Kent County Council

Flood Investigation Report

Location of Investigation: Deal

Date of incident: 28 August 2020

This document has been prepared by Kent County Council Flood and Water Management Team as the Lead Local Flood Authority under Section 19 of the Flood and Water Management Act 2010, with the assistance of:

- Kent County Council (KCC)
- Environment Agency
- Southern Water
- Kent Fire and Rescue Service (KFRS)
- River Stour Internal Drainage Board
- Dover District Council

The findings in this report are based on the information available to KCC at the time of preparing the report. KCC expressly disclaim responsibility for any error in or omission from this report. KCC does not accept any liability for the use of this report or its contents by any third party.

This report can be found here where more information can be found about the requirements and trigger for a Section 19 investigation and the roles and responsibilities of Risk Management Authorities.

For further information or to provide comments, please contact us at flood@kent.gov.uk

Summary of event

During the afternoon of 28th August 2020 intense rainfall and thunderstorms caused flooding to Deal and the surrounding areas. The nearest rain gauge is located in Deal which recorded approximately 19 mm of rainfall in 60 minutes. Additional rainfall analysis indicates the rain gauge is likely to have not recorded the peak rainfall, this is discussed further in the report. The average monthly rainfall for August in Kent is approximately 60 mm[1]. Consequently, highway drains, drainage ditches and the local sewer network were unable to cope with the intense and high volume of rainfall.

From the information received to inform the report, approximately twelve properties throughout Deal are reported to have been internally flooded by a combination of sewage and surface water runoff. A further 26 properties reported external flooding. The approximate locations of the reported flood incidents are shown in Annex 1 at the end of the report (please note: only the roads where the properties are located have been mapped, and not the individual properties). Southern Water have not provided information regarding the location of flooding reported to them, so these are not included in Annex 1.

[1] Source: https://www.southernwater.co.uk/water-for-life/regional-rainfall

KCC undertook a survey of affected residents in November 2020 collating information about the events of the flood to inform this Section 19 investigation. Table 1 provides a summary of the investigated flooding issues and known flood extents, including the information collated from the flood survey. 164 surveys were sent out to the residents, only 21 responses were collated by KCC. As a result, the information detailed in Table 1 is likely to not include all of the properties that were impacted by the flood event. Appendix A provides a breakdown of the number of flood surveys that were sent to each road within Deal.

Flood incident data from Southern Water has also been obtained due to the reports of sewerage flooding. Nine properties were reported to have internally flooded, although Southern Water have not provided information regarding the location of the properties. These properties are not included in Table 1 or Annex 1.

Table 1 Summary of the investigated flooding issues

Location	Details of reported flooding	Source of Report
Albert Road	4 properties flooded internally, with reports of up to 3 cm of floodwater within properties. 21 properties reported external flooding to gardens and garages to a depth of up to 50 cm.	KCC / Flood survey / KFRS
Golf Road	1 property externally flooded up to a depth of approximately 7 cm.	KCC / Flood survey
Allenby Avenue	Road flooded to a depth of approximately 10 cm.	KCC / Flood survey
High Street	2 commercial properties flooded internally with reports of up to ankle deep floodwater within the property.	KCC / Flood survey
Canute Road	1 property flooded externally, with reports of 12 cm of floodwater outside of the front door.	KCC / Flood survey
Milldale Close	1 property flooded internally.	KCC / KFRS
Gilford Road	Road flooding occurred. A number of cars had to be pulled from the floodwater.	KCC / KFRS
Anchor Lane	1 property externally flooded.	KFRS
Northwall Road	Road flooding report to a depth of 30 cm.	KCC
North Barrack Road	1 property internally flooded, with multiple properties externally flooded.	KCC
James Hall Gardens	1 property reported external flooding.	KCC
Southwall Road	Road and pavement flooded.	KCC
Church Lane	Road flooding to a depth of 50 – 60 cm occurred.	KCC
Manor Road	2 properties reported internal flooding and another property externally flooded.	KCC
Park Avenue	1 property reported internal flooding.	KCC
Ranelagh Road	1 property reported internal flooding.	KCC / Flood survey
Middle Deal Road	1 property reported nearly flooding internally. Road flooded from Southwall Road to the junction with Albert Road.	Local residents

Rainfall	
Rain Gauge	Deal (Station number: 304663)
Rainfall	19.17mm (1 hour: 13:45 – 14:45)
Annual Exceedance Probability	20%
	1 in 5-year return period
Environment Agency Rainfall Radar	
Average Rainfall from Environment Agency Rainfall Observation	48.77mm (1.25 hour: 13:30 – 14:45)
Annual Exceedance Probability	0.7%
	1 in 138-year return period

Rain Gauge Analysis

Reports received regarding the August flood event indicate that the flooding started at approximately 15:00. The rainfall gauge at Deal recorded 19.17mm of rainfall between 13:30 and 14:45 with a total of 21 mm rainfall recorded at the gauge on the 28th August.

Rainfall around the county is recorded by a series of rain gauges operated by the Environment Agency. These report the rainfall depth recorded over either a 15-minute interval or a day. To assess the rarity of the rainfall that fell the Flood Estimation Handbook[2] (FEH) web service Event Rarity Calculator assesses the Annual Exceedance Probability (AEP), which is the likelihood of rainfall of this depth or more falling in a year in that location. For instance, a rainfall event with an AEP of 1% means that rainfall of this depth or greater would only have a 1% chance of occurring in any one year in that location. This is also known as a '1 in 100 year' event.

Annex 2 at the end of the report shows the location of the Deal rain gauge. The rain gauge is located to the southwest of the town. The Event Rarity Calculator assessed the recorded rainfall as a 1 in 5-year event.

Environment Agency Radar Analysis

Figure 1 shows the rainfall radar provided by the Environment Agency showing a 5-hour accumulation of rainfall on 28th August from 12:00. The rainfall radar clearly shows a band of intense rainfall (white colours on the radar map) across the approximate area of Deal. The white colour equates to greater than 64 mm. This suggests that the rainfall gauge located at Deal did not accurately record the intense rainfall during the August flood event, and that the AEP for the rainfall event is greater than that derived from the rain gauge data.

Rainfall analysis using the Event Rarity Calculator based on the rainfall radar image in Figure 1 below using 64 mm of rainfall over a period of 5 hours indicated a 1.4% annual exceedance probability equating to a 1 in 70-year return period.

[2] FEH is the standard tool in the UK to estimate rainfall return periods. It is used by the Environment Agency and all professional hydrologists to estimate rainfall and rainfall return periods.

