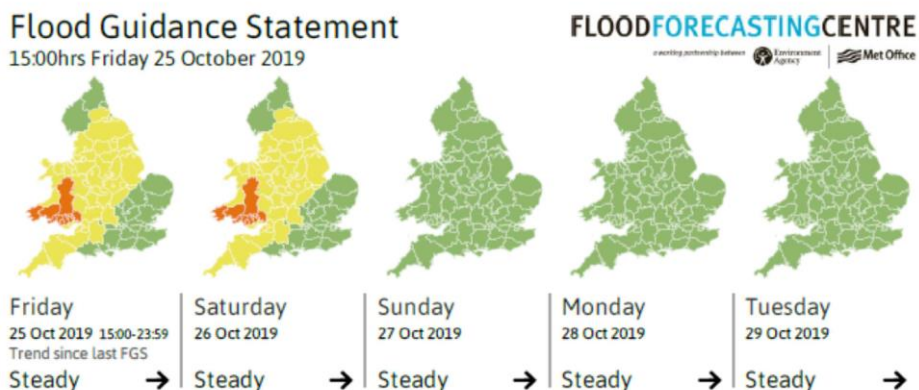


Figure 5: Flood Guidance Statement Thursday 24th October 2019

However, by Friday 25th October, the Flood Guidance Statement was revised to show parts of the country were now at a higher risk. This statement changed the likelihood of a flood event in Hull from “Low” to “Very Low”, however, any impact on Hull (and much of the country) was revised from “Minor” to “Significant”. Any flooding was expected across the country on Friday and Saturday.



Significant surface water and river flooding impacts are probable in south Wales, possible for the rest of Wales and possible but not expected in parts of England on Friday and Saturday. The overall flood risk is MEDIUM.

Specific Areas of Concern Map 1: Friday 25 to Saturday 26 October

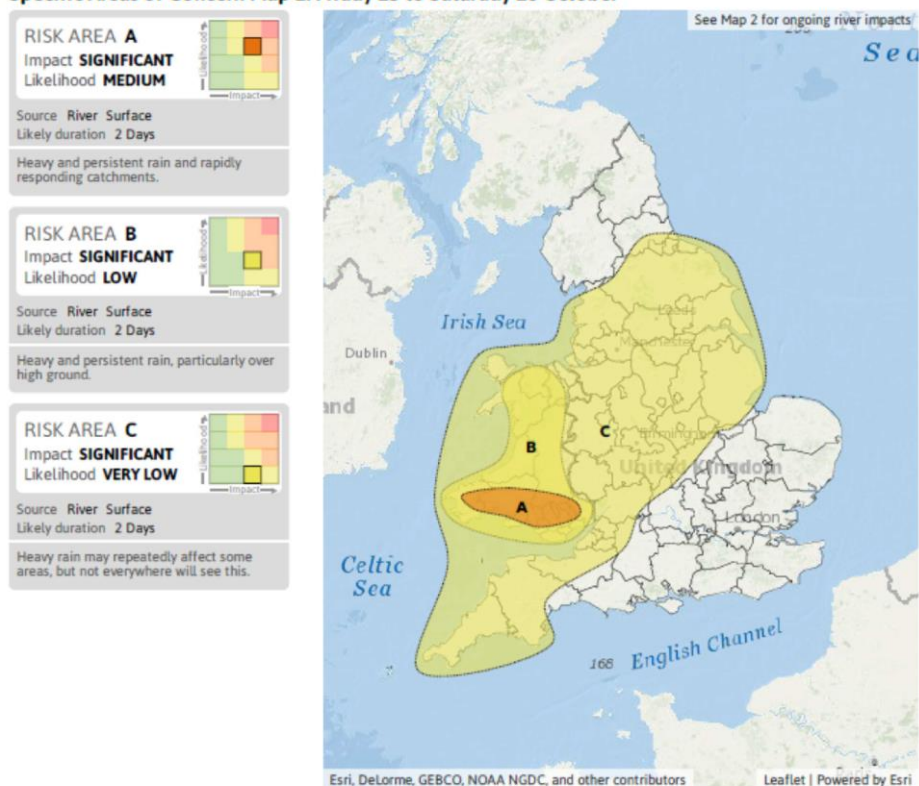


Figure 6: Flood Guidance Statement Friday 25th October 2019

A further Flood Guidance Statement was issued at 10.30am on Sunday 27th October which highlighted some risk to the midlands, including south of the Humber on the 27th and 28th, but Hull was not included in the area shown as being at risk.

