Cork County Council

Midleton Flood Relief Scheme

Storm Babet Flood Event Report

Reference: 252803-71

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Contents

Tables

Figures

Drawings

No table of figures entries found.

Pictures

No table of figures entries found.

Photographs

No table of figures entries found.

Attachments

No table of figures entries found.

Appendices

No table of contents entries found.

1. Introduction

1.1 Overview

Storm Babet was a major low pressure weather system that impacted the South of Ireland on the 17th and 18th of October, 2023. Significant amounts of rainfall fell over the course of the storm which led to fluvial flooding in a number of towns in County Cork. The worst affected towns were Midleton, Killeagh, Glanmire and Blackpool. Areas of Cork City were also subject to pluvial flooding during the event.

As part of the Midleton FRS project and as per Section 2.13 of the project brief, Arup has been asked by Cork County Council (CCC) to prepare a post-flood event review report that considers the impact of the event in Midleton. This report sets out the findings of the review.

Arup has also been asked by CCC to undertake an additional follow on study that (a) considers the suitability of implementing any interim measures that may help manage flooding in the immediate future in Midleton, and (b) reconsiders the design hydrology and preferred scheme in light of hydrology and flood levels associated with Storm Babet. This work will be presented in follow on report in the next period.

1.2 Scope of the flood event review

The scope of the post-flood event review is given as:

- Site walkovers to affected areas in the immediate aftermath of the event in order to gather data and anecdotal information on the impact of the flooding. The site visits were conducted by staff from Arup, CCC and the OPW on the 19th and 20th of October and included:
    - Observation of wrack marks on properties and roads. A large number of these wrack marks were subsequently surveyed by CCC and have been used to inform our analysis;
    - Observation of the damage caused to affected properties and infrastructure;
    - Liaison and discussion with affected landowners/occupiers in order to gather further anecdotal information on the event.
- Gathering of photographs and video footage of the event from various social media streams;
- Liaison with Irish Distillers (IDL) who were impacted by the event;
- Extensive liaison with CCC in order to ensure that all the data and information gathered by CCC has been assessed and considered in the report. This data includes aerial imagery of the event taken by the Guileen Coast Guard;
- Review of all emails and communication sent directly to Arup by members of the public via the project website;
- Review of the event hydrology and recorded rainfall data;
- Review of the mechanisms of flooding that were observed during the event and compare with the findings of the Midleton FRS Hydraulics report;
- Establish the likely maximum extent and depth associated with the flood event;
- Establish the likely number of both residential and commercial properties flooded during the event;

- Outline the scope of work required to inform follow on study which is to consider the following items:
    - Assessment of the design hydrology of the scheme in light of Storm Babet;
    - The likely return period of Storm Babet;
    - Assessment of the design water levels in light of any significant change to the scheme hydrology;
    - Confirmation of the suitability of the preferred scheme which has been detailed in length in the Options report for the project;
    - Detailed assessment of any suitable interim measures that could be implemented in the short term in order to manage flood risk in the study area;
- Prepare a summary report outlining the findings of the review study.

It is noted that this version of the report is in draft format and is subject to review based on the collection of any further additional data on the impact of Storm Babet which we may yet receive from various parties. Information used in this report is the best available to the Project Team at the time of writing.

1.3 Sources of data

Data on the flood event has been gathered from various sources and used to inform the findings of this report. The primary sources of data are listed as:

- Recorded rainfall and radar information from the event. This data has been supplied to Arup by Met Eireann;
- Observations and anecdotal information collected by staff from Arup, CCC and the OPW as part of the post event site visits;
- Wrack mark surveys[1] which indicate possible maximum water levels;
- Extensive number of photographs and video footage from social media posted by members of the public;
- Report and further information supplied by CCC;
- Aerial imagery of the event taken by Guileen Coast Guard. These images were supplied to Arup by CCC and were taken at circa 16:00hrs – 18:00hrs on the day of the event. It is noted however that as the peak of the event was circa 14:00hrs/15:00hrs, these images show the flood extent after the peak had passed.
- Drone footage of the event posted online by a member of the public. This data is not time stamped but is likely to be close to the peak;
- CCTV footage supplied to Arup by AIB;
- Information directly supplied to CCC/Arup by the general public;
- Existing LiDAR/ Topographic survey information;

[1] Wrack marks are defined as a line of debris (often vegetation/ silt or sediment) left on a wall or ground following a flood event. They can in some instances provide a very accurate indication of the maximum water level reached during the event. In other instances however wrack marks are less certain and somewhat ambiguous. The findings of such wrack marks should be considered with caution.

- Media reports.

1.4 Overview of the report

Chapter 1 provides an overview of the flood event review report. An assessment of the rainfall data for the event is considered in Chapter 2. The identification of Flood Routes and Flood Mechanisms for the event across the whole scheme area in Midleton is presented in Chapter 3.

The conclusions of the study and recommendations for further work are discussed in Chapter 4.

2. Rainfall analysis

2.1 Scope of the rainfall analysis

The scope of the Storm Babet rainfall analysis is to gain an understanding of:

- The geospatial distribution of rainfall within the Owenacurra/Dungourney catchments and the wider East Cork area during the event;
- The recorded rainfall amounts in the time leading up to and during the event;
- The magnitude and frequency of the Storm event based on the observed rainfall data.

2.2 Data availability

The following datasets were reviewed and assessed as part of the work. Due to the time constraints associated with delivering this report, some of the raw datasets supplied to Arup have not been quality checked. The findings of the rainfall data analysis are therefore provisional and subject to review once the QA of the data has been completed. Any changes to the conclusions presented in this report will be discussed in the follow-on Storm Babet report.

Table 1: Rainfall data

Collection method	Source	Dataset	Location of data collection	Quality checked
Radar	Met Éireann	Hourly Rainfall radar composite plots from Dublin and Shannon Airport UKMO radars in N. Ireland and Wales (Castor Bay, Crugygorllwyn and Cobbacombe Cross)	Shannon airport Dublin airport	Yes
Automatic climate /weather stations (AVS/AWS)	Met Éireann IFICS / Weather Observation Website (wow.met.ie)	Ten-minute to Hourly rainfall depths taken from seven automatic stations at 30km radius around Midleton	Roches Point, Moore Park, Youghal WWTP, Ballincurrig, N25 Midleton Bypass, Inishcarra, Rostellan	No
Synoptic station	Met Éireann website	Hourly rainfall for Cork Airport	Cork Airport 23km SW of Midleton	Yes
Manual stations	Met Éireann enquiries	Daily rainfall depths from seven manual stations at 30km radius around Midleton	Cloyne (Lisanley), Ballymacoda (Mountcotton), Killeagh Mogeely, Bartlemy, Montenotte (Cork City), Muskerry Golf Club, Tallow	No Data to be QC'ed in January 2024

2.3 Radar data

Single composite rainfall distribution maps based on the data collected at four different radar stations (Dublin, Cork and the UKMO radars in N. Ireland and Wales) have been provided by Met Eireann. The dates for which data was supplied are listed as:

- 10th October to 11:55 12th October
- 12th October to 19th October.

It is noted that radar data from the temporary radar at Cork Airport for the dates of Storm Babet is not publicly available and has therefore not been considered as part of the study.

A series of images from the composite radar maps is reproduced in the following set of figures. The images cover from 00:00 on the 17th of October to 21:00 on the 18th of October and are presented at a frequency of every 3 hours.

The units of the colour palette on the maps scale is provided in dBZ (Decibel relative to Z) which is a nondimensional "unit" of radar reflectivity that represents a logarithmic power ratio (in decibels, or dB) with respect to radar reflectivity factor, Z. The value of Z is a function of the amount of radar beam energy that is backscattered by a target and detected as a signal (or echo). The higher values of dBZ detected from precipitation areas generally indicate higher precipitation rates.

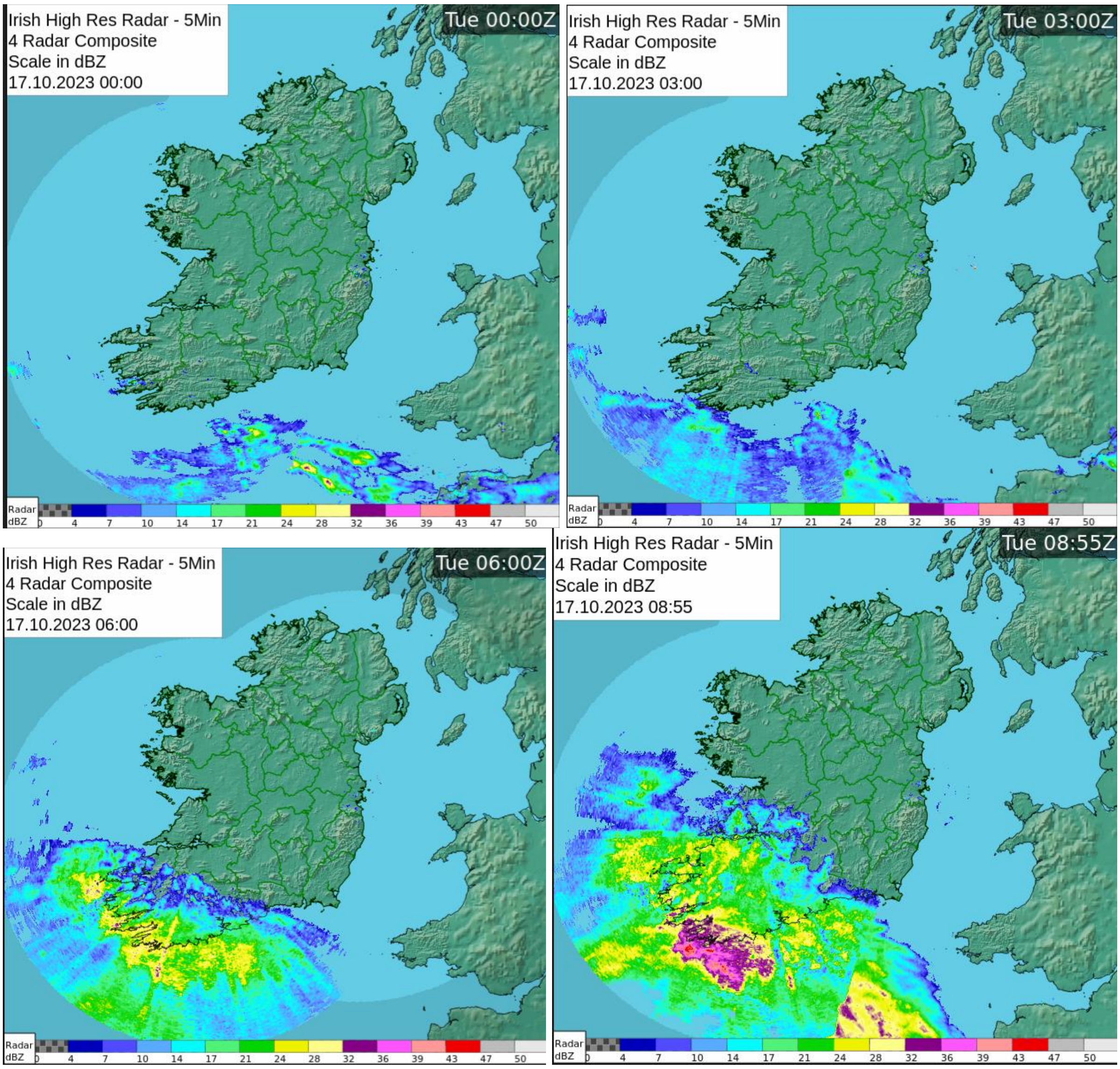
The table below (which we note is taken from the website of the National weather service, NOAA. website) uses the Marshall-Palmer formula to relate dBZ values to rainfall intensity. This needs to be considered when interpreting the composite images.