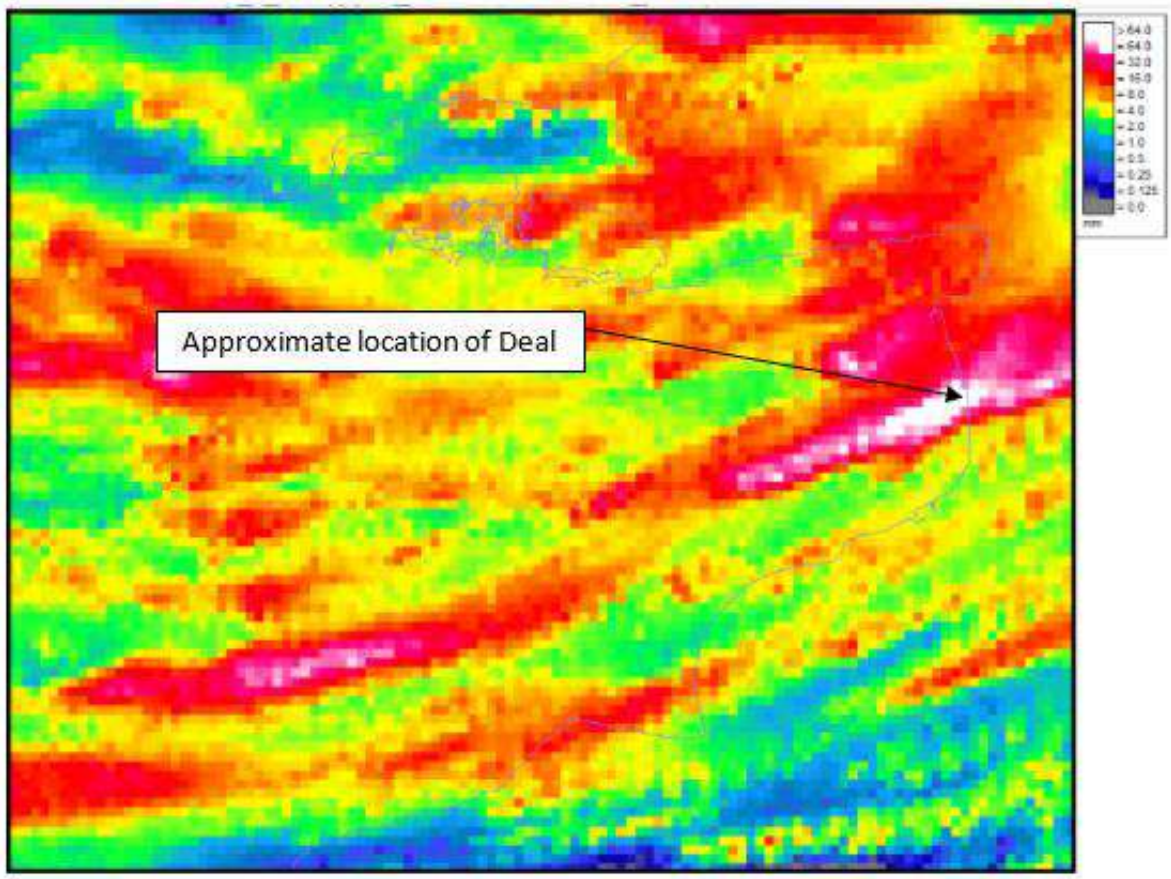


Figure 1 Rainfall radar during the August flood event

Due to the large discrepancy between the Deal rain gauge and the rainfall radar, further investigation into the radar rainfall was undertaken to support the S19 Investigation and is provided in Appendix B at the end of the report. Rainfall observation data was extracted from the radar data by the Environment Agency for Deal. The additional analysis undertaken indicates that there was localised high intensity rainfall that the rain gauge may not have recorded. Therefore, the annual exceedance probability for the rainfall is greater than the 1 in 5-year event as previously described. The additional analysis undertaken indicates that the average rainfall across the urban area of Deal was approximately 48mm which equates to an approximate 0.7% annual exceedance probability equating to in the region of a 1 in 140-year return period.

The two sets of rainfall data have produced very different annual exceedance probabilities. Neither annual exceedance probability is likely to be correct, however it is considered to be closer to the 1 in 140-year return period.

Site Location, Topography and Flood Risk

Deal is located along the coastline where the North Sea and the English Channel meet and is located approximately 13 km to the northeast of Dover.

A review of the Cranfield University Soilscapes database indicates that the majority of the underlying soils in Deal are freely draining loamy soils. The underlying soils to the northern part of the town are loamy and clayey soils with naturally high groundwater. This means that rainfall in this area is unlikely to significantly infiltrate into the ground and will runoff over land, especially in heavy rainfall events.

Annex 3 at the end of the report shows an extract from the Environment Agency's Flood Map for Planning (Rivers and Sea). The map indicates that the majority of Deal is located within the low-risk Flood Zone 1.

The northern region of Deal is located within the medium-risk Flood Zone 2 and high-risk Flood Zone 3[3]. These areas are indicated to be protected by flood defences.

Annex 4 at the end of the report shows an extract from the Environment Agency's Flood Risk from Surface Water map. Flooding from surface water is typically associated with natural overland flow paths and local depressions in topography where surface water runoff can accumulate during or following heavy rainfall events. The Environment Agency's map indicates that the areas at a high risk of flooding from surface water[4] sources include areas that experienced flooding during the August flood event and as a result provides a good estimate of areas that are prone to flooding.

Flood History

There are a number of historic flood events that have occurred in Deal prior to the event on the 28th August 2020. A Section 19 report was previously undertaken in response to a flood event in May 2014 along Albert Road.

Data for more recent events from the KCC's flood incident database, Surface Water Management Plans and the Environment Agency have been collated into Table 2.

Table 2 Summary of the historic flood records

Location	Date of flooding	Details of flooding
Albert Road	1973	Multiple properties internally flooded.
Golf Road	1978	Multiple properties internally flooded when sea defences were breached.
Albert Road	1979	Multiple properties internally flooded.
Albert Road	1988	Multiple properties internally flooded.
Albert Road	9th September 1989	No details provided.
Albert Road	13th September 1989	No details provided.
Farrier Street	2004	1 basement flooded.
Herschell Square	2004	Cellar flooding recorded.
Downs Road	2004	Property flooding recorded.
Manor Road	2004	Southern Water recorded flooding.
Albert Road	2005	Multiple properties internally flooded.
Albert Road	2006	Multiple properties internally flooded.
Church Street	2006	Basement and cellar flooding recorded. Possible source of flooding was high groundwater levels.
King Street	2006	No details provided.

[3] Flood Zone 2 is defined as having between 1 in 100 year (1%) and 1 in 1000 year (0.1%) chance of flooding from fluvial sources.
Flood Zone 3 is defined as having a greater than 1 in 100 year (1%) chance of flooding from fluvial sources.
[4] High risk of flooding from surface water is defined as having a greater than 1 in 30 (3.3%) chance of flooding.
Medium risk of flooding from surface water is defined as having between 1 in 100 (1%) and 1 in 30 (3.3%) chance of flooding.
Low risk of flooding from surface water is defined as having between 1 in 1000 (0.1%) and 1 in 100 (1%) chance of flooding.

Location	Date of flooding	Details of flooding
Church Street	2007	Basement and cellar flooding recorded. Possible source of flooding was high groundwater levels.
Albert Road	2007	Multiple properties internally flooded.
Albert Road	2008	Multiple properties internally flooded.
Albert Road	2009	Multiple properties internally flooded.
Albert Road	2010	Multiple properties internally flooded.
Church Street	2010	Basement and Cellar flooding recorded following heavy rainfall.
Southwall Road / Church Lane	August 2010	Road flooding.
Walmer	August 2010	Road flooding.
High Street	2010	No details provided.
Archery Square	2010	Road flooding.
Herschell Square	2010	Road flooding.
St. Leonard's Road	2010	1 property recorded flooding.
Allenby Avenue	2010	Road flooding.
Albert Road	2013	Multiple properties internally flooded.
Albert Road	21/05/2014	22 properties internally flooded.
Albert Road	September 2015	Pumping station failure.
Albert Road	2016	Multiple properties internally flooded.
Albert Road	2020	Multiple properties internally flooded.