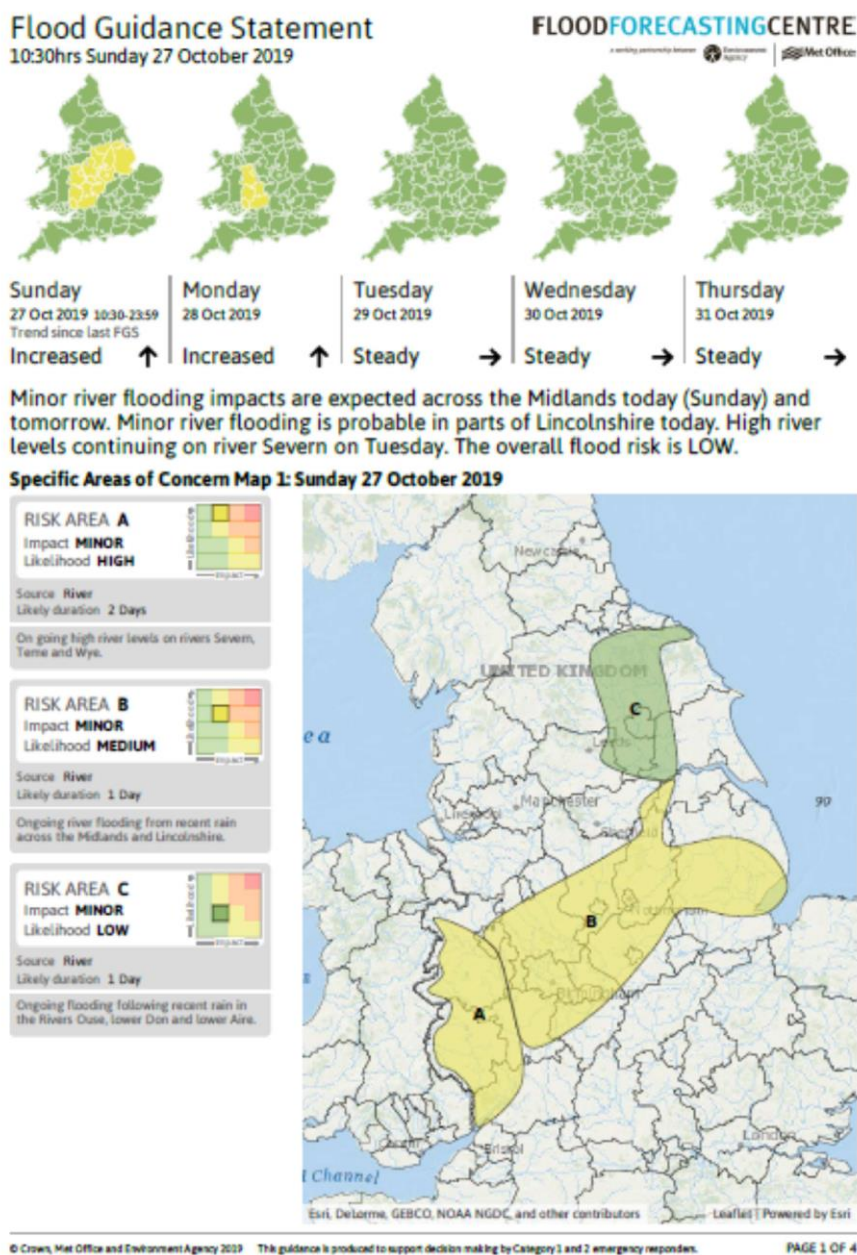


Figure 7: Flood Guidance Statement Sunday 27th October 2019

At 9.49am on Sunday 27th October 2019, the Environment Agency issued a flood alert for Holderness Drain.

A Flood Guidance Statement was issued at 3.30pm on Monday 11th November warning of possible severe impacts from river flooding across central and eastern England. Hull was only identified as potentially at risk on the 14th and 15th November, however further flooding occurred that evening.