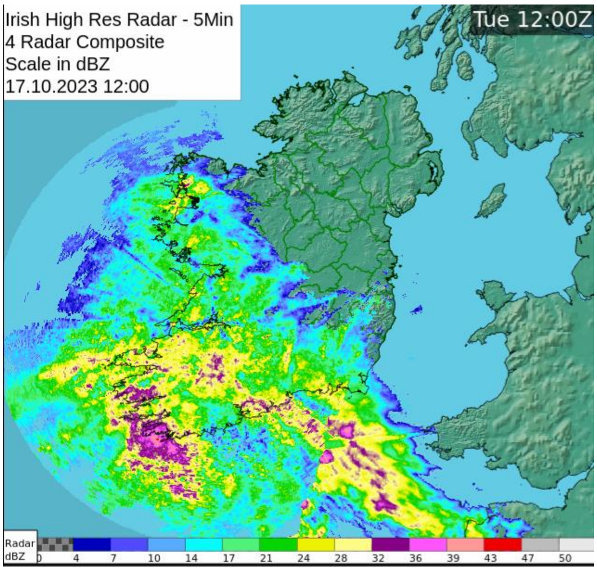
dBZ to rainfall rate comparison

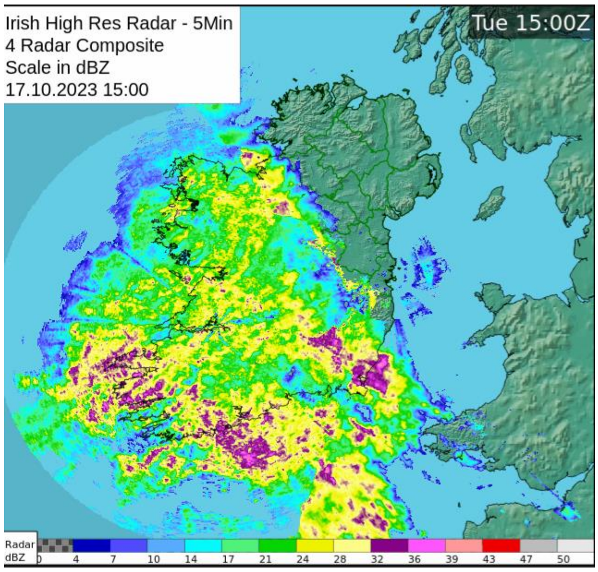
dBZ	Rain Rate (in/hr)	Rain Rate (mm/hr)
65	16+	420+
60	8.00	205
55	4.00	100
50	1.90	47
45	0.92	24
40	0.45	12
35	0.22	6
30	0.10	3
25	0.05	1
20	0.01	Trace
< 15	No rain	No rain

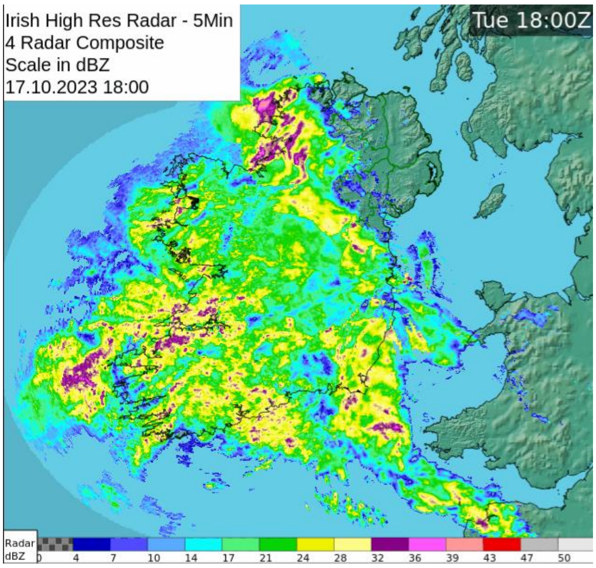
Figure 1: dBZ values to rainfall intensity comparison

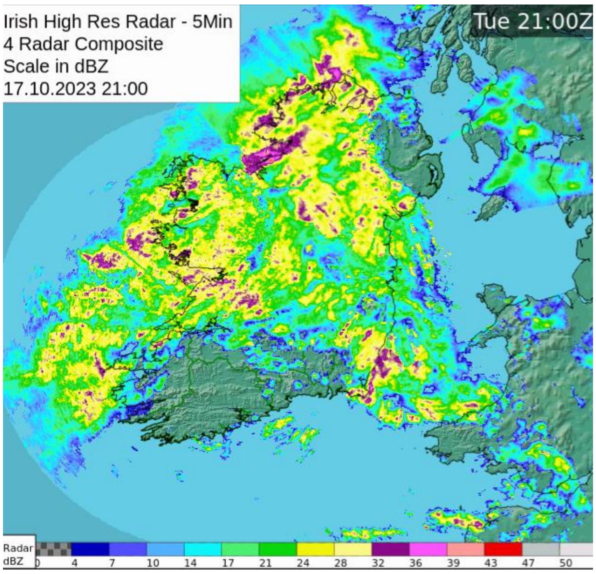
17th October



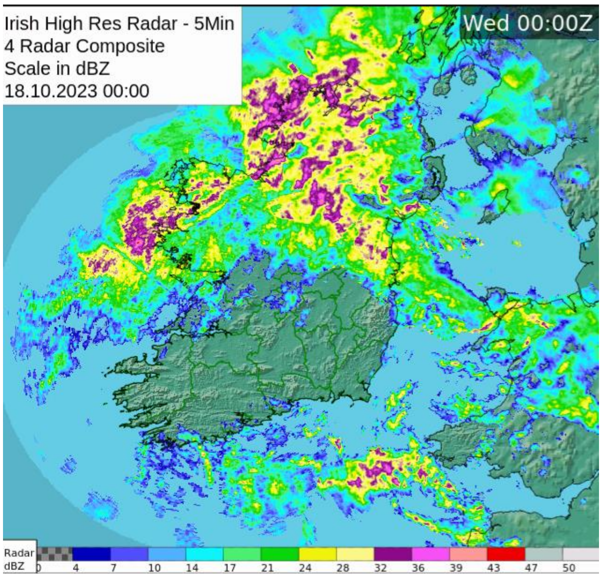


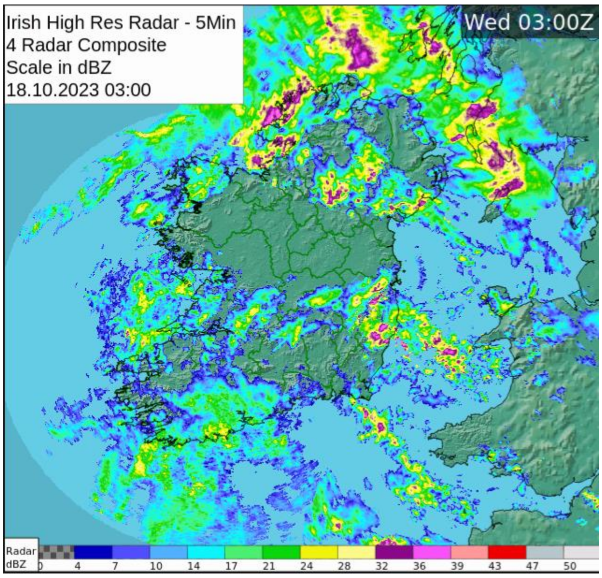


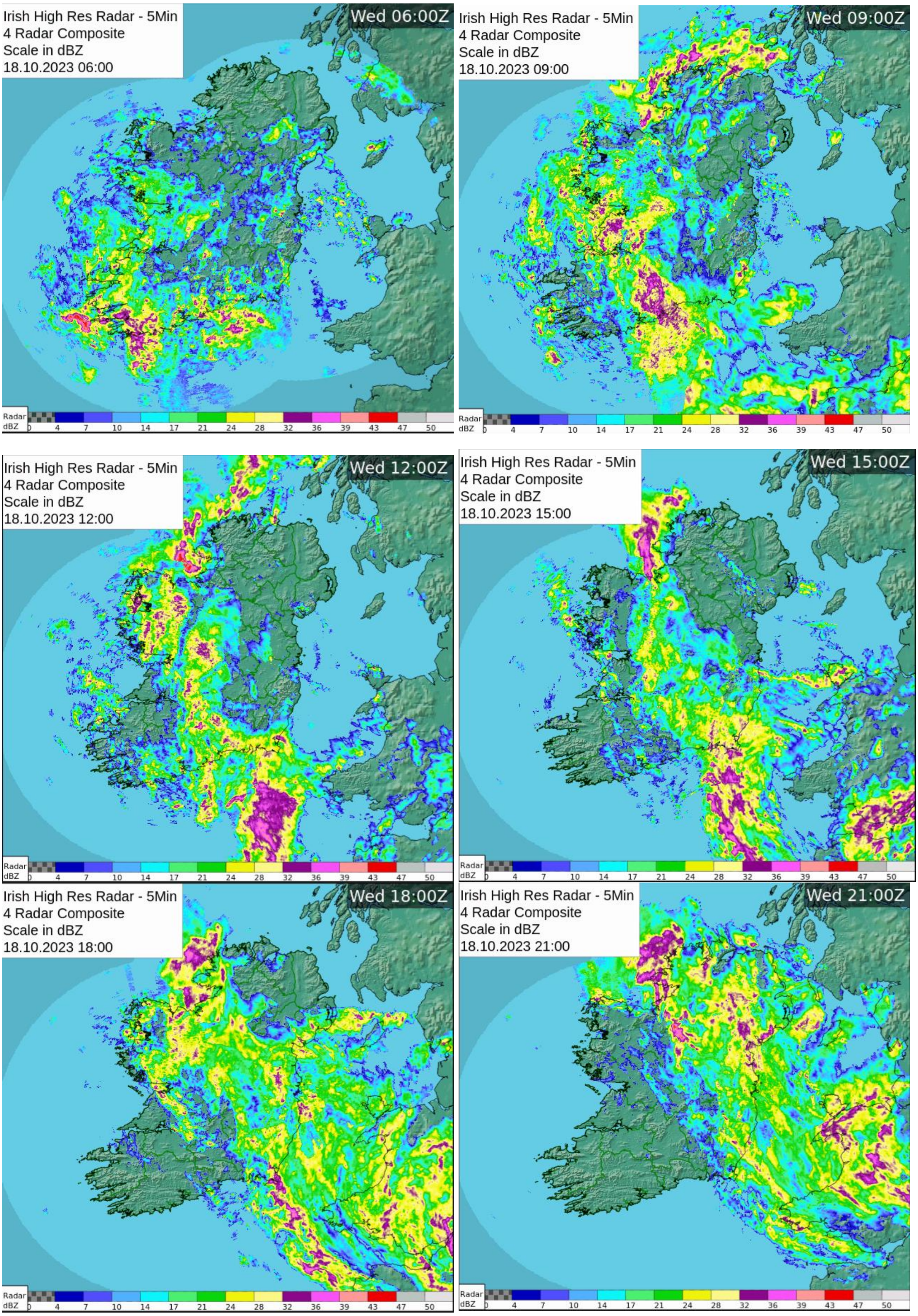




<u>18th October</u>






Irish High Res Radar - 5Min
4 Radar Composite
Scale in dBZ
18.10.2023 06:00
Wed 06:00Z
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Irish High Res Radar - 5Min
4 Radar Composite
Scale in dBZ
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Radar dBZ 0 4 7 10 14 17 21 24 28 32 36 39 43 47 50
Irish High Res Radar - 5Min
4 Radar Composite
Scale in dBZ
18.10.2023 12:00
Wed 12:00Z
Radar dBZ 0 4 7 10 14 17 21 24 28 32 36 39 43 47 50
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4 Radar Composite
Scale in dBZ
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Scale in dBZ
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Radar dBZ 0 4 7 10 14 17 21 24 28 32 36 39 43 47 50
Irish High Res Radar - 5Min
4 Radar Composite
Scale in dBZ
18.10.2023 21:00
Wed 21:00Z
Radar dBZ 0 4 7 10 14 17 21 24 28 32 36 39 43 47 50

In reviewing the radar data provided, the following observations are made:

- On the 17th October, a large band of rain is seen to move from the southwest to the northeast. The rainfall is seen to impact Midleton from 06:00hrs onwards, with the heavier rain arriving by 15:00hrs that afternoon. The values in the plot range from 24 to 32 dBZ, indicating rainfall intensities between 1mm/hr – 2.7mm/hr which is relatively light to moderate rain. The rain clears over Midleton by 21:00hrs.

- A second band of rain travels in a northerly direction and impacts Midleton on the 18th October from circa 03:00hrs. The rainfall intensity peaks at Midleton around 09:00hrs and but continues until 15:00hrs.

- It is evident from the data that there is significant spatial variation in the rainfall distribution in East Cork, specifically at the peak of the rainfall intensity at 09:00hrs. The data varies from 14 to 39 dBZ in a very short distance at that particular moment in time, indicating rainfall intensity variation between 0.3mm/hr-11.5mm/hr which is deemed to be very significant.

- The radar plots demonstrate significant spatial variation of rainfall intensity across Midleton and its catchments. As such, it is expected that rainfall intensities recorded at rain gauges could vary significantly from place to place. Further we note that as the radar plots are set at 3-hour intervals it is not possible to examine the temporal variation in the rainfall with any high degree of precision from the data. Greater intensities than what is presented on the images may have occurred during the event but they have been missed by the 3 hour sampling frequency.

2.4 Automatic Climate Stations & Synoptic Stations

Data from Roches Point, Moore Park, Youghal Wastewater Treatment Plant (WwTP), Ballincurrig and N25 Midleton Bypass (Carrigtwohill) Met Éireann automatic stations were downloaded from Met Éireann's IFICS database and used to inform the analysis.