Table 3 below provides an overview of when Southern Water have deployed their emergency measures for Albert Road and the local area. The emergency measures comprise the monitoring of local rainfall forecasts with set trigger levels identified, above which various proactive measures are undertaken. These measures include increased operational attendance at the Golf Road pumping station, having a tanker on standby ready to enforce a road closure, overpumping of the sewers to a ditch and warning local residents to deploy property flood measures.

Table 3 Summary of Southern Water emergency measures deployment

Date	Observed level of rain
23/09/2020	Average
29/09/2020 to 04/10/20	Continual rain but not exceptional - tankers emptying sewers were working to capacity.
20/10/2020	Heavy rainfall but not exceptional
14/11/2020	Heavy rainfall but not exceptional
03/12/2020	Heavy rainfall but not exceptional – tankers deployed.

Date	Observed level of rain
26/12/2020	Heavy rain
13/01/2021	Moderate but continual rain
16/06/2021 to 22/06/2021	Heavy rainfall but not exceptional – tankers were on standby, advised by Southern Water to deploy property flood measures.
12/07/2021	False alarm from Southern Water
21/08/2021	Emergency measures deployed.
09/09/2021	Emergency measures deployed.
14/09/2021	Emergency measures deployed.

Drainage

The surface water drainage system within Deal consists of a mixture of public surface water, combined and foul sewers which are owned and maintained by Southern Water. Highway drainage, owned and maintained by KCC as the Highway Authority, generally consists of gullies connected to the public surface water and combined sewers. Annex 5 at the end of the report shows a map with the location of the sewers sized 200 mm and greater. The map shows that the majority of the local sewers are designated as either foul or surface water sewers. Generally, the foul sewers in Deal are in fact combined sewers that have a strong rainfall response and convey both foul and surface water. They are incorrectly designated as foul sewers, though some of these are likely to be foul sewers.

The foul and combined sewers in Deal are collected at a pumping station at Golf Road and pumped to the wastewater treatment works at Weatherlees, to the north of Sandwich. If the pumping station becomes overwhelmed during storm conditions, untreated, screened effluent is pumped out to sea on a long-sea outfall.

The foul/combined sewer network in Deal is complex, with a number of sub-catchment and linkages between these sub-catchments. In general, the foul and combined sewers in the area to the south of the town, comprising Upper Walmer, Walmer, Mill Hill, Sholden, Upper Deal, and Middle Deal, are collected in one sub-catchment, which also includes flows from Kingsdown and St Margaret's at Cliffe. The foul and combined sewage in Lower Walmer and Lower Deal town form another sub-catchment.

There are several connections from the upper sub-catchment to the lower sub-catchment. Connections are at the railway crossing between Park Avenue and Gilford Road, between Mill Road and Blenheim Road and at the railway crossing between Albert Road and Western Road. It is not clear from the sewer network map which way these connections operate or if they operate in both ways, but it appears that the upper catchment largely flows through the sewer at Albert Road.

The sewers also appear to contain a number of storage tanks, particularly at Victoria Park, to store water when the capacity of the sewers is exceeded.

In Albert Road a foul/combined sewer flows from the south under Albert Road from the junction of Middle Deal Road, to connect the southern sewer catchment to the north catchment and the Golf Road pumping Station. This sewer is 825mm at the southern end of Albert Road. This sewer splits in two along Albert Road and one of these is joined by another sewer from Bridgeside. The two foul sewers continue under the railway line to Golf Road, they are 1200 mm and 450 mm in diameter. Downstream of Albert Road, in Western Road, there is a large foul sewer, 1,800 mm, connected to the 1,200 mm combined sewer that

flows from Albert Road. This sewer flows to the northwest, then northeast under Northwall Road and West Lea, across the marshes and into the Golf Road Pumping station. This sewer appears to provide sewer relief.

The surface water sewers in Deal collect surface water and discharge it to the sea via sea outfalls. Surface water sewers are more common in the southern part of the town, in Walmer, Mill Hill, Upper Deal and Middle Deal. There are sea outfalls near Granville Road, Canada Road, and North Barrack Road. There are also surface water sewers serving some of the newer developments, which discharge into the marshes to the west of Deal.

There is a separate surface water sewer in Albert Road that collects the surface water runoff via the gullies in Albert Road and discharges to the ditch at the back of Matthews Close. The surface water sewer is 450 mm in diameter, which is large for such a relatively small catchment area. It may be that this sewer is oversized to act as a form of sewer overflow as Albert Road is prone to combined sewer overflows.

Albert Road has had a long history with flooding, with 15 instances in 38 years known to KCC at the time of writing, this includes ten flood events in the last 14 years. These floods are all associated with the combined sewer overflowing. Some of these floods are associated with mechanical or operational issues, rather than with surcharging due to extreme rainfall, nevertheless Albert Road appears to be highly vulnerable to sewer flooding. It is the lowest point on the sewer from the southern sub-catchment in Deal to Golf Road, which makes it susceptible to flooding should there be any reason the sewer downstream cannot convey the flow.

Following the flooding in 2016, Southern Water invested in upgrades at the Golf Road pumping station. Albert Road has flooded since this investment. They have also installed sensors in the sewer at Albert Road and agreed to an emergency response to flood forecasts that involves having tankers on standby to pump the sewer at Albert Road, closing the road, to prevent traffic from increasing the risk of internal flooding, and warning residents so they can deploy flood barriers.

The residents of Albert Road have raised their high frequency of flooding with various parties including Southern Water the sewerage undertaker, and Ofwat, their regulator. Ofwat have undertaken a preliminary assessment of the flooding in Albert Road in 2016 and concluded, based on evidence provided by Southern Water, that the sewer is designed to cope with a 1 in 50-year return period rainfall event and that they did not need to open a complaint against Southern Water (see Appendix C). The standard of service referred to in this correspondence is only referring to the hydraulic capacity of the sewer and does not include the risks from mechanical or operational failures that lead to flooding.

Flooding Description and Mechanism

The flood incident that occurred on 28th August 2020 was the result of intense rainfall during the afternoon which led to the drainage systems within Deal becoming overwhelmed and to surcharge.

Properties located along Albert Road reported that flooding started at approximately 15:00, with the manholes along the sewer network surcharging causing sewage and surface water to pond and accumulate. Figure 2 below shows a manhole along Albert Road. This led to the road flooding from the junction of Middle Deal Road to the railway. Although only 4 properties have reported internally flooding due to the number of historic flood events along Albert Road it is likely that this number is in fact higher. Only 11 flood survey responses were received from properties along Albert Road. Six properties reported external flooding during the flood event and noted that either sandbags or flood boards prevented internal flooding.