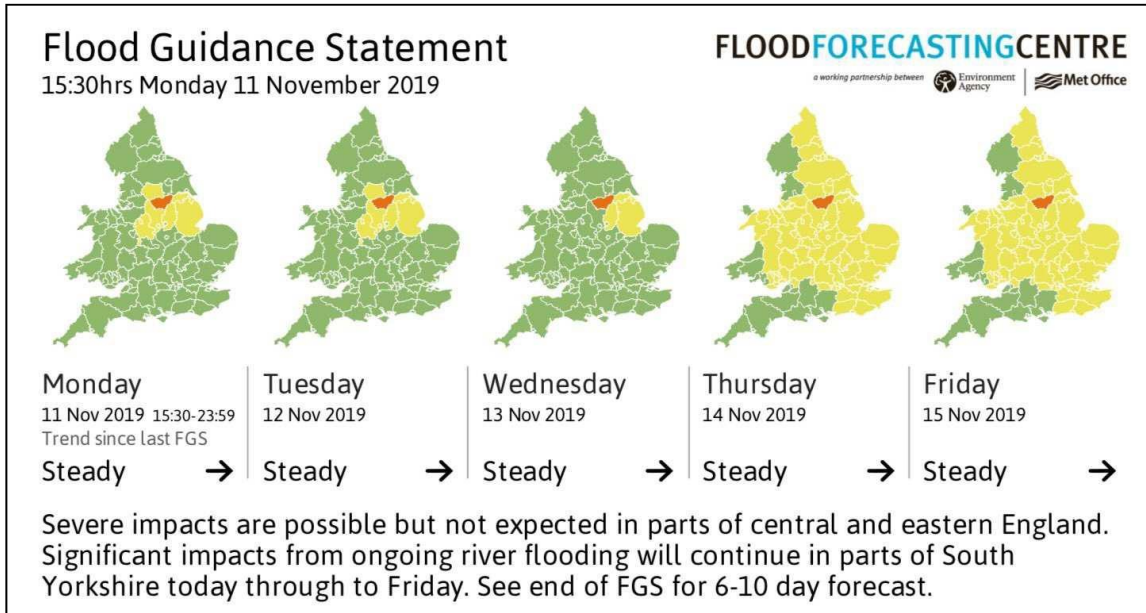


Figure 8: Flood Guidance Statement Monday 11th November 2019

3.7 Rainfall Data

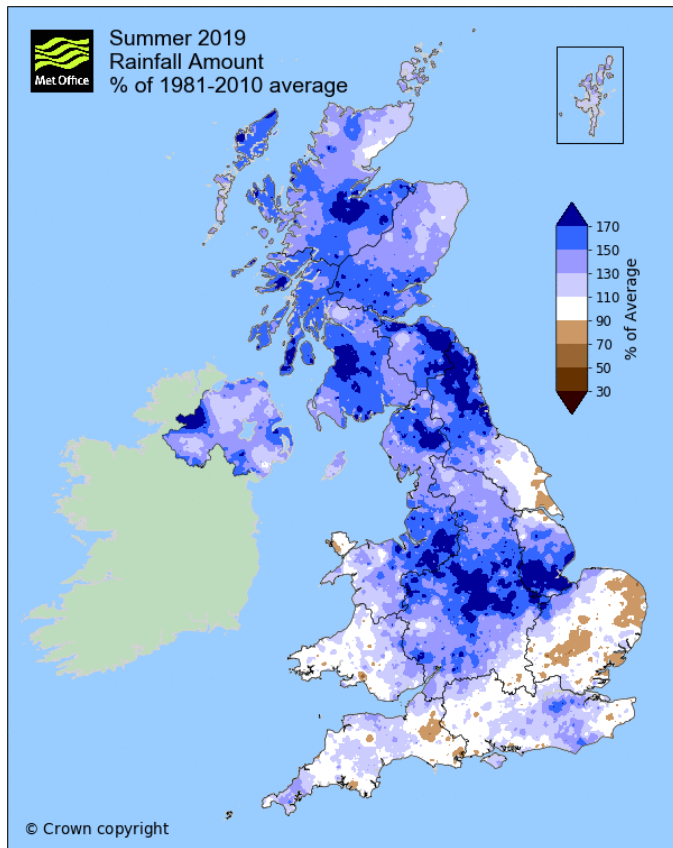


Figure 9: Summer Rainfall Data

In Hull the summer of 2019 was a relatively normal one in terms of average rainfall levels, however the start of autumn saw unprecedented levels of rainfall. This can be seen in the table below with data gathered from the Great Culvert gaugemap.

	Rainfall		Percentage of 2014/8 average		Average 2014 - 2018
Sep-19	96.2	mm	272.37%		35.32mm
Oct-19	141.2	mm	304.05%		46.44mm
Nov-19	123.8	mm, to 19th November	198.14%		62.48mm

More detailed information on rainfall is shown on the tables below. The following tables are from the Environment Agency’s Flood Hydrology Facts, Yorkshire Area. Fact sheet 35.

Rainfall

Tables 1-3 show the rainfall recorded by tipping bucket rain gauges in the area for three events covering 25th-26th October, 7th-8th November and 14th-15th November. Figures are provided for the peak accumulation, the peak rainfall return period, and a percentage of the October or November monthly long term average (LTA) for a range of durations.

25th October 2019 - 26th October 2019	Cottingham	Driffield	Great Culvert	Newbald Beckles	Tickton	Winstead Booster	Weighton Logger
Peak Rainfall accumulation (mm)							
3 hour total	14.0	9.8	9.0	17.2	15.4	6.6	16.0
4 hour total	14.8	12.0	10.0	18.2	16.4	8.4	17.8
6 hour total	20.0	15.6	12.6	23.6	22.8	11.0	21.4
11 hour total	26.2	21.0	19.2	30.8	28.8	16.2	28.2
12 hour total	27.4	22.0	20.4	32.4	30.0	17.0	29.2
16 hour total	33.0	27.6	26.2	38.8	35.4	23.0	35.8
18 hour total	34.6	29.2	26.8	41.0	36.8	24.4	38.0
24 hour total	44.0	37.0	37.8	49.0	45.2	26.4	47.0
36 hour total	46.2	38.6	39.8	52.2	47.2	28.0	49.6
Peak Rainfall as % of October LTA							
3 hour total	27	21	21	n/a	27	14	33
4 hour total	28	25	23	n/a	29	18	37
6 hour total	38	33	29	n/a	40	23	44
11 hour total	50	44	44	n/a	50	34	56
12 hour total	53	46	47	n/a	53	35	60
16 hour total	63	56	60	n/a	62	48	74
18 hour total	66	61	69	n/a	64	51	79
24 hour total	84	78	87	n/a	78	55	87
36 hour total	89	81	92	n/a	83	58	103
Peak return period (years)							
peak 3 hour total	<1	<1	<1	2	1	<1	2
peak 4 hour total	<1	<1	<1	2	1	<1	2
peak 6 hour total	2	<1	<1	2	2	<1	2
peak 11 hour total	2	<1	<1	3	2	<1	2
peak 12 hour total	2	<1	<1	3	2	<1	2
peak 16 hour total	2	1	1	4	3	<1	3
peak 18 hour total	3	1	2	4	3	<1	4
peak 24 hour total	5	2	3	7	6	<1	7
peak 36 hour total	4	2	2	6	4	<1	6