Data from two additional stations (Inishcarra ACS Met Éireann station and a private station in Rostellan) were also retrieved from the Weather Observation Website (wow.met.ie). This website allows for the upload of data from official and private stations and is supported by Met Éireann.

Finally, hourly data from Met Éireann Synoptic station at Cork Airport were also retrieved and analysed as part of the work.

The hourly rainfall variation at four of the gauging stations is presented in the figure below. The following observations are made:

- Extensive rainfall occurred across the study area for the 36 hour period leading up the peak of the flood event in Midleton at lunchtime on the 18th of October. There was however a short pause in the rainfall for circa 4 hours from 20:00 on the 17th to 00:00 on the 18th when the recorded rainfall was close to zero. This pause is also detected in the radar data analysed above.

- The data at Rostellan has a gap of circa 13 hours in-between the two peaks. The data immediately after the gap may be erroneous as it is inconsistent with the data from the other gauges at that particular moment in time. The peak in the Rostellan data at 08:30 is however consistent with data from the other gauges and may therefore be reliable. It should be noted that this is a privately owned station that has not been quality checked.

- The highest instantaneous rainfall recording from the gauges is 20mm and was recorded at Youghal at circa 08:00 on the 18th. This timing of the peak coincides with the peaks at the other rainfall stations. It is evident however that the peak at Youghal is much higher than the peaks at the other gauges which are all approximately 10mm. This suggests that the storm event may have included very localised intense rainfall patterns such that there was considerable variation in the distribution of rainfall across East Cork. This pattern is also evident from the radar data as noted above.

- Given that both the Owenacurra and Dungourney catchments are ungauged, the rainfall intensity directly in the catchments for the duration of the event has not been determined.

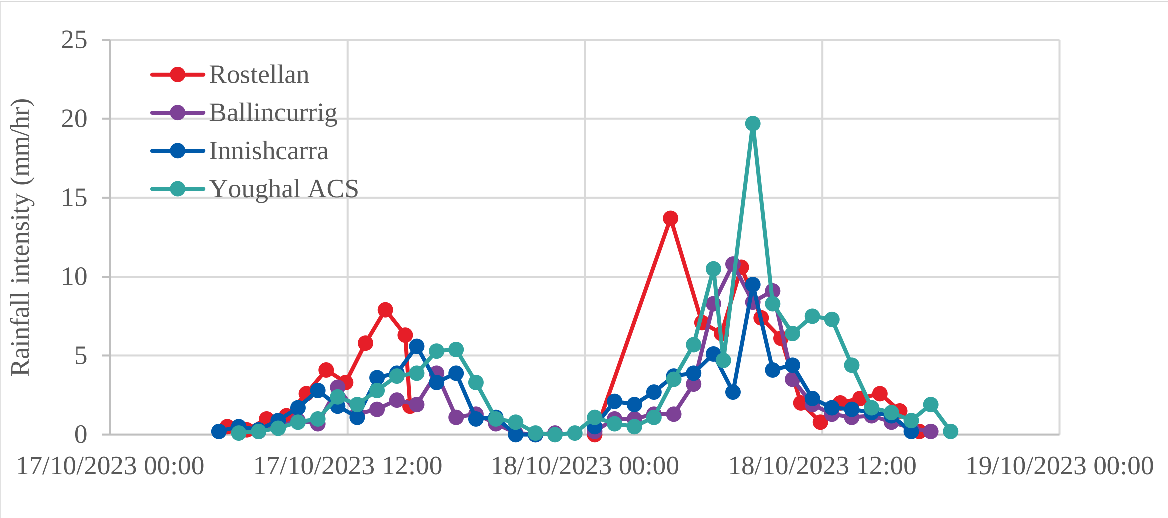

Figure 2: Hourly rainfall variation at 4 gauging stations

The rainfall depths and the associated estimate of the rainfall return period during the two days of Storm Babet at each of the stations is presented in Table 2.

The rainfall return period for the depths recorded at each station has been estimated using the rainfall depth-duration-frequency (DDF) model developed by the OPW and shared through the FSU Rainfall database platform (https://opw.hydronet.com/). The return period was exported from the platform for a series of durations, from 1 to 10 days, in order to allow for the antecedent conditions to be considered as part of the work. The return period has calculated at the location of each rainfall station using the nearest node from the DDF model.

It was found that the most extreme return period is calculated when assessing the rainfall duration as a longer single event (approximately 35hrs long) and not as two individual events of shorter durations. This is illustrated for the Inishcarra and Youghal stations in the two tables below. In the case of Youghal it can be seen that the return period of the rainfall for the two events in isolation are the 1 in 2 year (for the 17th of October) and the 1 in 78 year (for the 18th of October). When considered together for a 36 hour duration, the return period of the rainfall is over 1 in 200 year event.

Inishcarra	**Duration, hrs**	**Depth (mm)**	**RP, years**
17th October	14:00:00	31.7	1:1
18th October	16:00:00	49	1:4
Total	35:00:00	80.7	1:17

Youghal WWTP	Duration	Depth (mm)	RP, years
17th October	16:00:00	33.1	1:2
18th October	20:00:00	87.6	1:78
Total	36:00:00	120.7	1:227

A spatial illustration of the rainfall depths at the stations below is shown in Figure 3.

Table 2: Rainfall records at gauging stations near Midleton during Storm Babet

Station	Ownership	Distance from Midleton	17th October (mm)	18th October (mm)	Total rainfall (mm)	Event length (hrs)	FSU return period at station location
Roches Point AWS	Met Éireann AWS	14km SW	50.6	39.1	89.7	35	**1:40**
Moore Park AWS	Met Éireann AWS	30km N	19.1	31.1	49.3	37	**1:2**
Youghal WWTP ACS	Installed and maintained by Met Éireann	23km E	33.1	87.6	120.7	36	**1:227**
Ballincurrig ACS	Installed and maintained by Met Éireann	9km N	19.7	55.0	74.7	35	**1:6**
N25 Midleton Bypass (Carrigtwohill)	Installed and maintained by Met Éireann	6km W	36.2	66.9	103.2	35	**1:44**
Inishcarra ACS	Installed and maintained by Met Éireann	30km W	31.7	49	80.7	35	**1:17**
Rostellan (Private)	Private station	7.5km S	34.8	62.7	97.5	35	**possibly erroneous data**
Cork Airport Synoptic Station	Met Éireann Synoptic	22.5km SW	36.8	55.6	92.4	34	**1:33**

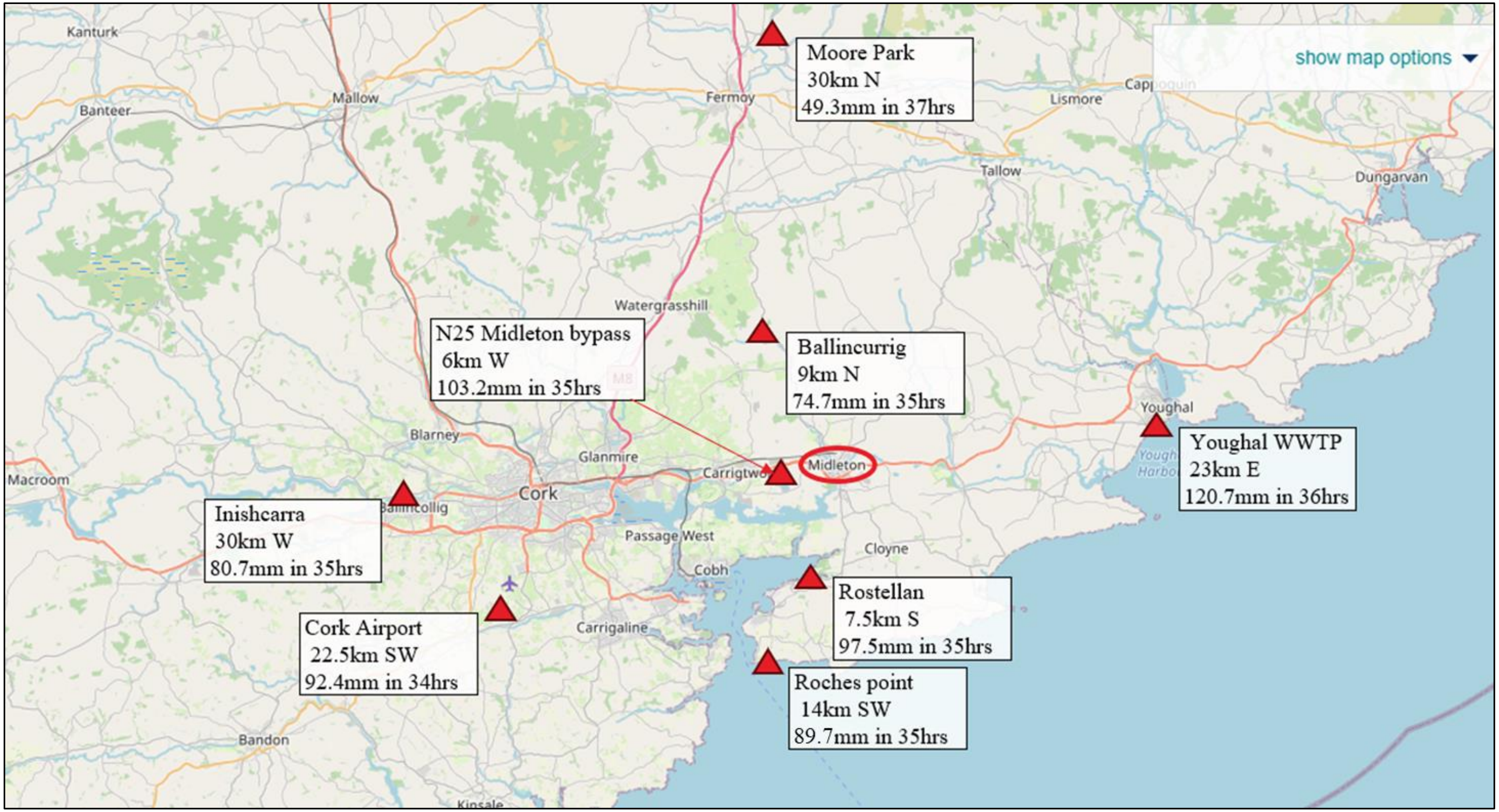

Figure 3: Map of AWS/ACS and synoptic rainfall gauges and total rainfall depths

2.5 Manual stations

Daily rainfall depths have been provided by Met Éireann for seven manual rainfall gauging stations around Midleton. The data have not been quality checked yet. Table 3 includes the data provided for each day, total rainfall depths and calculated return period, assuming a 35hr storm duration.

The return periods were calculated from the FSU rainfall database platform as per the methodology noted in the previous section.

Table 3: Manual Met Éireann rainfall stations

Station	Distance from Midleton	17th October (mm)	18th October (mm)	Total rainfall (mm)	FSU return period at station location
Cloyne (Lisanley)	6.8km S	87.2	28.9	116.1	**1:99**
Ballymacoda (Mountcotton)	17.6km E	76.6	45	121.6	**1:366**
Killeagh Mogeely	10.5km E	66.4	54.5	120.9	**1:133**
Bartlemy	16km NW	38.6	37.7	76.3	**1:6**
Montenotte, Cork City	18.8km W	74.2	52.2	126.4	**1:283**
Muskerry Golf club	30km W	37	39.2	76.2	**1:7**
Tallow	22km NE	48.5	61.4	109.9	**1:31**

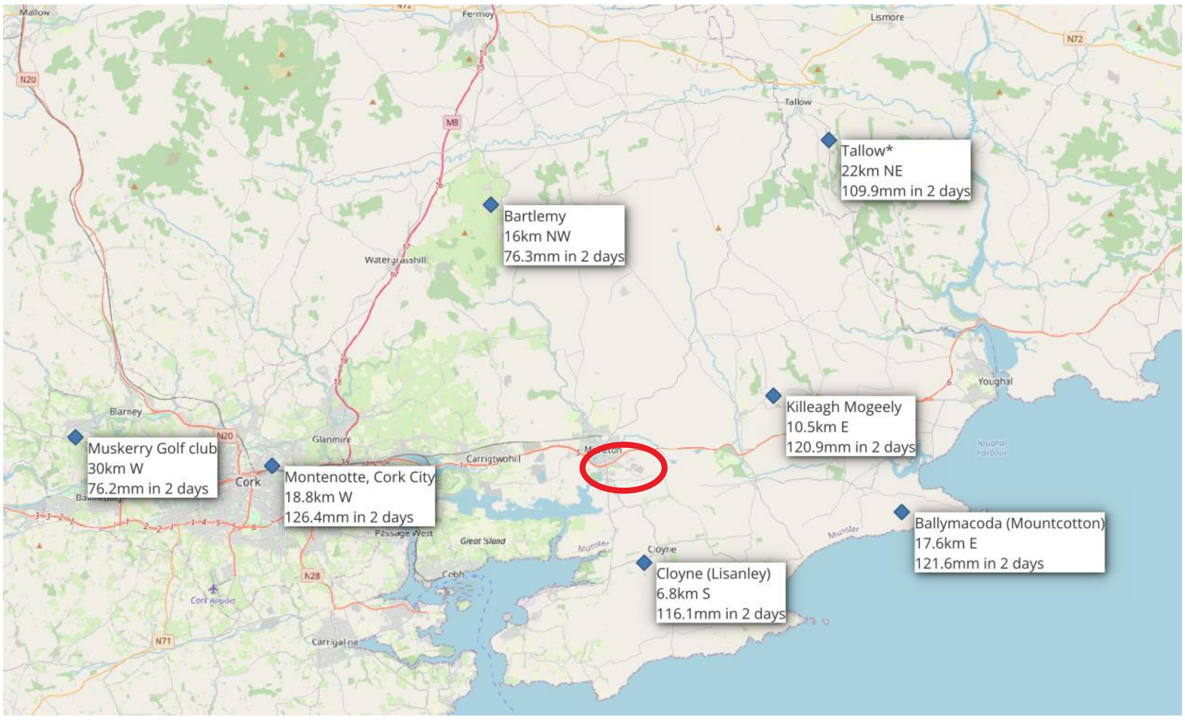

Figure 4: Map of manual rainfall gauges and total rainfall depths

The total rainfall depths for Storm Babet at all the rainfall gauges (automatic and manual) are shown in Figure 5.