Southern Water did not initiate their emergency response and Albert Road was not initially closed to traffic, which lead to a number of vehicles driving through the floodwater creating bow waves. Reports from residents along Albert Road note that the bow waves were very close to causing internal flooding to their properties. KCC highways and the police attended the event and put a road closure in place at approximately 16:45 as a result of the flooding along Albert Road. KCC highways also provided a tanker to clear the flood water.

Figure 2 Photograph of manhole surcharging along Albert Road. Credit: Peter Wyatt

High Street, at the junction with South Street Deal, flooded as a result of the sewerage system surcharging as unable to deal with the volume of rainfall. The pedestrian area and a number of shops and businesses were affected by the flooding. KCC Highways received reports of a collapsed drain cover and surface water was reported to be flowing towards Alfred Square.

Church Lane at the junction with Southwall Road was severely flooded, as a result of the local sewerage system surcharging and not able to deal with the heavy rainfall. The police reported flooding along Church Lane to a depth of approximately 50-60cm.

Road flooding occurred along Allenby Avenue as a result of the local sewerage system surcharging. KCC highways closed the road to prevent bow waves causing internal and external flooding to properties.

KCC Highways attended to flooding along Park Avenue to clear flood water, under the railway bridge, where one property internally flooded. The flooding was a result of the local sewerage system surcharging during heavy rainfall.

Local sewerage systems also surcharged due to the intense rainfall causing the following localised issues:

- One property internally flooded along Manor Road due to the local sewerage system surcharging during the heavy rainfall. Road flooding occurred between St Leonards Road and Bruce Close.

- Highway flooding along Golf Road between Athelstan Place and Godwyn Road was reported to KCC Highways.
- North Barrack Road one property is reported to have internally flooded, with multiple properties externally flooded as well.
- One property reported internally flooding along James Hall Gardens.
- Road flooding occurred along Western Road at the junction with Northwall Road.

Reports of sewer covers becoming displaced as a result of the heavy rainfall along London Road near to the junction of Haywards Close and along Mill Hill between Beuchamp Avenue and Davis Avenue. KCC Highways reported that the road surface along Mill Hill had broken up due to the surcharge pressure from the local sewerage system.

Severe and prolonged flooding of the carriageway along Canute Road was reported to KCC Highways. The flooding was as a result of the soakaways located in the road verge. KCC highways also provided a tanker to clear the flood water. One property is reported to have flooded externally.

KFRS attended the flood event along Anchor Lane, Milldale Close, Gilford Road and Albert Road. KFRS unblocked foul water drains along Albert Road and reduced water levels. KFRS also cleared up debris to prevent further blockage.

Southern Water did not attend during the flood event or implement their emergency plan for the local area. All residents who reported sewerage flooding to Southern Water during the flood event have had correspondence since. There were no blockages found within the Southern Water system and the pumping station downstream of Albert Road continued to pump throughout the event.

Flood Response

Since the August flood event flood incident, a number of actions have already been undertaken by risk management authorities and other organisations.

KCC Highways have performed routine gulley cleansing along the affected roads and have identified a number of blockages and defects. Since the flood event several issues with the highway drainage have been raised within Deal. Table 4 summaries the different remedial works that the KCC Highways department have undertaken since the 28th August 2020 in relation to the flood event. The works include gully cleansing and the removal of blockages identified as well as work to highway ditches. The highways team will continue to undertake remedial works within the highway drainage system to ensure it is able to operate effectively.

Table 4 Summary of KCC Highways remedial works

Location	Details
Albert Road	Following the flood event 10 road gullies were cleansed.
Southwall Road	Inspection after the flood event found 4 road gullies to be blocked.
Allenby Road	9 road gullies cleansed following the flood event. Small section of the road was repaired after the flood event in order to reduce surface water ponding.
James Hall Gardens	Road gullies were jetted in response to the flood event.

Southern Water have also confirmed that they are currently undertaking survey work along the local network as a result of the August flood event. The results of the survey were not available to inform the Section 19 Report. Southern Water have re-instated their emergency response measures for Albert Road.

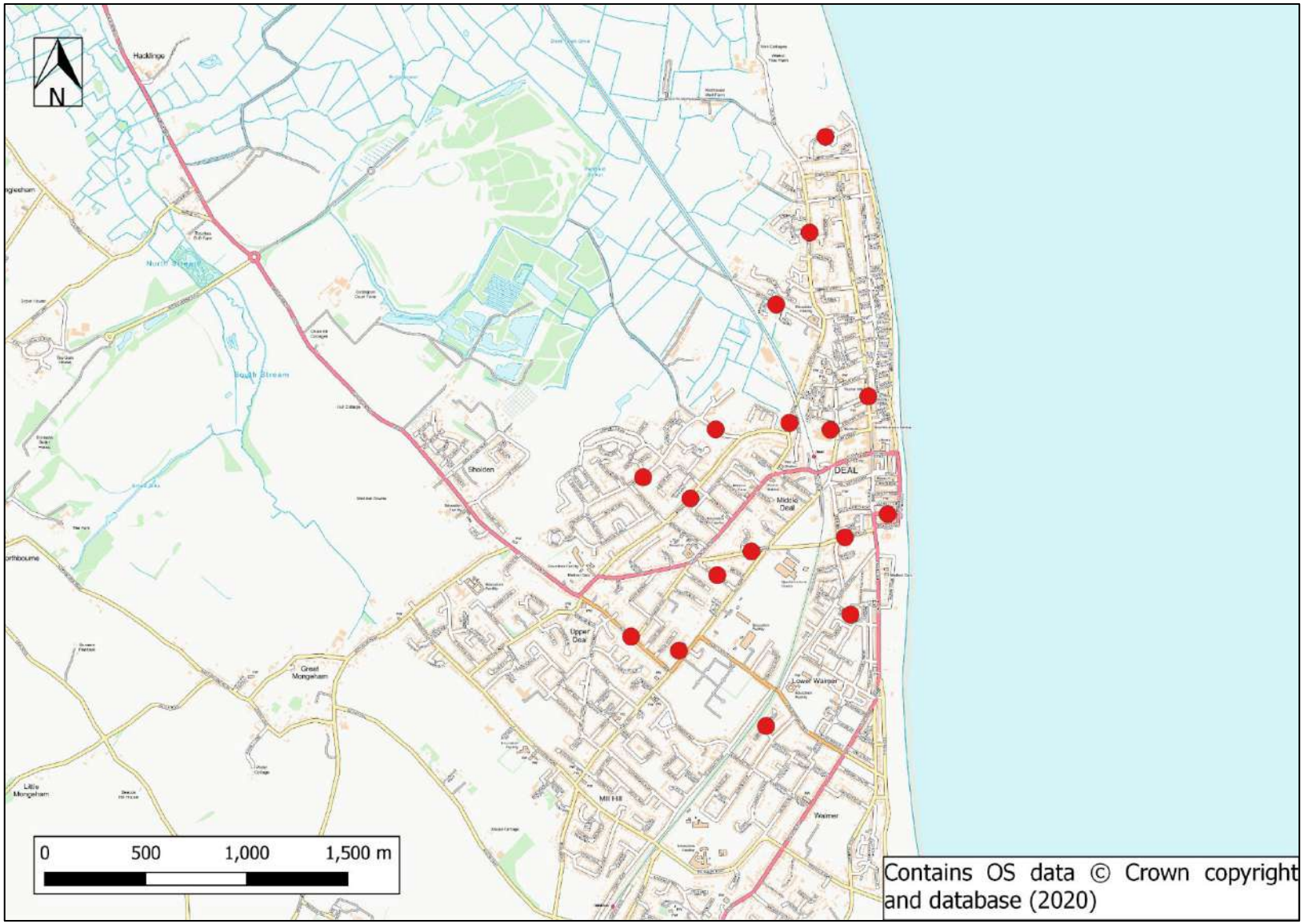
Conclusion and Further Work

On the 28th August 2020 intense rainfall and thunderstorms overwhelmed the drainage infrastructure in Deal causing flooding to multiple properties and disruption to many local roads. The intense rainfall fell over a short duration, as highlighted by the narrow-localised band of rainfall on the rainfall radar image and rainfall analysis. The rainfall gauge is unlikely to have accurately recorded the peak of the event and therefore it is likely that approximately 48 mm of rainfall occurred during the August flood event at Deal.