LTA	50% to 74%	Return Period	3 to 4
	75% to 99%		5 to 6
	>100%		7

Table 1: River Hull catchment and other local peak rainfall totals during Friday 25th October 2019 to Saturday 26th October 2019

7th November 2019 - 8th November 2019	Driffield	Great Culvert	Newbald Beckles TBR	Tickton	Winstead Booster	Weighton Logger
Peak Rainfall accumulation (mm)						
3 hour total	4.2	13.8	12.8	8.6	12.8	12.0
4 hour total	5.2	16.4	14.6	10.0	15.4	15.4
6 hour total	6.6	20.8	17.0	12.4	20.4	20.8
11 hour total	10.0	28.8	22.8	19.0	30.8	32.2
12 hour total	10.2	30.2	23.8	19.2	32.2	34.0
16 hour total	10.6	33.6	26.8	21.8	36.0	40.2
18 hour total	10.6	33.6	27.0	21.8	36.8	41.8
24 hour total	11.2	34.8	28.0	22.4	37.2	44.4
36 hour total	11.2	35.6	31.4	23.4	38.8	46.0
Peak Rainfall as % of November LTA						
3 hour total	7	25	n/a	15	23	23
4 hour total	8	30	n/a	17	28	29
6 hour total	11	38	n/a	21	37	39
11 hour total	16	52	n/a	33	56	61
12 hour total	16	55	n/a	33	59	64
16 hour total	17	61	n/a	37	66	76
18 hour total	17	61	n/a	38	67	79
24 hour total	18	63	n/a	39	68	84
36 hour total	18	64	n/a	40	71	87
Peak return period (years)						
peak 3 hour total	<1	1	<1	<1	<1	<1
peak 4 hour total	<1	1	<1	<1	<1	1
peak 6 hour total	<1	2	<1	<1	2	2
peak 11 hour total	<1	2	<1	<1	3	3
peak 12 hour total	<1	2	<1	<1	3	3
peak 16 hour total	<1	3	<1	<1	3	5
peak 18 hour total	<1	2	<1	<1	3	5
peak 24 hour total	<1	2	<1	<1	3	5
peak 36 hour total	<1	2	<1	<1	2	4

LTA	50% to 74%	Return Period	3 to 4
	75% to 99%		5 to 6
	>100%		7

Table 2: River Hull catchment and other local peak rainfall totals during Thursday 7th November 2019 to Friday 8th November 2019

Figure 10: EA Hydrology Fact Sheet 35 Extracts

The data above shows that ground conditions in the catchments of the River Hull, Holderness Drain and Old Fleet Drain and the other drains and watercourses flowing into Hull were saturated by the start of autumn. This meant any rain falling on the catchment was quickly discharged to the watercourses rather than soaking into land. Given the season, much of the agricultural land was

ploughed as crops had been removed so therefore any interception from vegetation would be limited and runoff and siltation increased.

4. Risk Management Authorities operation response

4.1 Old Fleet Drain

Old Fleet Drain does not have any formal flood defences for its length but some tidal pointing doors situated at Lord's Clough prevent tidal water from backing up the drain and flooding the city. The land levels on the drain are lower than the high tide levels are therefore without this asset flooding would occur on a frequent basis. The doors naturally close when the tidal flows are greater than the fluvial flows of the drain. Once the doors close the fluvial flows are effectively dammed, meaning they back up until the tide has gone down enough for the doors to open and to let the flow outfall. A high tide is usually beneficial as it means there is a greater tidal range so the low tide allows much more flow out as a greater tidal extent.

During the previous flood event in 2018, the Environment Agency confirmed that Lord's Clough, where Old Fleet Drain joins the Humber, had been recently checked and was in working order, and that the drain had been checked and no blockages or defects had been found. After these latest events, Lord's Clough was again checked and no defects were found but the Environment Agency identified that the bank at Bexhill Avenue is lower in this location.

There is no EA telemetry on Old Fleet Drain so no specific flood warning that covers this watercourse as no trigger levels and no forecasting. There is a telemetry point at Bilton which ERYC operate.

On the 27th October the Environment Agency deployed 2 x 8" and 2 x 6" pumps at Lords Clough at the time of the flooding at Bexhill, and over-pumped when the doors were tide locked. The pumps have been used during the subsequent storms and accompanying high water levels and the pumps remained on site throughout November. Hull City Council deployed 5 operatives and a pump in attendance at Bexhill avenue from 0900 – 1300, 1600 – 0000, 0000 – 0600. A manager was also in attendance from 0630 – 1400 for Holderness Drain and Bexhill Avenue.

In November along with the Environment Agency, Hull City Council operated the pumps at Lords Clough and there were pumps on site locally to discharge some of the water into the sewer system.

2 Hull City Council operatives and a pump were in attendance at Bexhill Avenue for a total of 36 hours over the 2 days with a manager also in attendance 16 hours over the 2 days, covering the high tides.

Details of the pumps deployed are listed in the table below.

Pumping record

Lords Clough	Old Fleet Drain, Salt End	1	EA360048	Hydrostal	Superhawk	8"	14/11/2019
		1	EA351072	Pioneer	CAT3A	8"	08/11/2019
		1	EA350994	Pioneer	150SL	6"	08/11/2019
		1	HCC	Selwood		6"	10/11/2019

Following this event Hull City Council's Grounds Maintenance team went out on site to establish if they could clear some of the undergrowth along the bank of Old Fleet Drain so a sandbag wall

could be constructed. These works were delayed by the high levels in the drain and the health and safety risks associated. On the 15th November the site was cleared and the Environment Agency were able to construct a sandbag wall as a temporary defence.