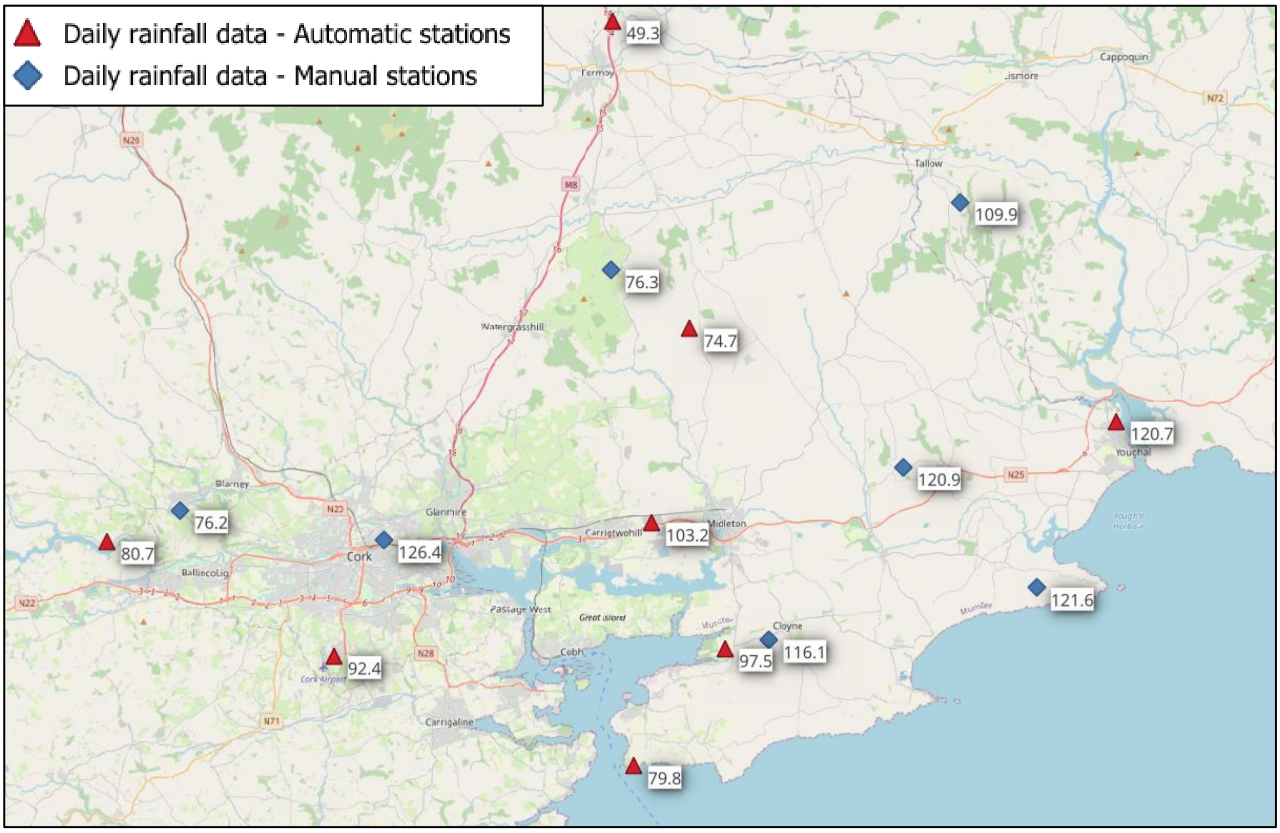

Figure 5: Total rainfall depths recorded around Midleton by Met Eireann for 17th-18th October 2023

While the measurements are not quality checked and subject to review, the following points are noted:

- Significant rainfall depths are recorded circa 10-20km east of Midleton, with approximate depths of 120mm. The rainfall amounts are very consistent between the three gauges in the area;
- The rainfall depths to the West of Cork City were approximately 80mm, this is noticeably lower (circa 40mm) than what was observed to the East of Midleton;
- The highest depths were recorded within the City at Montenotte and are equal to 126mm of rain. The depths between Cork City and Midleton were recorded as 103mm along the N25;
- The two stations to the North of Midleton are reasonably consistent with each other and are roughly approximate to the depths experienced to the West of the City (circa 75mm).
- There is no agreement between the stations south of Midleton (Rostellan and Cloyne stations). The Rostellan station is privately owned and an outlier point has been noted.

It is therefore evident that there was considerable spatial variation in the rainfall distribution across Cork City and East Cork during Storm Babet. The highest rainfall fell along an axis that reaches West to East from Cork City to Youghal with Montenotte recording the highest amount of 126mm. The rainfall amounts circa 15km to the North of this axis are noticeably less (circa 74/76 mm of rain) as are the amount at Roches Point circa 12km to the South (circa 90 mm of rain).

2.6 Observations and conclusions

Storm Babet hit Ireland between the 17th October to 18th October 2023. The storm lasted approximately 35 hours, with a break in-between around midnight. The month leading to the event was relatively wet and anecdotal data collected suggests that the ground was saturated in the days before the event such that the runoff rates during the event were very high.

The radar data shows significant spatial variation of rainfall intensity across the area of interest. This pattern is also observed in the rainfall totals across numerous gauging stations.

The rainfall totals for the storm vary from approximately 80mm on the West, to 120mm East, 75mm North and >100mm South of Midleton. Nearest to Midleton, the rainfall at the N25 Midleton bypass station by TII, recorded a total rainfall of 103.2mm, equivalent of the 1:44 year rainfall event.

It is possible that an even greater spatial distribution of rainfall occurred than what is suggested by the data such that the intensities within areas of the Owenacurra and Dungourney river catchments could be higher than what has been observed from the gauged data.

However no gauges are available within the catchments and as such it is not possible to provide an accurate estimation of the direct rainfall intensity in the relevant catchments.

3. Identification of Flood Routes/Mechanisms during Flood Event

3.1 Overview

The following sections of the report set out the mechanisms of flooding that occurred during Storm Babet in the key areas across the scheme area in Midleton. The maximum flood extent and flood depths associated with the event, as well as the number of properties flooded, are also presented.

Following both the requirements of the project brief and also recent discussions with CCC, the impact of the event has been compared with the findings of the hydraulic model developed as part of Stage I of the Midleton FRS. This comparison has been undertaken in order to validate the findings of the model against an actual extreme event and also to identify if there were any mechanisms of flooding that occurred during the event which were not captured as part of the model.

The maximum flood extents and depths associated with the Q1000 current scenario has been used as the modelled extent to compare with the maximum observed extents and depths from Storm Babet. This return period event was selected as it was apparent from our initial site visits that Storm Babet was an extreme flood event and that the Q1000 modelled results offer the closest approximation to the event in the context of the observed extents and levels. We note however that further analysis is required before we can consider the actual return period of the event and our comparing of the impact of the event to the modelled Q1000 results should not be interpreted as the return period of Storm Babet being equivalent to the 1000 year event.

The actual return period of the event will be assessed in detail and will be presented in our follow on report.

3.2 Relevant model assumptions

A large number of assumptions were adopted as part of the development and running of the hydraulic model. The assumptions directly relevant to the analysis undertaken as part of this report are listed as:

- For the Q100, Q200 and Q1000 events, all walls in the study area have been excluded from the model as their structural integrity cannot be guaranteed for these extreme events given that none of them were designed to act as formal flood defences structures. This assumption has been validated by the impact of Storm Babet given that a number of walls collapsed during the event (refer to later sections in the report for further information on locations). This assumption needs to be considered when comparing the Q1000 model extents against the observed Storm Babet extents given that some walls remained standing during the event and hence diverted flood water in directions that would not have been possible to replicate with the hydraulic model. Additionally, it is noted that all of the wall collapses occurred after the flood had been in progress for a number of hours and hence would have influenced the overland flow routes up to the moment in time at which the collapse occurred;

- Based on the Joint Probability undertaken as part of the Midleton Hydraulics study, the Q1000 event was paired with a T5 downstream tidal boundary (which has a peak water level of 2.47mOD). Storm Babet however peaked at circa 14:00hrs in the town centre on the 18th and this time coincided with a low spring tide (circa -1.1mOD). The difference in the tidal water levels between the model and what occurred during Storm Babet therefore needs to be carefully considered when comparing the modelled Q1000 water levels in the tidal dominated reach to the maximum extents associated with the event;

- All the design runs of the model assumed zero blockage at all the structures. It was evident from our site visit however that blockages occurred Moore's Bridge during the event such that this also needs to be considered when comparing model results to observed extents;

- The hydraulic model assumed that the FFLs of all the properties could be represented by adding 150mm to the average of the ground elevation across the footprint of the building as estimated from the Lidar data. While in most cases this is an accurate assumption, it may in the case of a small number of properties lead to a slight over- or underestimation of the FFLs in the model. This also needs to be considered when comparing the results of the model to the observed flood extents.

3.3 Breakdown of the scheme area

For the purpose of this report the whole of the study area has been schematised into different geographical areas which are aligned with the area breakdown as per the Options report. These areas are listed as:

- Area 1&2 – Tir Cluain to Riverside Way
- Area 3 North– Cork Road Bridge to the N25 (i.e. the town centre)
- Area 3 South–Bailick Road South of the N25
- Area 4 – Lauriston Estate, Rugby Club and the East of the IDL site
- Area 5 – Ballinacurra
- Area 6 – Water rock

The hydrometric gauge at Ballyedmond is not in the scheme area but given its relevant to the overall study, the impact of Storm Babet at the gauge has also been considered as part of this report.

3.4 Area 1&2 – Tir Cluain to Riverside Way

Area 1 and 2 is situated north of Midleton Town Centre and covers the upper reach of the Owenacurra as well as the Glenathonacash and the Owenacurra Millrace. This area includes Tir Cluain, Moore's Bridge, Willowbank, Millbrook, the Northern Relief Road, Midleton Train Station, the Railway Cottages, Cork Road Bridge and extends to Riverside Way. The extent of Area 1&2 is show in Figure 6

Figure 6: Areas 1 and 2

3.4.1 Tir Cluain

Mechanisms of Flooding in Hydraulic Model

As detailed in the hydraulics report, there are three mechanisms by which Tir Cluain is flooded:

A. The Owenacurra River gets out of bank north of Tir Cluain and collects to the East of the estate. From there it bypasses the existing embankment at the rear of the estate and flows into Tir Cluain for the Q10 event and above. Once water enters the estate it flows in an eastward and south eastward direction and inundates of a large number of residential properties.

   The perimeter brick wall surrounding sections of the estate was removed from the Q100/Q200 and Q1000 hydraulic model. It is noted that this wall did not collapse during Storm Babet. This mechanism of flooding/ flow path is shown in Figure 7 using the "A" arrow.

B. Further downstream there is an additional mechanism of flooding whereby the Owenacurra gets out of channel on the right bank. The threshold at which this mechanism leads to flooding of the estate in the hydraulic model is the circa Q1000 event. This potential mechanism is shown in Figure 7 using the "B" arrow.

C. The southern area of Tir Cluain is at risk of flooding from overland flow resulting from the two mechanisms which are noted above. There is however an additional risk to this area from the Owenacurra overtopping the right bank which is shown in Figure 7 using the "C" arrow. The threshold of flooding of this mechanism in the hydraulic model is the circa Q100 event

Figure 7 presents the estimated maximum extent of Storm Babet within Tir Cluain along with the modelled existing scenario Q1000 maximum flood extent as per the Hydraulics report. As noted in the opening chapter of this report, the maximum extent from the event has been estimated by undertaking an in-depth review and assessment of a number of different data: observations during the post-event site visit, anecdotal information provided by the residents who were impacted by the flood, wrack mark surveys, aerial imagery, existing ground elevations from the Lidar data.