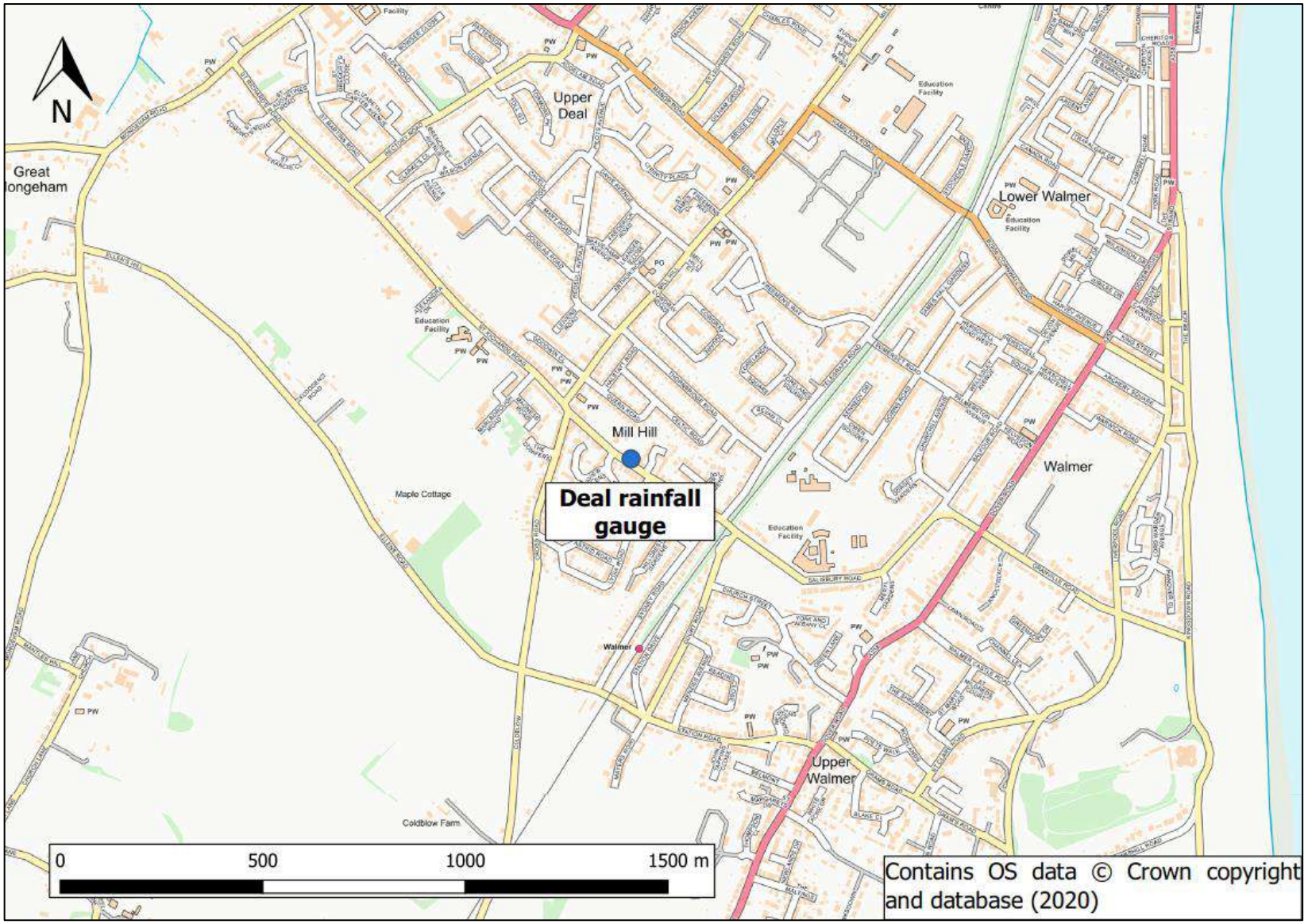
Whilst the rainfall may have been an extreme event, Deal is vulnerable to combined sewer flooding and there have been a number of incidents historically. Deal should be considered for review under the Drainage and Wastewater Management Plan with a view to making the sewer network more resilient to internal and external flooding, performance in a 1 in 50-year event, combined sewer overflows (CSOs), pollution and surface water management.

Albert Road appears to be particularly vulnerable to flooding from the combined sewer irrespective of the cause of the flooding, whether due to extreme rainfall or operational issues. We would recommend that Southern Water prioritise Deal and Albert Road in their Drainage and Wastewater Management Plans and investigate opportunities to minimise the risk of flooding at Albert Road. Options to consider could include:

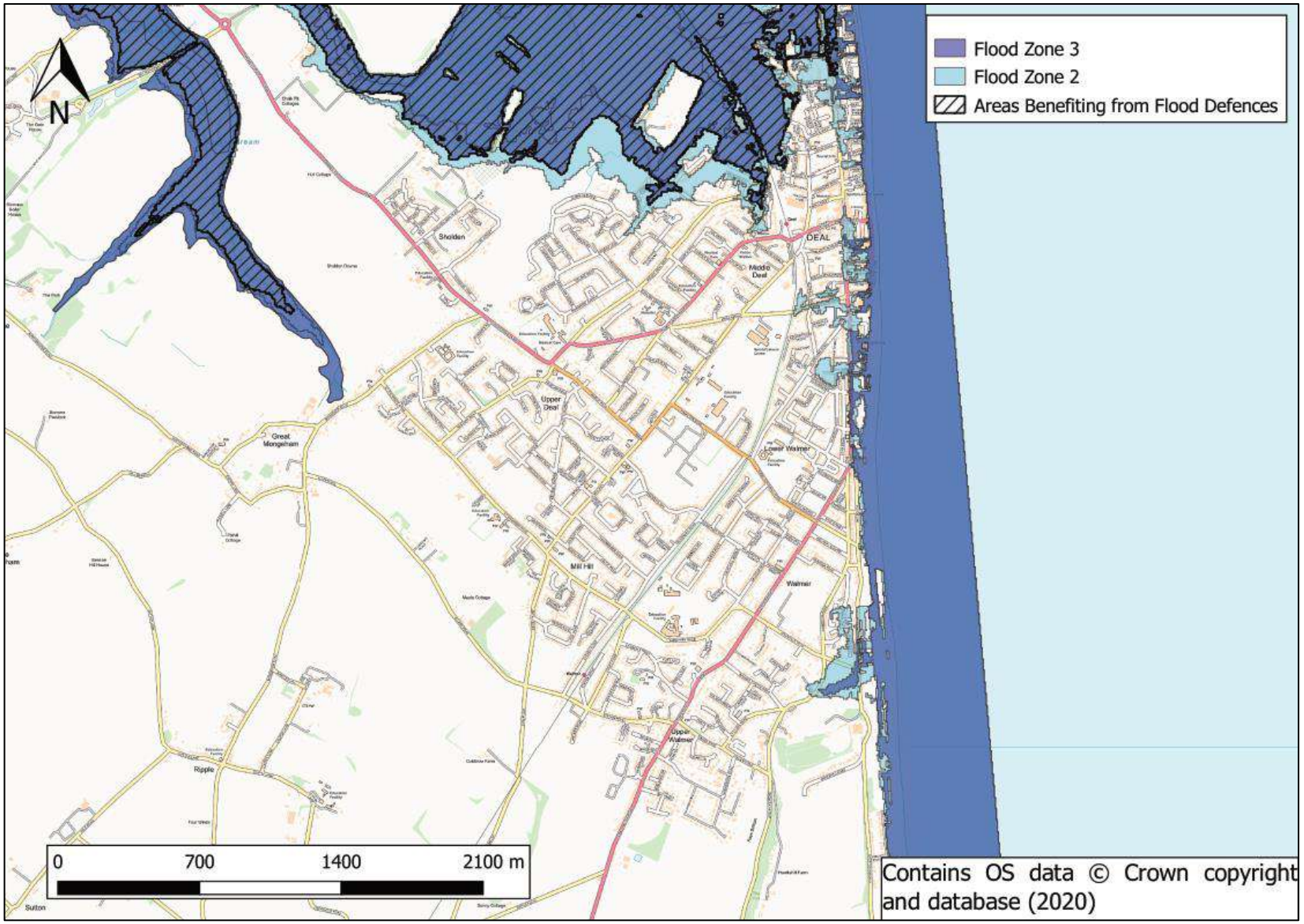
- A relief sewer for Albert Road, similar to the one that the sewer downstream of the railway line at Albert Road appears to benefit from, would potentially be of benefit (although it is noted that the railway line could be a design constraint) or an alternative route for some sewage upstream of Albert Road to Golf Road.
- Formalising a combined sewer overflow (CSO) at Albert Road (It is noted that CSOs are rightly in the news and that adding a new one may be unwelcome at this time, however, the surface water sewer currently acts as a CSO whenever Albert Road floods, so there is unlikely to be any additional pollution as a result but properties might be protected from flooding).
- Providing storage for storm flows on the sewer network at or prior to Albert Road.
- Southern Water should review their network of sensors in the sewers at Albert Road that provide warnings of sewer surcharges and investigate whether they are operating correctly and the triggers are appropriate.



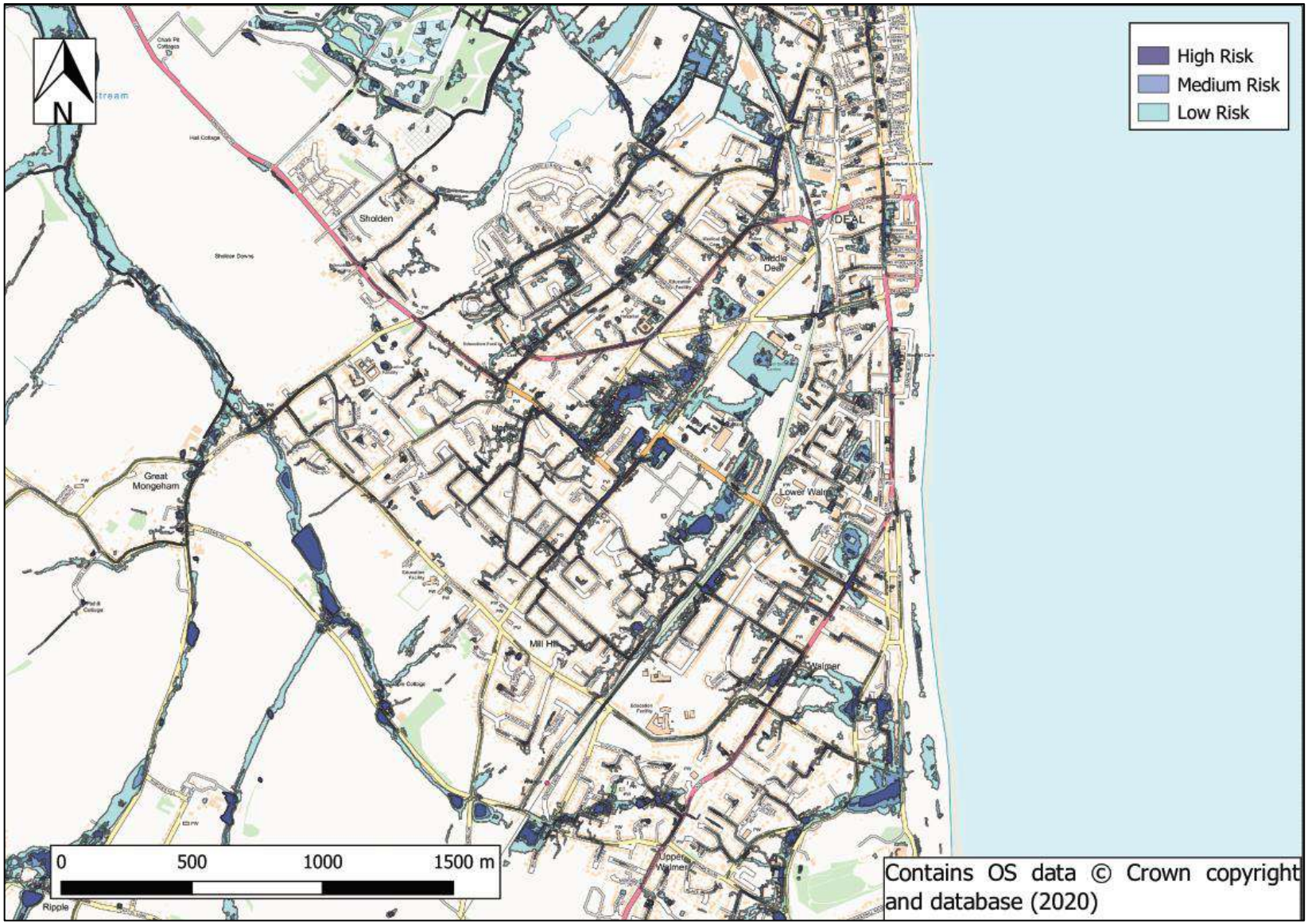
Annex 1 Location of reported flood incidents in Deal