Streetscene staff who attended site have also looked into the possibility of installing a pipe to help direct flows to an area where the water could then be pumped into the sewer system.

Property Flood Resilience measures such as flood doors and air brick covers were installed on 2 properties at Bexhill Avenue in January 2020. This cost £14,712 and was funded by the Environment Agency and Hull City Council.

4.2 Cumbrian Way

The sewer system for Branshome and Kingswood is a separate system, unlike the rest of the city where it is combined. This means that the foul flows are directed to Saltend Waste Water treatment works but the surface water is discharged directly to the River Hull via Bransholme Pumping Station.

The storm pumps at Bransholme Surface Water Pumping station operated on the following dates:

- 2th November 2019
- 4th November 2019
- 5th November 2019
- 7th November 2019 - the storm pumps started operating at 08:48hrs and pumped through to 14:14hrs on 8th November
- 8th November 2019
- 11th November 2019
- 12th November 2019
- 13th November 2019
- 14th November 2019 - the storm pumps started operating at 11:15hrs and continued to pump through to 11:26hrs on 15th November.
- 15th November 2019

Approximate volumes based on pump design and run time:

- 7th/8th November 2019 event - 321,840m³ pumped
- 14th/15th November - 327,840m³ pumped

A CCTV survey of the trunk sewers is currently ongoing to establish if there was a blockage in the system. So far half of the system has been surveyed and a large number of chains have been found, however these would not have caused the sewer to block. Please see photos below:

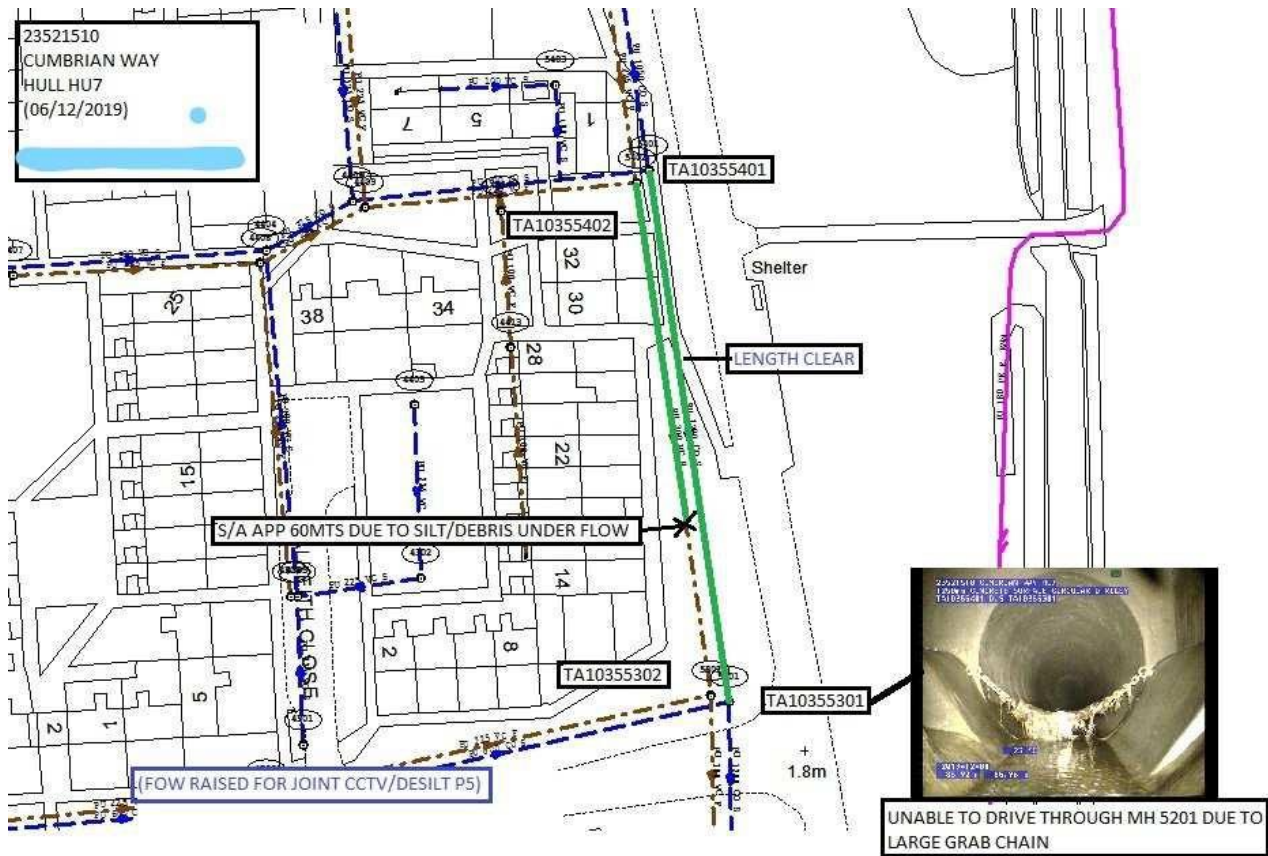


Figure 11: YW Survey Results 1

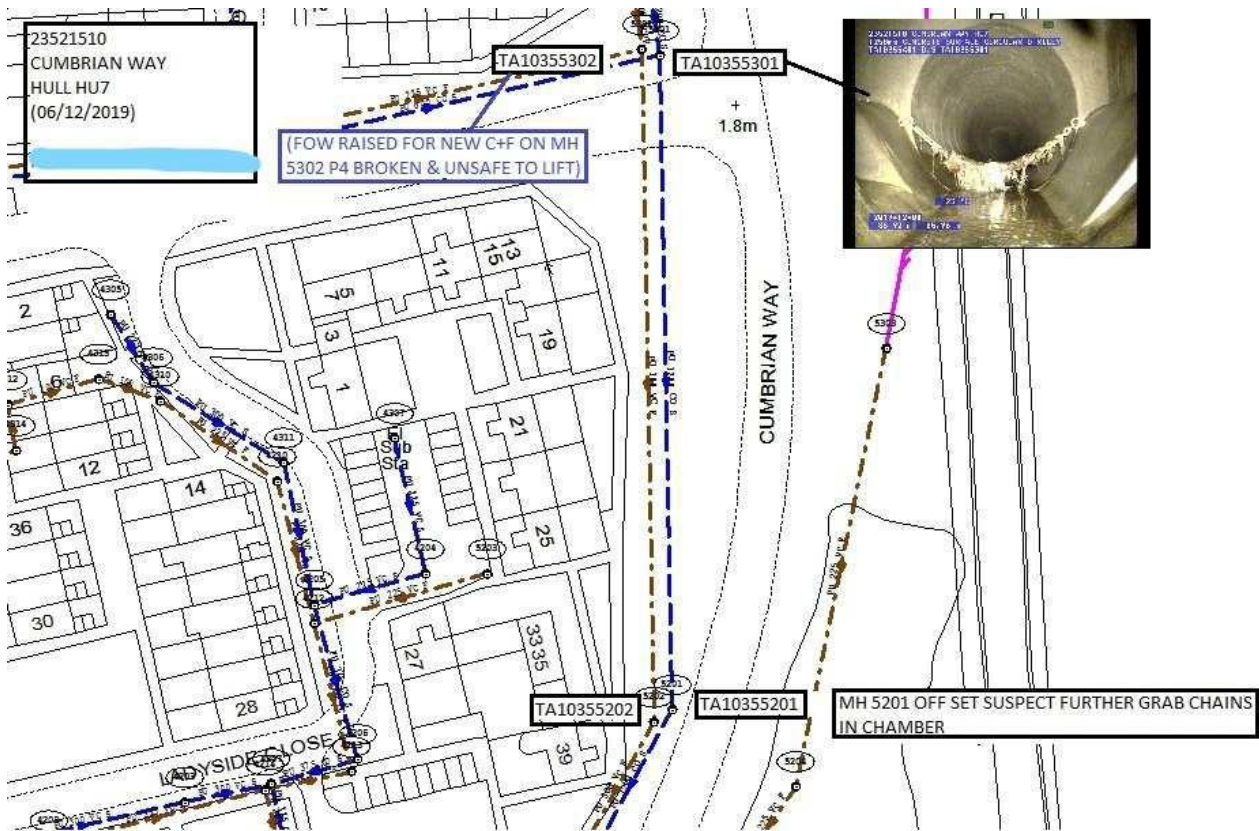


Figure 12: YW Survey Results 2

4.3 Norland Ave

Norland Avenue and the surrounding area has suffered frequent surface water flooding in the last 10 years. The areas foul and surface water discharges into the Newington Trunk sewer which joins the Northern trunk sewer and flows down to the West Hull Pumping Station. Problems occur in heavy rainfall when surface water runoff is unable to get into the sewer system via the highways gullies and its ponds in the low spots. The large flood alleviation schemes to the west of the city (Willerby and Derringham, Cottingham and Orchard Park and Anlaby and East Ella) will help reduce the risk indirectly as they will hold back some of the flows which previously filled the same sewers, however there remains a localised issue.

A request was made to Yorkshire Water asking for details of when their pumps at East and West Hull pumping stations were operated in the periods around the 11th November 2019. Details of pumping were as follows:

The pumps at West Hull operated pumping the city's flows on the following dates:

- 7th November 2019 - pumps started at 18:04 and pumped through to 05:48.
- 8th November 2019 - pumps restarted on 14:35 and pumped through to 16:43.
- 14th November 2019 - pumps started at 17:27 and pumped through to 02:07.

Approximate volumes based on the pump design and run time:

- 7th-8th November 2019 - 671,590m³ pumped
- 14th November 2019 - 370,878m³ pumped

The pumps at East Hull operated pumping the city's flows on the following dates:

- 7th November 2019 - pumps started operating at 18:21 and stopped operating at 23:22.
- 14th November 2019 - pumps started operating at 17:14 and stopped operating at 19:30.

Approximate volumes based on pump design and run time:

- 7th November 2019 - 162,298m³ pumped
- 14th November - 100,729m³ pumped

4.4 Holderness Drain

Holderness drain is an artificially created watercourse which drains agricultural land to the north and east of Hull. The land levels and topography of the catchment means that pumping is required to keep flows moving and to outfall to the estuary.