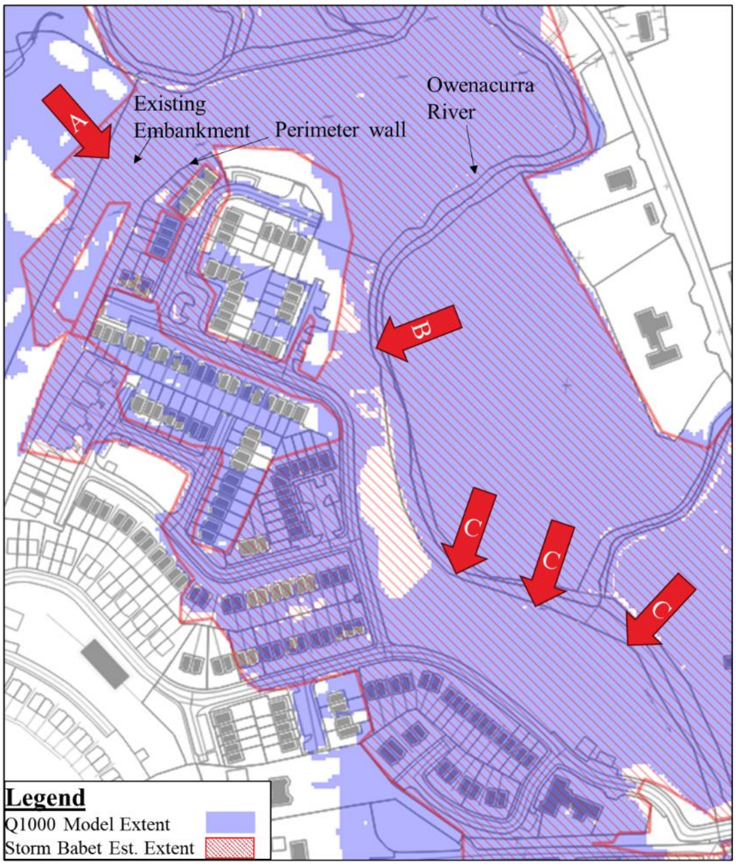

Figure 7: Existing Flood Mechanisms in Tir Cluain

Each of the key mechanisms of flooding identified in the hydraulics report (and referred to above) occurred during the Storm Babet flood event. Data/ information gathered during/ after the flood event in relation to the Tir Cluain area is summarised in the next section.

Comparison of Modelled vs Observed Mechanisms During Storm Babet

The perimeter wall at the back of the North Western area of the estate ("The Green") did not fail during the event. It was however reported to Arup that the high depths of water on the floodplain side of the wall lead to seepage underneath the wall which resulted in flooding of the back gardens of the houses. The houses were not reported as having been flooded and there was no sign of any damage to them on our site visit. A small volume of water is likely however to have gotten around the houses and led to overland flow along the access roads leading up to the houses.

The absence of a perimeter wall further south in the estate within "The Meadows" caused water from the Owenacurra to flow directly into the estate. A number of ground floor apartments were inundated as a result. A resident of one of these apartments noted to Arup that the water levels in the estate peaked at circa 11.30am/12pm and that his apartment was flooded for circa 5 hours. The maximum water level in the apartment was stated as being "just over a foot" (approximately 300 – 320mm).

An estimation of the likely flow path for this area is presented in Figure 8. It can be seen from the figure that the Q1000 maximum extent is greater than the estimated extent from the event and includes a greater number of houses. The numbers in the figure represent the difference between the surveyed wrack mark levels and the Q1000 maximum water levels with positive value denoting that the wrack mark is at a higher elevation than the maximum modelled Q1000 elevation and negative values indicating that the wrack mark is lower than the model.

It can be seen from the image, that there is inconsistency between the differences:

- In "The Green" the surveyed wrack marks are between 0.023m to 0.075m lower than the modelled Q1000 modelled water levels;
- In "The Meadows" the delta is between 0.379m lower and 0.463m higher

Given that the maximum water level gradient across the estate during the event would be consistent to the modelled water level profile, the validity of the recorded wrack marks in this area is therefore questionable and they may not be representative of the peak levels recorded during the event.

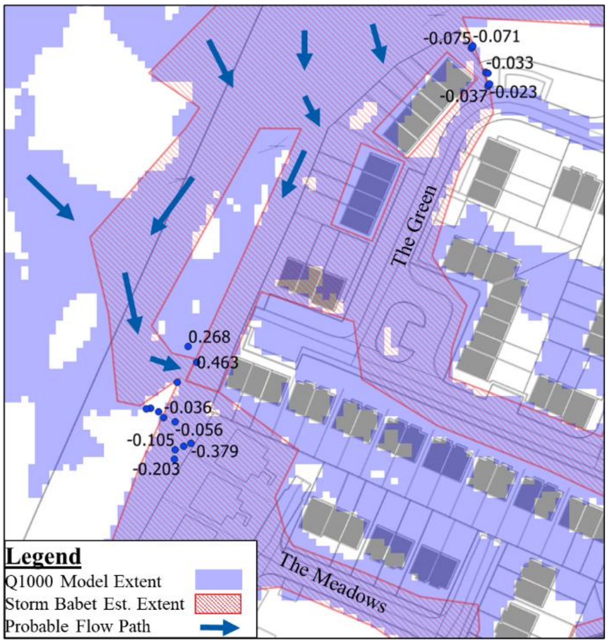

Figure 8: Tir Cluain North-West: Wrack Marks vs Q1000 Modelled Levels (m) and Flow Path

Figure 9 presents the estimated flood extents, modelled Q1000 extent and differences between the wrack marks and model for the area to the East of "The Green". There is consistency between the modelled and wrack mark levels for the six Northern survey points. The points further down the reach are however inconsistent which may be due to uncertainty in the wrack mark data and/or uncertainty in the roughness parameters of the channel/floodplain in the model.

The primary mechanism of flooding in the model is indicated by the blue arrows in Figure 9 and represents overland flow moving across the estate from West to East. Should the three more southern wrack marks on the figure be representative of actual flood levels during Storm Babet then it is possible that the Estate is also at risk of flooding from overland flow from the Owenacurra moving from East to West at this location.

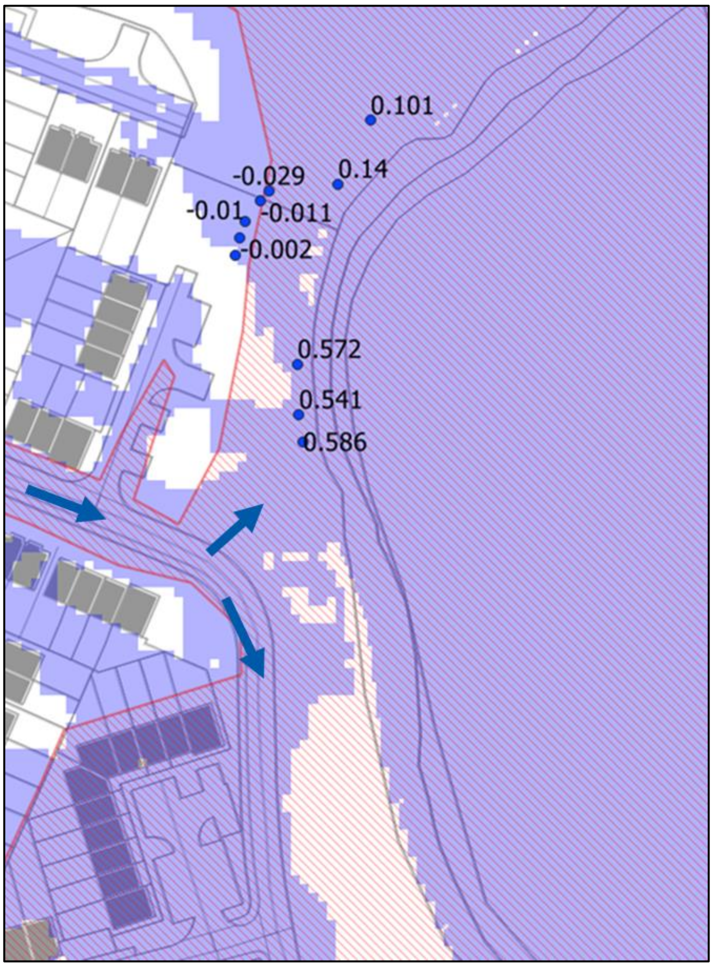

Figure 9: Tir Cluain North-East: Wrack Marks vs Q1000 Modelled Levels (m) and Flow Path

The southern area of Tir Cluain is at risk of flooding from (a) overland flow that originates from further up in the estate as described above, and (b) overtopping of the right bank of the Owenacurra upstream of the access bridge into the estate which is indicated using the "C" arrow in Figure 7 and with the blue arrows in Figure 13.

Based on our detailed inspection of the impact of Storm Babet, it can be concluded that the same mechanisms of overland flow that were represented by the model occurred during the event. There are however differences in the recorded and Q1000 flood extents due to the influence of the boundary wall between the estate and Broomfield Ridge. A large section of the wall failed during the event as shown in the figures on the following page. Up until the point of failure however the wall retained a large volume of water and caused water to collect to a depth of circa 1.2m at the back of the First Steps creche. These depths are circa 0.75m higher than the Q1000 flood depths, given that the wall was not accounted for in the model such that water was not able to collect upstream of it.

The Western section of the wall however remained standing during the event such that the modelled Q1000 extent is greater than the estimated extent from Storm Babet in this area. A wrack was taken by Arup on the section of the wall which did not fail and the depth of flooding at this location was measured as 1m (Figure 11).

Figure 10: Wall failure at rear of First Steps Creche

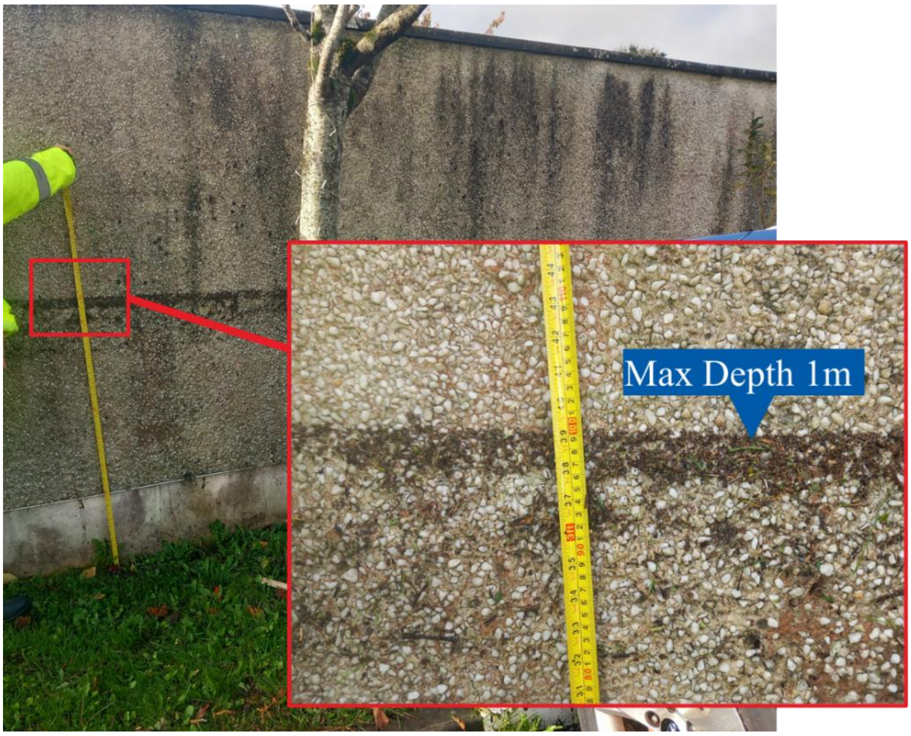

Figure 11: Wrack Mark on Wall at rear of First Steps Creche

A wrack mark was also recorded by Arup at the front door of the First Steps Creche, the maximum depth of flooding at this location was circa 0.69m as shown in Figure 12.