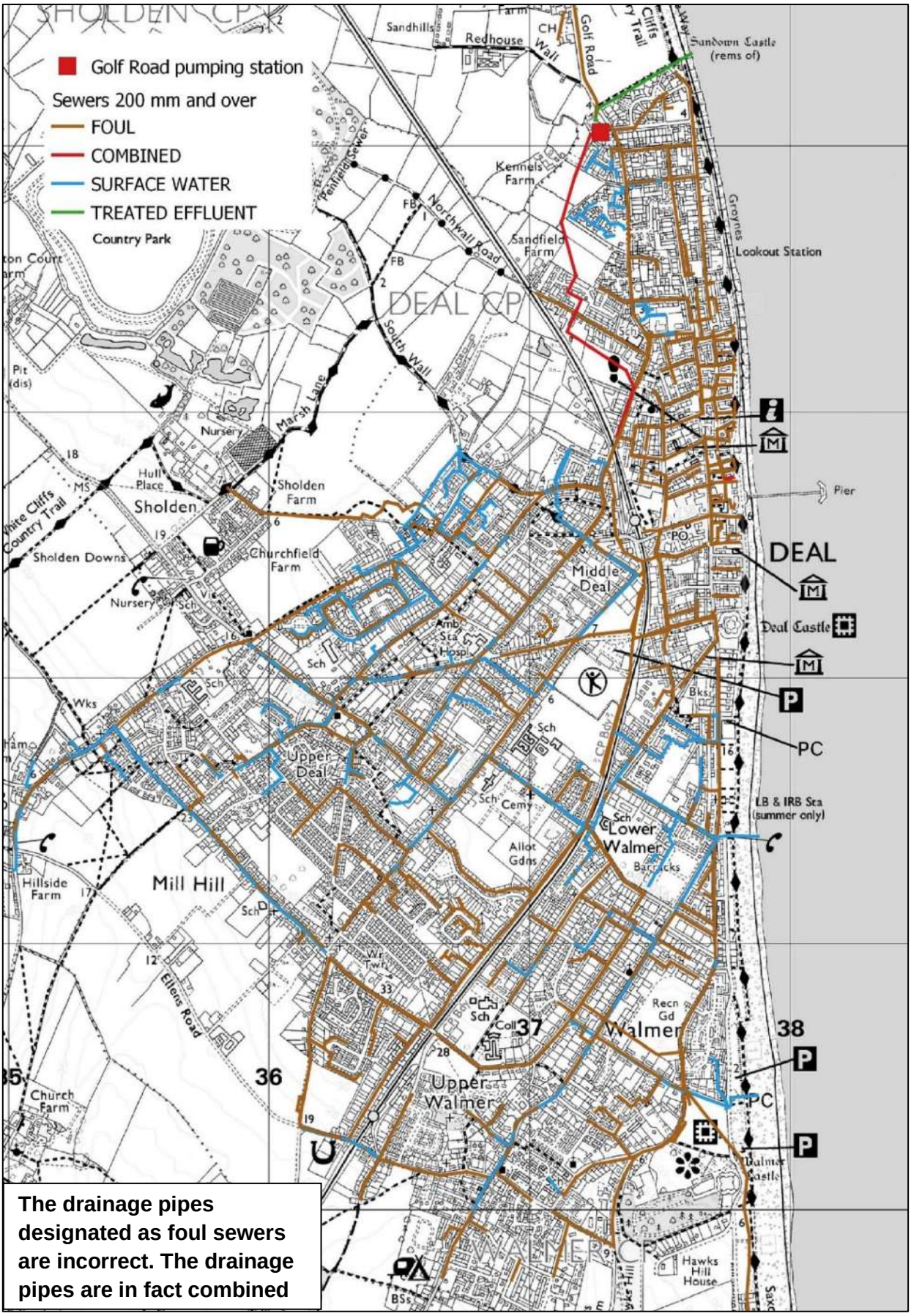
Annex 2 Location of Deal rain gauge



Annex 3 Extract from the Environment Agency's Flood Map for Planning



Annex 4 Extract from the Environment Agency's Flood Risk from Surface Water map



The drainage pipes designated as foul sewers are incorrect. The drainage pipes are in fact combined

Annex 5 Location of Southern Water sewers (200mm and greater).

Appendix A: Flood Surveys

Table 1 below provides a breakdown of all of the roads that flood surveys were sent to and compares the number of flood surveys per road with the number of responses received.

Table 1 Summary of flood surveys

Location	No. of flood surveys sent	No. of flood surveys received
Albert Road	62	12
Bridgeside	2	-
Canute Road	10	1
Southwall Road	4	-
North Barrack Road	1	-
James Hall Gardens	16	-
Milldale Close	1	-
Golf Road	27	1
Allenby Avenue	10	1
High Street	4	2
Manor Road	8	2
Ranelagh Road	1	1
Victoria Road	5	-
West Street	1	-
Middle Deal Road	33	-
Grange Road	3	1

Appendix B: Additional rainfall analysis

OFWAT have formally adopted the Flood Estimation Handbook (FEH13) as the standard method for assessing the severity of rainfall events[5].

Rainfall observation data was provided by the Environment Agency for an approximate 20km² area covering Deal. The data comprised 28 individual points relating to an area equal to approximately 1km². The average total rainfall for each of the 28 points is shown in Figure 1 below. The graph clearly shows a peak in the rainfall occurring between 13:30 and 14:45 which corresponds to the peak in rainfall obtained from Deal rain gauge.