There are 2 key pumping station- Great Culvert which is situated on the Hull/East Riding of Yorkshire boundary just north of Castle Hill and East Hull pumping station which is situated on the A1033 at Marfleet.

There are 2 aspects to East Hull Pumping Station, one side which pumps the sewer system of east Hull (excluding Bransholme and Kingswood) to help move flows to Saltend Waste Water Treatment Works and during storm events, when there is a risk to the city and its population is able to divert and pump flows directly to the estuary. This is a Yorkshire Water Pumping Station. The other which is an Environment Agency Pumping Station lifts the Holderness Drain into the estuary ensuring it can discharge. The pumps are set up so that the Holderness Drain can also be pumped by the Yorkshire Water pumping station if required.

Historically the asset will have been the responsibility of Humberside County Council but was divided between the Environment Agency (EA) and Yorkshire Water (YW) as the authorities were formed.

The pumps to discharge Holderness Drain for the EA were red carded and declared unfit for purpose in 2018. Since this time the EA has relied on YW attending and operating their pumps to ensure Holderness Drain can continue to flow around the tide-locked outfall and to reduce the risk of flooding to the city.

Unfortunately, due to the pumped nature of the catchment and the gravel underlying geology forecasting as to when pumping is required is very difficult if not impossible. This has caused issues with the EA duty staff being unable to give a good amount of notice to YW about when pumping is required and for how long. Given the nature of the catchment water levels in the drain tend to run high for a considerable time.

There is a historical agreement/protocol in place between the EA and YW for East Hull regarding the arrangements for pumping. This is based around YW best endeavours to pump when asked, and is based on availability of resources and priority of operating other assets. For example the same technical staff are required to operate Bransholme and West Hull pumping stations which, if not operated, could result in a greater number of properties flooding with sewage. When the agreement was made it was based on a low probability of pumping required, as the Yorkshire

Water support would only be requested as a result of extenuating circumstances e.g. Pump Failures, Restricted Manpower or extended operation periods on the EA pumping station. In the last year the Holderness Drain has required pumping a significant number of times, with the pumps operating over 30 times in the 3 weeks at the end of October early November alone. This has continued into December, January and again in February.

The Holderness Drain Flood Alleviation Scheme has funding secured to construct a new online pumping station to reduce the reliance on the YW asset. The planning application for this pumping station is currently in the planning system with decision due in March. The timescales for constructing the new asset will be to have it operational by April 2021.

5. Roles and Responsibilities

5.1 Lead Local Flood Authority

Hull City Council is defined as a Lead Local Flood Authority in the FWMA, main responsibilities: flooding from surface runoff, groundwater and ordinary watercourses, permissive powers to maintain none Main Rivers, development of a Local Flood Risk Strategy, Asset Plans and Investigations.

5.2 Environment Agency

Key responsibilities are: flooding from main rivers, the sea and reservoirs including coastal erosion risk management, permissive powers to maintain Main Rivers, Strategic Overview over all forms of flooding and development of a National Flood Risk Strategy.

As a fluvial event, the Environment Agency has roles in relation to main River watercourses and in providing flood warnings for main-river flooding and Flood Guidance Statements. With respect to their Main River responsibilities, the Environment Agency has been carrying out routine maintenance to both the watercourse (keeping the channel clear and ensuring the banks are in good condition), and Lord's Clough (Operation and condition)

Since the previous flooding event, we have identified that the East Riding of Yorkshire Council has telemetry at Bilton which gives an indication of levels in Old Fleet Drain, and which Hull City Council now has access to and monitors

5.3 Water and Sewage Company

Yorkshire Water Services are the water and sewage company covering Hull City Council and the surrounding catchment area, their key responsibilities are: the provision of a water supply, the discharge of foul and grey water from properties. This includes managing the risks of flooding from water supply, surface and foul or combined sewer systems and commenting on planning applications in regards to the capacity of the sewers to accept discharge from new developments.

The majority of surface water and overland flows in the city discharges to the sewer system so therefore a joined up approach to managing flood risk from these sources is required. In this instance Yorkshire Water were not required to be involved. Their nearby sewers were not at capacity and were capable of accommodating the water sucked up by the pumps deployed on Bexhill Ave.

5.4 Residents

Residents are encouraged to understand the flood risk in their local area and have a flood plan to help target what actions they could do themselves to help in a flood situation. Communities are also encouraged to have plans to enable help for the more vulnerable people in the area. Actions such as placement of sandbags, moving valuable items to a safe place and semi / permanent measures such as installation of floodgates, airbrick covers etc. are encouraged to reduce the consequences of flooding at a property level.

It is recommended that residents sign up to appropriate warnings for their area and keep contact details up to-date and act upon all warnings appropriately. When flooding does occur residents are encouraged to document as much information as possible to aid the investigations of all operating authorities and to provide information to their loss adjusters and insurers.