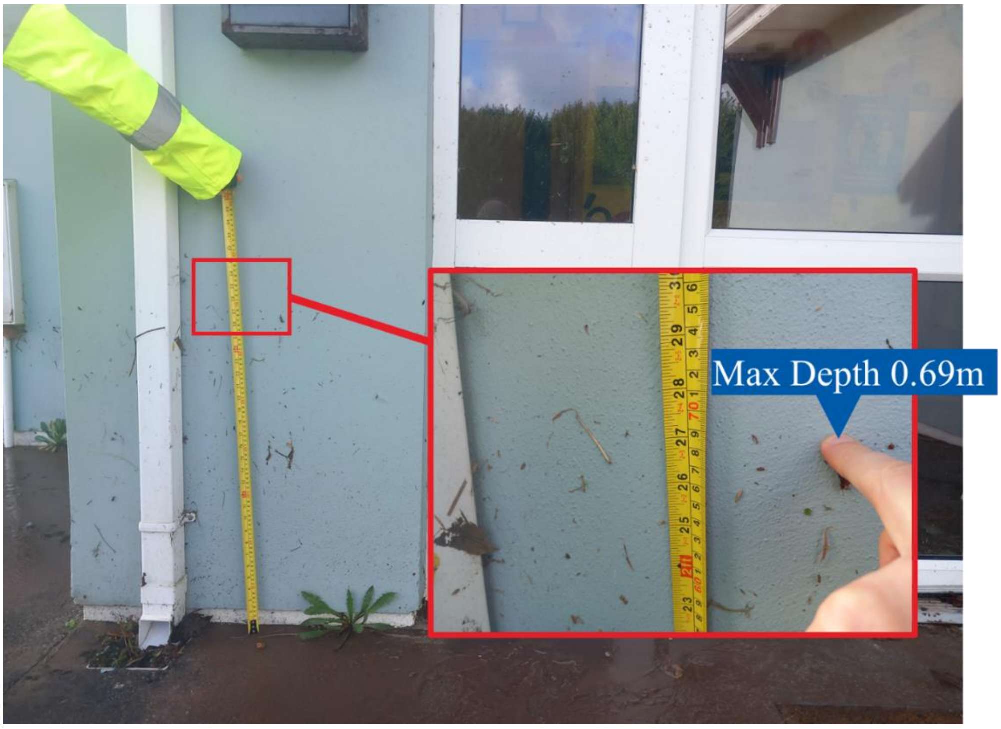

Figure 12: Wrack Mark at entrance to First Steps Creche

Conditions at the First Steps Creche during the flood event were exceptionally dangerous and necessitated the rescue of people from the building by emergency services. Video footage taken during the event and which was posted to social media shows that the velocities and flood depths in the vicinity of the building were sufficient to cause a small car to be carried by the flood water along the road adjacent to the creche. The footage also shows children waiting to be rescued by the emergency services having to stand up on the walls to the front of the creche. This was to avoid having to stand in the water which would have presented significant difficulties to their health and safety.

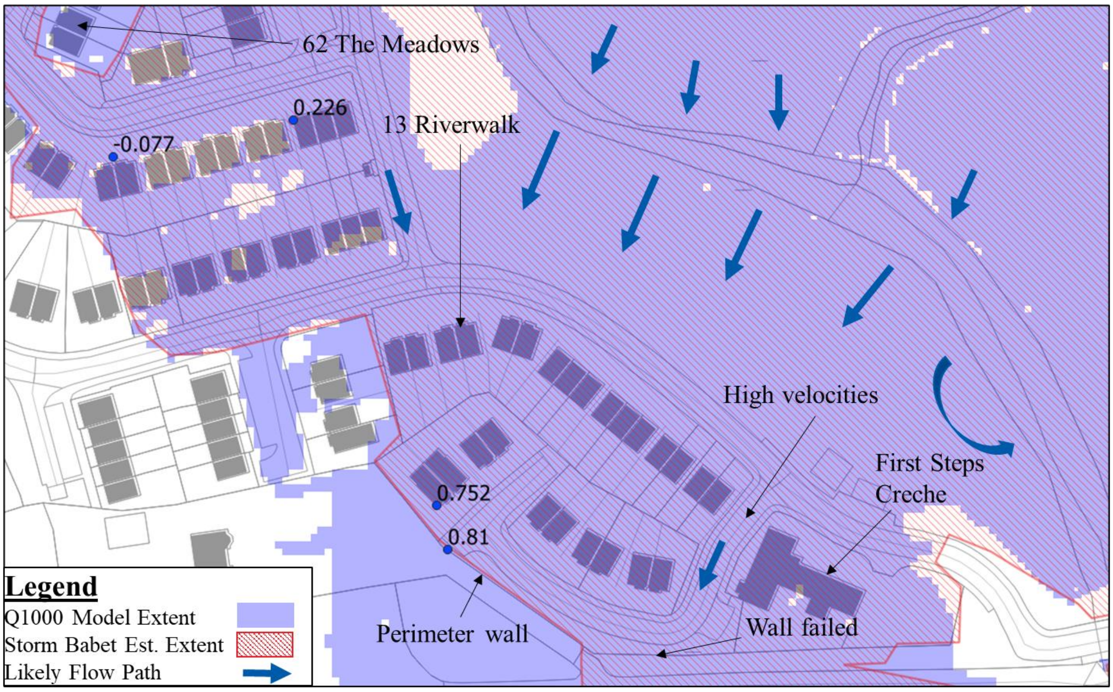

Figure 13: Tir Cluain South: Wrack Marks vs Q1000 Modelled Levels (m) and Flow Path

A wrack mark was recorded by Arup at No. 62 The Meadows and No. 13 Riverwalk (locations outlined in Figure 13). The maximum depth of flooding at No. 62 The Meadows was circa 0.55m as shown in Figure 14 and 0.95m at No. 13 Riverwalk as shown in Figure 15.

Figure 14: Wrack Mark at No. 62 The Meadows

Figure 15: Wrack Mark at No. 13 Riverwalk

It is estimated that circa 66 residential properties and one commercial property (First Steps Creche) were flooded in in the Tir Cluain area during the Storm Babet Event.

3.4.2 Carrigogna Bridge and Clohessy's Yard

Mechanisms of Flooding in Hydraulic Model

The primary mechanism of flooding on the Elfordstown stream is overtopping of the left bank of the stream immediately upstream of the Carrigogna Bridge situated along the main Midleton to Lisgoold road (R626). Water levels at this location are a function of both the Owenacurra backwatering up the stream as well as an afflux along the Elfordstown stream caused by the bridge itself.

Both of these mechanisms of flooding occurred during the Storm Babet flood event such that the model is representative of the mechanisms of flooding for large events. Data gathered during and after the flood event in this area is summarised in the next section.

Comparison of Modelled vs Observed Mechanisms During Storm Babet

Figure 16 presents the modelled existing scenario Q1000 max flood extent in blue and the Storm Babet estimated extent in red hatch. The delta between the surveyed wrack marks and the modeled Q1000 max water levels, as well as the likely flow paths which occurred during the event are also detailed in Figure 16.

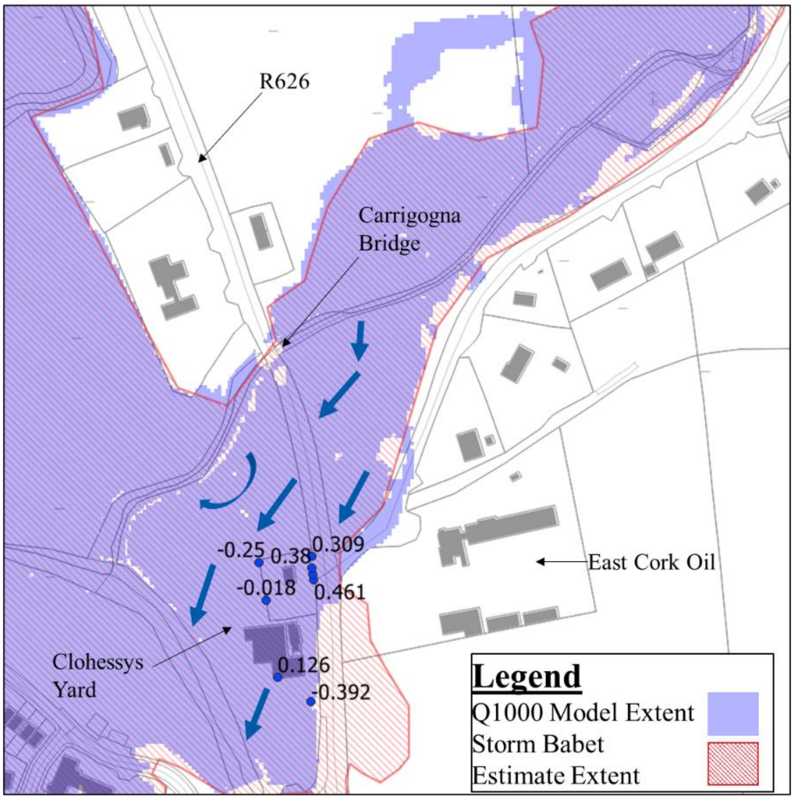

Figure 16: Carrigogna Bridge and Clohessy's Yard: Wrack Marks vs Q1000 Modelled Levels (m) and Flow Path

It can be seen from the figure that the modelled Q1000 extent is generally consistent with the estimated extent from Storm Babet with the exception of the area at the Southern end of the East Cork Oil property.

It can also be seen that the differences between the wrack marks and the modelled Q1000 water levels are inconsistent as the differences vary from -0.392m to 0.461m across a relatively short reach (circa 70m). There are likely to be a number of reasons for this:

- Uncertainty in the wrack mark as an indication of the true maximum water level attained during the event;
- All the local boundary walls in this area remained standing during the event and would have therefore influenced the overland flow paths and local maximum water levels. As these were

removed from the model any localised backwatering associated with the walls would not be captured by the model.

CCC received reports that the South East wing wall of Carrigogna Bridge had been damaged during the event. There were also reports that a 4m long tree truck was removed from the channel upstream of the bridge on the weekend after Storm Babet (i.e. the 21st/ 22nd of October) which may have been the source of any damage that was caused to the bridge. From their initial inspection, CCC noted that there was no evidence of any significant cracking or subsidence on the road or verge at the location.

Arup were subsequently asked to undertake an inspection which was carried out on two separate days: the 25th of October and the 31st of October. The bridge inspection report was issued to CCC on the 9th of November and noted that there were some defects associated with the bridge which need to be addressed by CCC in the short term. The report did not comment on the possibility that the bridge was blocked during Storm Babet or that it was damaged by the event.

The presence of a tree trunk in the channel would have caused a partial blockage of the opening of the bridge which in turn would have increased the volume of water over topping the left bank of the Elfordstown Stream. As the hydraulic model assumed an unblocked bridge, the model and what may have occurred during Storm Babet are not equivalent. This may be a contributing factor to the differences in the flood extents in the East Cork Oil property as presented in Figure 16. The flow rate in the channel during the event may also have been greater than the design Q1000 flow for the upstream Elfordstown stream catchment.

Three buildings (2 residential properties and a CCC asset) as well as large warehouse were inundated during Storm Babet in this area.

3.4.3 Moore’s Bridge/ Mill Road Upper

Mechanisms of Flooding in Hydraulic Model

As detailed in the hydraulics report there are three mechanisms by which the area downstream of Moore’s Bridge is flooded:

A. Water gets out of bank downstream of the bridge on the left bank. This mechanism is represented using the “A” arrows in Figure 17.

B. Water also gets out of bank downstream of the bridge on the right bank. This mechanism is represented using the “B” arrows in Figure 17.

C. A number of properties along the right bank downstream of Moore’s Bridge are also at risk of overland flow coming from Tir Cluain to the North during extreme events (assuming the perimeter wall has been removed). This mechanism is represented using the “C” arrows in Figure 17.