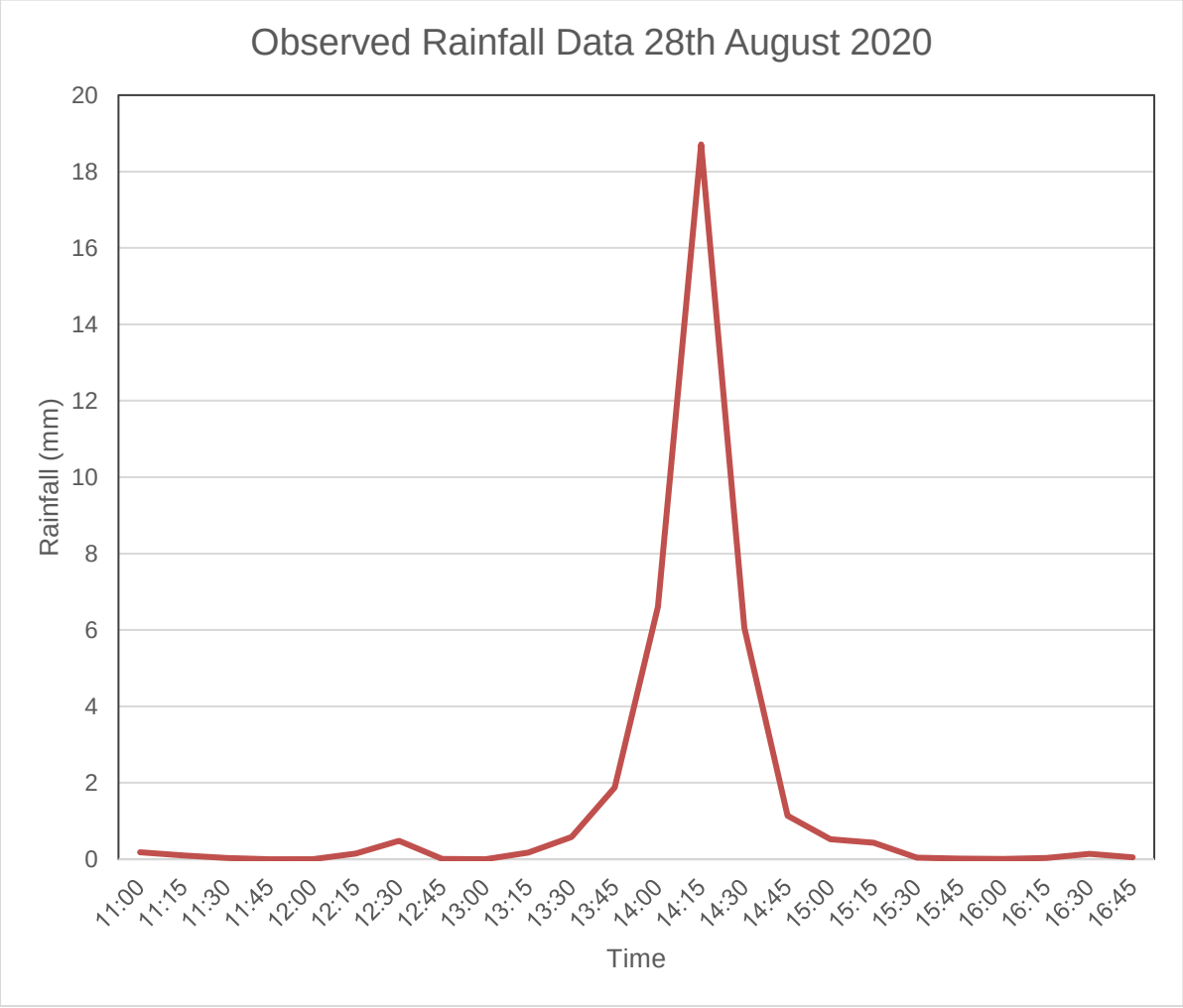


Figure 1 Observed rainfall during the August flood event

The total observed rainfall between 13:45 and 14:45 for each of the 28 points across Deal was calculated based on the Environment Agency's rainfall observation data. Figure 2 below shows the total rainfall depths (mm) and the location for which it was calculated across Deal. The points on the map do not represent individual rain gauges but the location for which the rainfall analysis has been based on. The 28 points have been assigned a colour dependant on the total rainfall depth and correspond to the colours used in the rainfall radar image in the report. There are three points with a greater than 64mm depth of rainfall between 13:30 and 14:45 which also corresponds to the pattern of white within the rainfall radar imagery.

[5] https://www.ofwat.gov.uk/wp-content/uploads/2018/03/Reporting-guidance-sewer-flooding.pdf

The location of the recorded flood incidents as shown in Annex 1 also correspond to the locations which recorded the greatest amount of rainfall.

The location of the Deal rain gauge is also shown in Figure 2 in the report. The four nearest points to the rain gauge range from 22.1mm to 65.03mm of rainfall, indicating that the rain gauge was not located within the area that recorded the greatest amount of rainfall, and as a result may not have recorded the peak rainfall across Deal during the flood event.

The Thiessen Polygon method was used to calculate the average observed rainfall for the area of Deal based on the additional Environment Agency data. The analysis concluded that the average rainfall across Deal was approximately 48mm which equates to an approximate 0.7% annual exceedance probability equating to a 1 in 138-year return period.

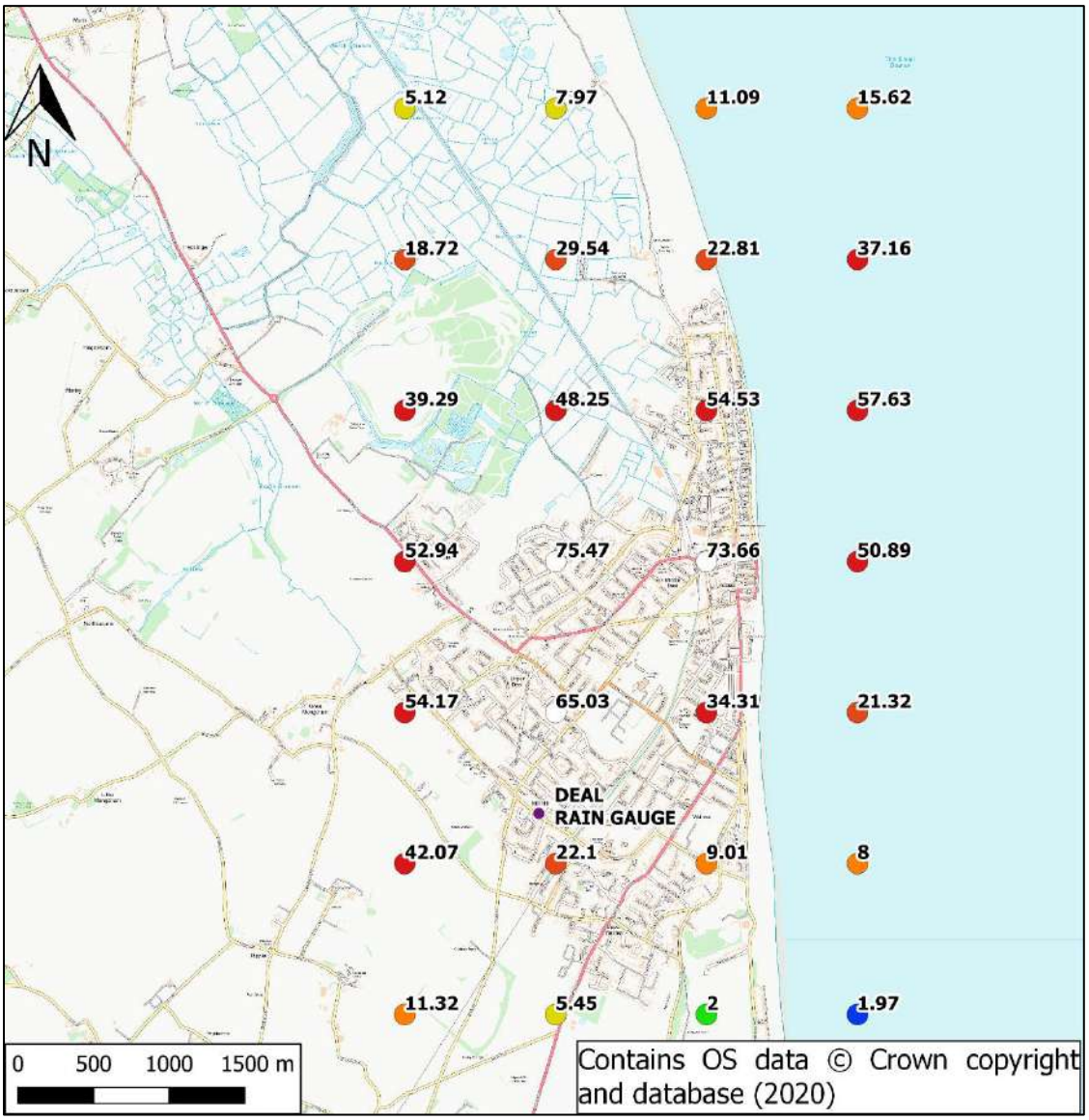


Figure 2 Total observed rainfall (mm) during the August flood event

Appendix C: Ofwat Letter