6. Recommendations

Action	Reason	Agency
Bexhill Avenue		
A topographical survey of the Old Fleet Drain banks is completed and shared with partners.	To check for low points in the banks	Environment Agency
Details are provided of the maintenance programme and process on the drain so this can be discussed and if required improved.	To assess whether more maintenance or different measures are required to reduce the risk of flooding	Environment Agency
Complete feasibility on a longer term solution to reduce the flood risk to Bexhill Avenue. This may include raising the banks on the west side of the Old Fleet Drain, Natural Flood Management in the catchment or retrofitting more homes in the area with property flood resilience (PFR).	To provide detailed information to enable a scheme to reduce flooding to be considered.	Environment Agency and Hull City Council
Ensure there is a line on the national flood investment programme for a scheme as mentioned above.	This highlights the fact a scheme is required and potentially allocated Flood Defence Grant in Aid, however it should be noted that the benefit cost ratio for any scheme is likely to be low as there are few properties benefitting, particularly as 2 already have PFR so it's unlikely to receive any government funding.	Environment Agency
A survey carried out to establish if Lords Clough could be operated more efficiently to allow for greater flows to discharge.	To enable maximum discharge of flows in the Old Fleet Drain when tidal levels allow to prevent backing up.	Environment Agency
Clear silt from the outer gates at Lords Clough	To enable maximum discharge of flows in the Old Fleet Drain when tidal levels	Environment Agency

	allow to prevent backing up.	
Investigate the drainage under the green space which may have been left following demolition of the maisonettes.	To provide additional capacity and improve connection to the main sewers.	Hull City Council Flood team and Housing team
Work with the Internal Drainage Boards to establish if there are any land management practices which can be utilised in the catchment to reduce fluvial flows.	To reduce the amount of flow coming down Old Fleet drain.	Hull City Council, Environment Agency and the IDB's.
Install CCTV at the pointing doors at Lord's Clough	Due to the remote location, observation would become possible at all times / tides	Environment Agency
Install telemetry	To ensure some degree of control over the alarms on Old Fleet Drain.	Environment Agency
Cumbrian Way		
Complete a CCTV survey of the North Bransholme Trunk Sewer and share results with partners.	To ensure there are no blockages in the sewer system and to reduce the risk of flooding.	Yorkshire Water
Norland Avenue		
Continue to work on the hydraulic modelling to establish a local scheme to reduce flood risk to the area.	To understand the complex hydrology in the area which will enable a scheme to be proposed.	Hull City Council, Yorkshire Water and East Riding of Yorkshire Council
Arrange a flood bus in the Norland Avenue area	To talk to residents about the modelling work and to work with the local community on the solution.	Hull City Council, Yorkshire Water and East Riding of Yorkshire Council
Holderness Drain		
Establish a process for a multi-agency response to resource pumping at East Hull Pumping Station in the interim before the new station is completed.	To enable the drain to be pumped as and when required.	Living with Water Board (Yorkshire Water, Hull City Council, East Riding of Yorkshire Council)

7. Conclusion

The investigation has concluded that the high levels of rainfall experienced in September led to the catchment of the majority of watercourses in the Hull and East Riding area to be saturated. This meant that when the rainfall totals increased in October and November it led to watercourses overflowing and drainage systems to be overwhelmed.

The high volumes of water flowing down Old Fleet Drain also combined with high tides on the 27th, 28th, 29th and 30th October meant levels in the drain were kept high for a number of days as they were unable to effectively discharge.

The flows which would normally be contained within the banks overflowed and flowed through gardens to flood properties at Bexhill Avenue.

There is no evidence of any deliberate acts in the catchment to increase the amount of water discharging into the Old Fleet Drain and the flood infrastructure at the mouth of the drain was operated as intended.

The investigation has concluded that there is a low spot in the bank at Bexhill which may have been compounded by other landscaping in the area, the results of which are that flows of water from the drain has a route to the properties. None of this has been done intentionally and is more likely to be a result of previous development activities in the area.

The impacts of climate change will mean that this situation will get worse. Rising sea levels will mean that water is unable to discharge into the Humber and we will see more intense and frequent rainfall which could exacerbate the situation. Therefore it is important to ensure that the recommendations contained in this report are actioned and that the Risk Management Authorities and the communities work on the managing the risk together.

Abbreviations / Acronyms

EA Environment Agency

HCC Hull City Council

FIR Flood Investigation Report

FWMA Flood and Water Management Act 2010

LDA Land Drainage Act 1991

LLFA Lead Local Flood Authority

WRA Water Resources Act 1991

Useful Links and Contacts

Useful Contacts and Links

Environment Agency

General Enquiries 08708 506 506 (Mon-Fri, 8am - 6pm)
Incident Hotline 0800 80 70 60 (24hrs)

Lead Local Flood Authority

Hull City Council

General Enquiries (emergency calls handled via this number) 01482 300 300

Water and Sewage Operator

Yorkshire Water 0845 1 24 24 24

Flood and Water Management Act 2010:

<http://www.legislation.gov.uk/ukpga/2010/29/contents>

Highways Act 1980:

<http://www.legislation.gov.uk/ukpga/1980/66/contents>

Water Resources Act 1991:

<http://www.legislation.gov.uk/ukpga/1991/57/contents>

Land Drainage Act 1991:

<http://www.legislation.gov.uk/ukpga/1991/59/contents>

EA - 'Living on the Edge' a guide to the rights and responsibilities of river side occupation:

<http://www.environment-agency.gov.uk/homeandleisure/floods/31626.aspx>

EA - Prepare your Property for Flooding:

How to reduce flood damage

Flood protection products and services

<http://www.environment-agency.gov.uk/homeandleisure/floods/31644.aspx>