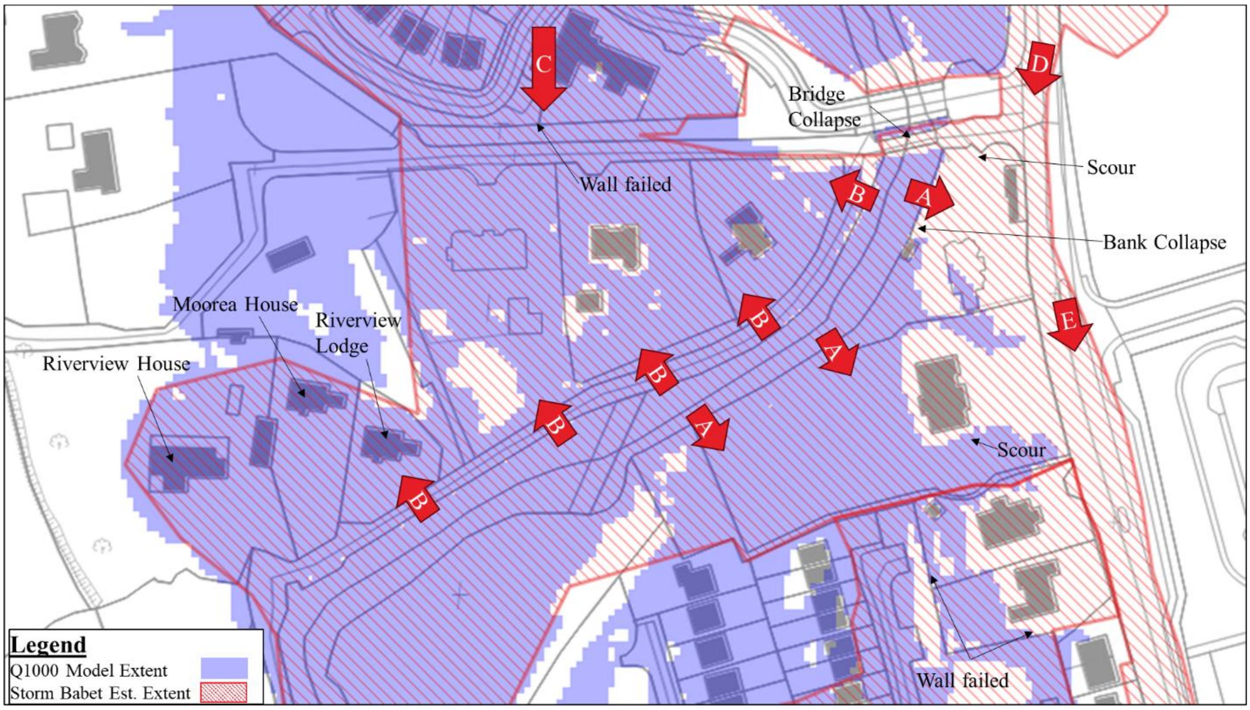

Figure 17: Existing Flood Mechanisms Moore's Bridge/ Mill Road Upper

Arup have confirmed that each of the key mechanisms of flooding identified in the hydraulic report (and as noted above) occurred during Storm Babet. Mechanism C occurred due to the collapse of the wall behind the First Steps creche, and mechanisms A and B occurred due to the capacity of the channel being greatly exceeded during the event.

Two additional mechanisms occurred during the event however which were not captured by hydraulic model:

- Water entered the property immediately downstream of Moore's Bridge on the left bank via the vehicle entrance from the R626. This mechanism is represented using the "D" arrow in Figure 17.
- Water also traveled South along the R626 (Mill Road) resulting in flooding of 2 residential properties in this area. This mechanism is represented using the "E" arrows in Figure 17.

Moore's Bridge was significantly blocked and also partially collapsed during the event (Figure 18). The blockage would have greatly elevated water levels upstream of the bridge and very likely led to water to spill out onto Mill Road leading to the mechanisms which have been labelled as "D" and "E" above. Any overland flow travelling from the direction of Clohessy's yard would have exacerbated this mechanism of flooding.

Data/ information gathered during/ after the flood event in relation to the area downstream of Moore's Bridge is summarised in the next section.

Figure 18: Moore's Bridge Collapse- Image taken post Storm Babet (19/10/2023)

Comparison of Modelled vs Observed Mechanisms During Storm Babet

Figure 19 presents the modelled existing scenario Q1000 max flood extent in blue and the estimated extent from Storm Babet estimate in the red hatch. The delta between the surveyed wrack marks and the modelled Q1000 max water levels are also detailed in the figure. It can be seen that the estimated extent is greater than the modelled Q1000 extent along Mill Road and also within the properties which face out onto the road.

The finished floor levels of the three houses on Moore's Lane (plotted in Figure 17) range from 11.8mOD to 12.16mOD. Based on a maximum water level wrack mark of 12.58mOD recorded in this area, it is estimated that the depth of flooding of these properties during the event ranged from circa 0.42- 0.76m.

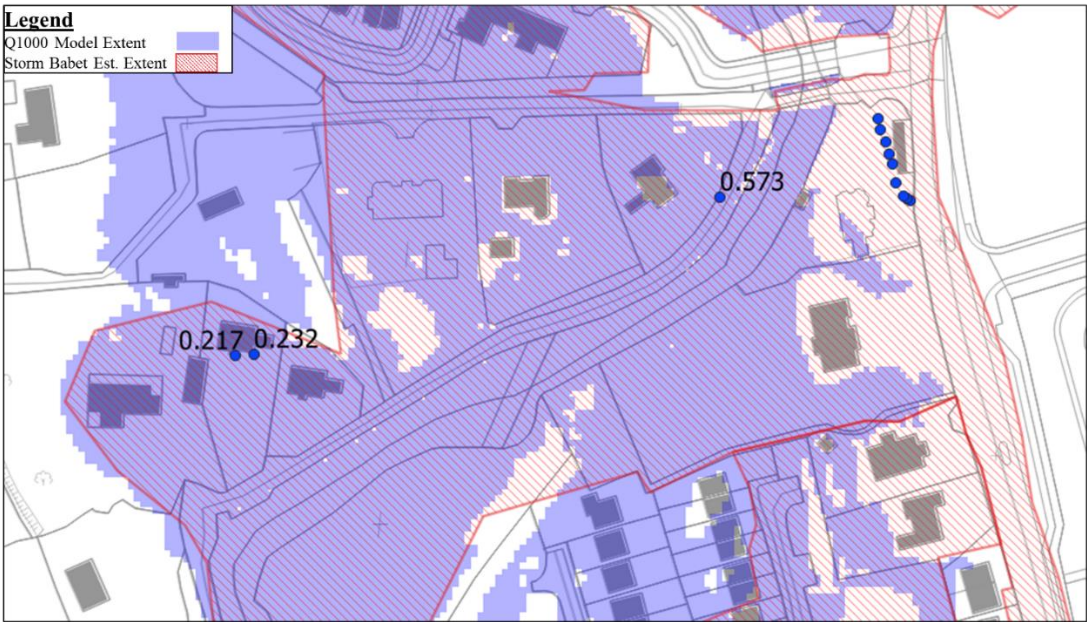

Figure 19: Downstream of Moore's Bridge: Wrack Marks vs Q1000 Modelled Levels (m)

A video posted to social media on the day of the event shows the water level downstream of Moore's Bridge to be at the same level as the top of the wall along the left bank which is set at 14.62mOD. It is not known exactly when this video was taken or if it coincides with the peak of the event. However, by comparing this level to the modelled Q1000 water level at this location (13.4mOD) it can be seen that the observed water levels during the event are significantly (+1m) higher than the Q1000 levels at this location.

The recorded finished floor level of the property immediately downstream of Moore's Bridge on the left bank is 13.6mOD and wrack marks recorded close to the house suggest the max water level was circa 14.15mOD. The estimated depth of flooding of the property during the event is therefore circa 0.55m.

Figure 20: Still of Video Recorded showing Moore's Bridge During Flood Event

Images taken by CCC during a post event site walk over show that a section of the left bank downstream of Moore's Bridge collapsed (Figure 21). It was also evident from the site walkover that 3-4 trees fell into the river during the event which may cause a risk of blockage in the channel at the present time.

Figure 21: Collapsed Left Bank Downstream of Moore's Bridge

As part of a further site visit by CCC on 20th November, it was noted that the road downstream of Moore's Bridge (Broomfield Ridge) had been undermined at a number of locations during/ post the storm event and is presently unsafe to traverse (Figure 22).

Figure 22: Broomfield Ridge undermined

CCC also noted deposition from the event at the bend in the river circa 240m downstream of Moore's Bridge, Figure 23, was taken at the river bend looking upstream and shows the deposition of material.

Figure 23: Deposition of material on the left bank and in channel (photo looking upstream)

A significant number of scour holes occurred across Midleton during Storm Babet and one such hole occurred at the entrance to the property immediately downstream of Moore's Bridge on the left bank. Figure 24 is an image of the scour hole which was estimated to be circa 400mm deep. It is therefore evident that the velocities at this location during the event would have been very significant. Further scouring was observed in the front yard of the neighbouring property immediately to the south as indicted in Figure 25.

Figure 24: Significant Scour: Entrance to Property Immediately downstream of Moore's Bridge (left bank)

Figure 25: Significant Scour: Property downstream of Moore's Bridge (Left Bank)- Southeast corner of property

Further south along the R636, two boundary walls which are located at boundary of the Willowbank estate failed during the event which led to a significant volume of overland flow to enter the estate. The location of these boundary walls and images taken as part of the post flood event site walk over are below. The direction of flow from North to South is also shown in Figure 26. The impact of this wall collapse on properties in the Willowbank Estate will be discussed further in the next section of the report.

It is estimated a total of 11 residential properties were inundated during the Storm Babet event in the area downstream of Moore's Bridge.

Figure 26: Boundary Walls Failed

3.4.4 Willowbank

Mechanisms of Flooding in Hydraulic Model

The primary mechanism of flooding to Willowbank in the hydraulic model is due to overland flooding from the North. This flood mechanism is represented by the "A" arrows in Figure 27.

The boundary walls around the estate were removed from the Q100 and Q1000 events in the hydraulic modelling such that all the overland flow enters the estate unimpeded. All the walls within the estate itself have also been removed such that there is no impediment to the movement of the water from any structures within in the estate in the model.

As noted above two boundary walls to the North of the estate failed during the event which justifies our approach in removing the walls for extreme events. The walls in the estate however remained standing and did exert an influence on the flow paths during the event. This needs to be considered when comparing the estimated extent from the event with the modelled Q1000 extent.

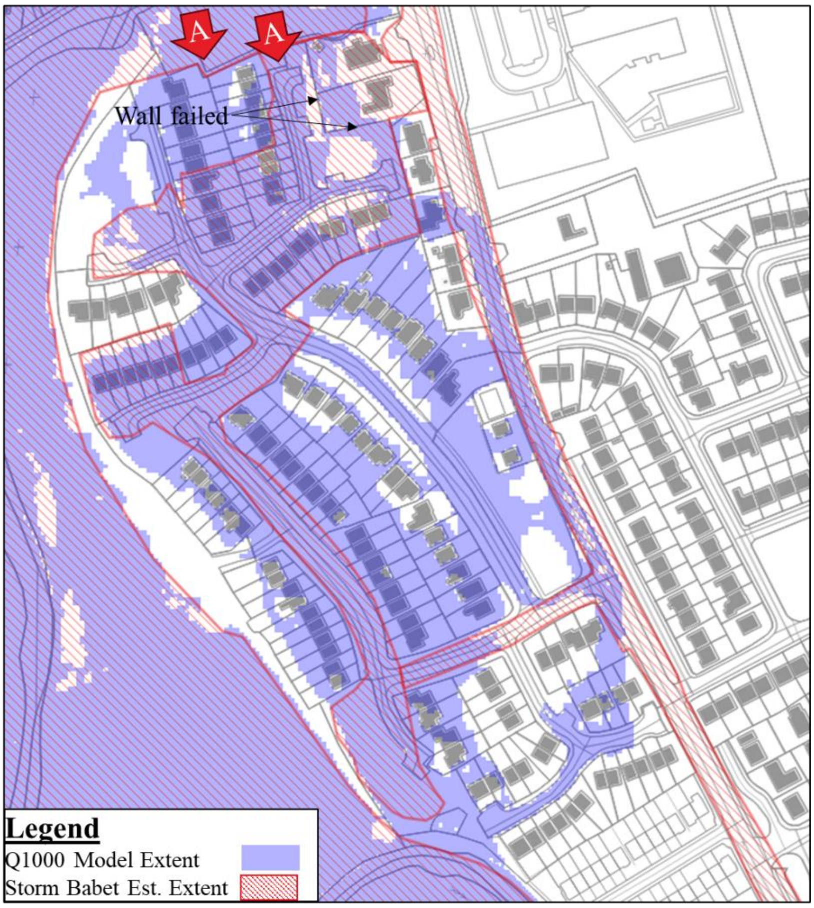

Figure 27: Existing Flood Mechanisms Willowbank

Comparison of Modelled vs Observed Mechanisms During Storm Babet

The failure of the two boundary walls provided a route for the overland flow from the Owenacurra to enter into the estate. Once in the estate the floodwater travelled in a south westerly direction due to the fall in ground elevation in that direction. A video posted online at 2.20pm on the day of the event indicates the velocities and depths of flooding which we note were significant. A still of this video is presented in Figure 28 and shows the failed wall and the extent of flooding close to the peak of the event.

Figure 28: Still of video captured close to the peak of the flood event in Willowbank

A number of wrack marks were recorded across the Willowbank Estate and in all cases, the Storm Babet maximum water levels exceeded the Q1000 modelled water levels. The delta between the surveyed wrack marks and the modelled Q1000 max water levels and the probable flow path are detailed in Figure 29. It is evident however that there are some inconsistencies between the modelled and observed levels indicated in the figure.

OPW staff discussed the observed flow paths with local residents and noted that that flood waters escaped back on to the R626 (Mill Road) south of properties on which the boundary walls failed. This flow path is also included in Figure 29.

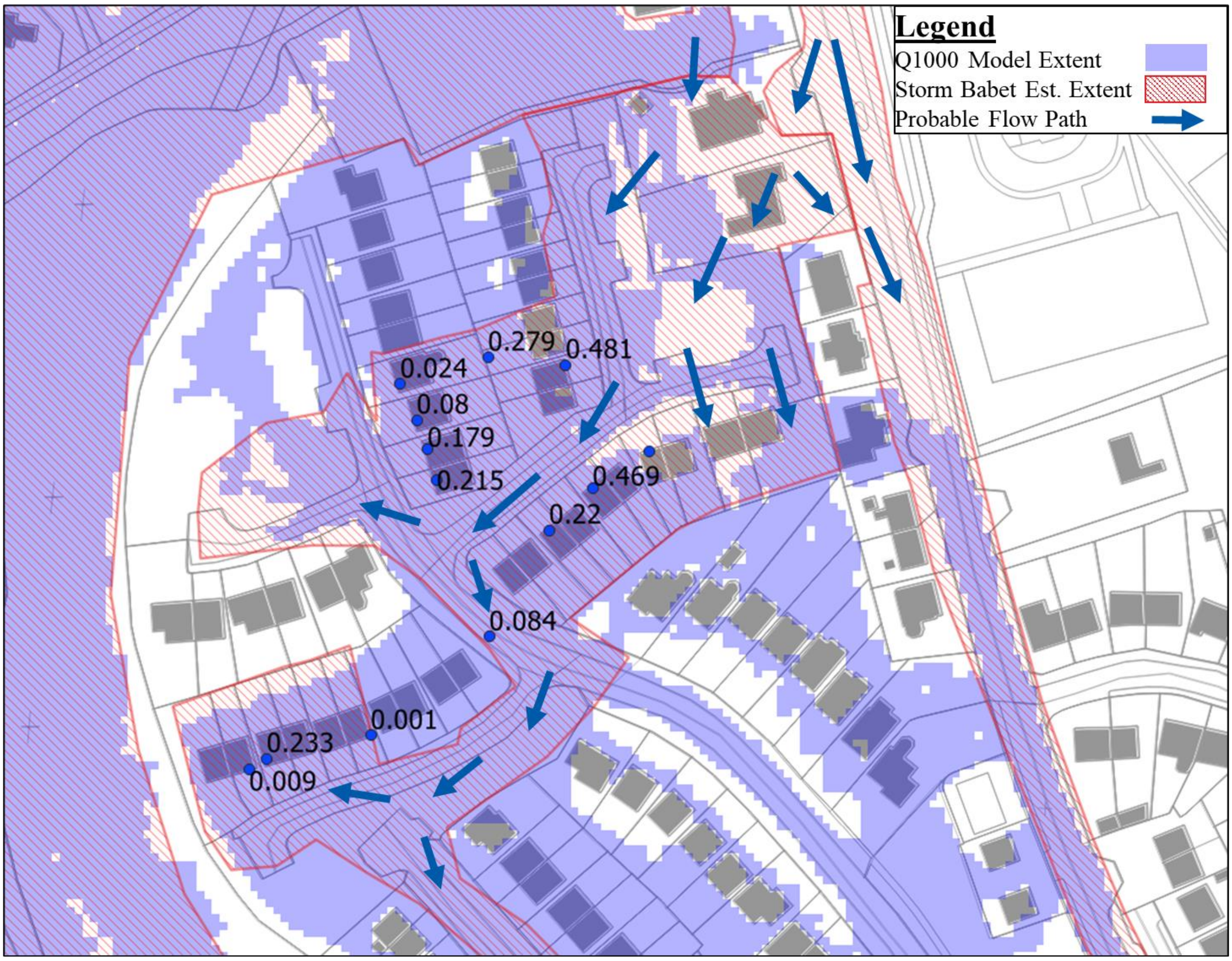

Figure 29: Willowbank: Wrack Marks vs Q1000 Modelled Levels (m) and Flow Paths

A wrack mark was recorded by Arup at a house on Willowbank Court, the maximum depth of flooding at this location was circa 0.50m as shown in Figure 30.

Figure 30: Wrack Mark at Willowbank Court

The informal embankment along the left bank of the Owenacurra was not over topped during Storm Babet which is consistent with the Q1000 model results.

It is estimated a total of 24 residential properties were inundated during the Storm Babet event in the Willowbank Estate.

3.4.5 Northern Relief Road/ Rail Line Level Crossing

Mechanisms of Flooding in Hydraulic Model

As detailed in the hydraulics report there are three mechanisms by which the Northern Relief Road/ Rail Line Level Crossing area is inundated. The mechanisms of flooding detailed below correspond to the arrows in Figure 31:

A. The Northern Relief Road (NRR) Bridge and Weir cause an afflux along the Owenacurra River upstream of the structures which in turn leads to overtopping of the left hand bank of the river. Once water escapes, it flows in a South Easterly direction and proceeds to flood the R626 (Mill Road) and the Railway cottages

B. For extreme events water over tops the NRR to the West of the NRR Bridge;

C. Flood water escapes the Owenacurra River immediately downstream of the NRR and floods the site adjacent to the river. For the Q100 event and above the volume of water on the site is sufficient to drive water across the site and inundate the area of the railway cottages;

D. Flood water escapes the millrace immediately upstream of the railway culvert for the Q100 event and flows overland towards the Railway cottages.

The railway crossing that intersects with the R626 road in the vicinity of the Railway cottages is elevated above existing ground levels and therefore acts as a control on flood levels. For the Q100 event, the volume of water collecting on the northern side of the railway line is sufficient to overtop the crest level and cause water to flow down Mill Road towards the Super Valu and roundabout at the top of Main Street.

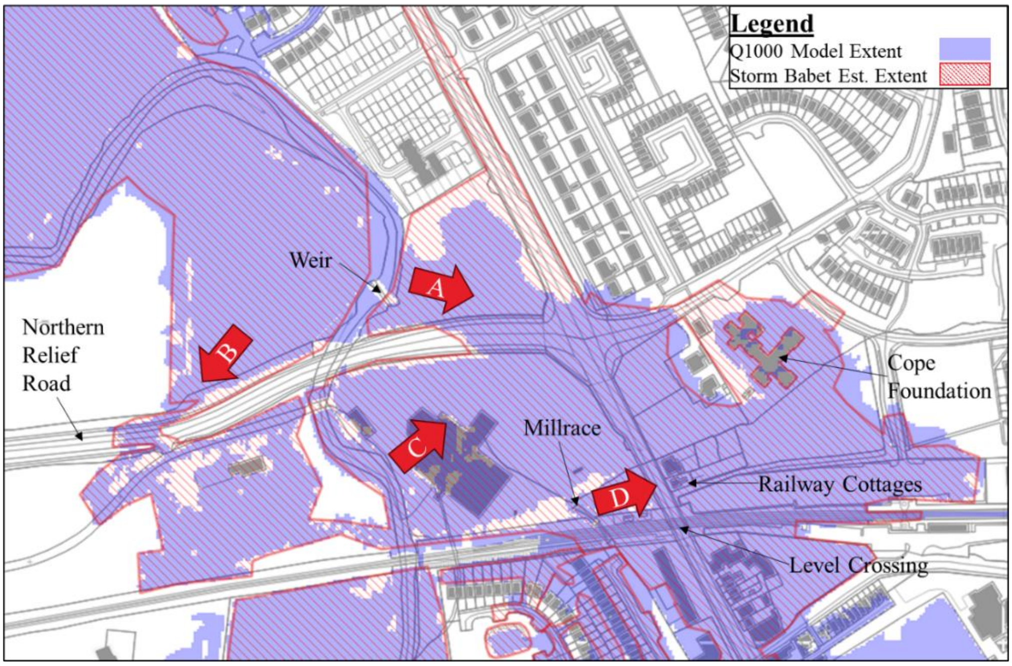

Figure 31: Existing Flood Mechanisms Northern Relief Road/ Rail Line Level Crossing

Comparison of Modelled vs Observed Mechanisms During Storm Babet

All the mechanisms of flooding identified by the model in this area were observed to occur during Storm Babet.

Water got out of bank upstream of the NRR/Weir resulting in a very large volume of water travelling in a South Easterly direction towards Mill Road. This corresponds to Mechanism A in Figure 31.

The road to the West of the NRR Bridge was also over topped during Storm Babet and flow was clearly observed to travel along the road and into the field to the south. Figure 32 presents a still of a video captured at 2.30pm which clearly shows this mechanism. It is noted that this corresponds to Mechanism B in the Figure 31.

Figure 32: Water overtopping NRR West approach road

An arial image taken from a drone and shared on social media also shows Mechanism B during Storm Babet (Figure 33).

Figure 33: Water overtopping NRR West approach road (arial image)

The bridge downstream of the NRR was also surcharged during the event. Based on inspection of the video and cross referencing it against the surveyed cross sections for this reach, the water level is estimated to be circa 9.1mOD at the bridge which is higher than the Q1000 maximum water level of 8.6mOD at this location. Flow can clearly be seen getting out of channel via the left bank in the direction of the railway cottages.

Figure 34: Bridge Downstream of NRR Bridge surcharged

An aerial image captured by Guileen Coast Guard shows the approximate extent of the flooding in this area. Flood mechanism A and C in this area are evidently occurring in the image.

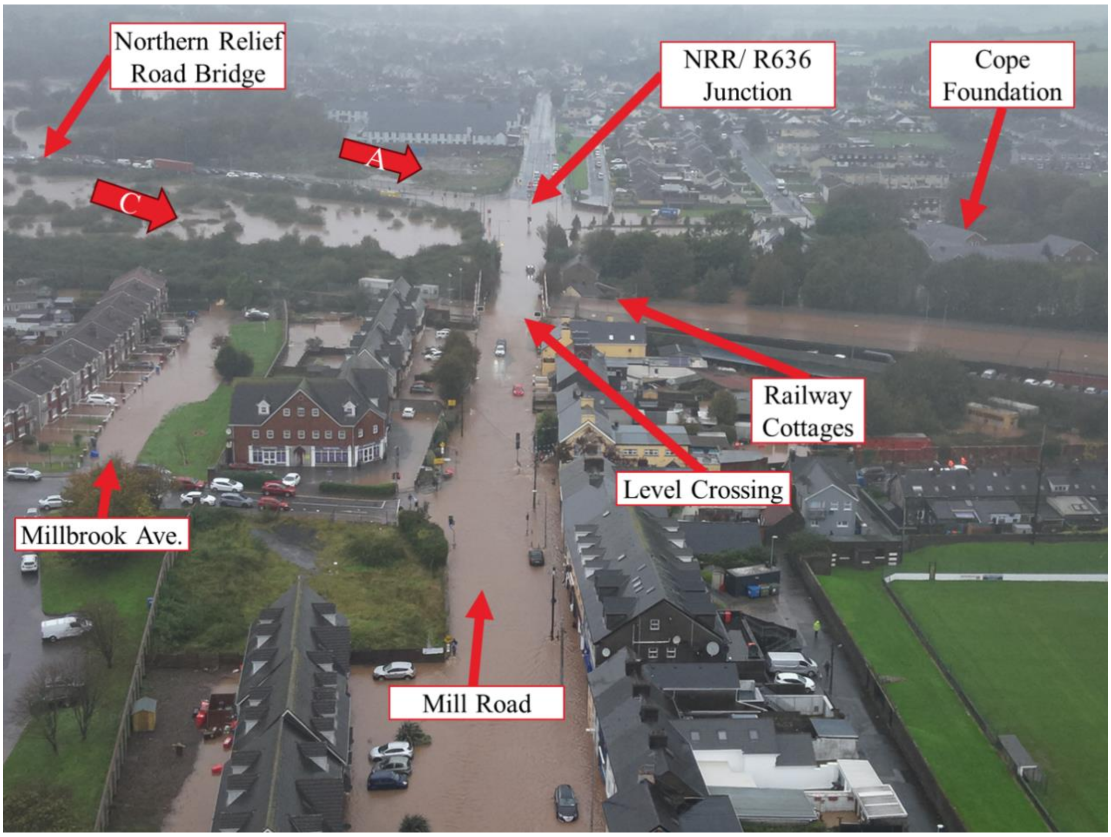

Figure 35: Aerial Image of Northern Relief Road/ Rail Line Level Crossing (Guileen Coast Guard)

The train station car park to the North of the railway track was also inundated as was the rail line itself (Figure 36).

Figure 36: North Train Station Car Park flooded

An additional mechanism not captured by the model but which occurred during the event relates to water travelling from Upper Mill Road down to the low point upstream of the rail line crossing. The absence of this mechanism from the model is in keeping with differences between the model and observations from the event with locations further upstream which have been discussed in the previous sections. As noted previously, these differences are due to the partial collapse and blockage of Moore's Bridge as discussed in Section 3.4.3.

Two residential properties (the Railway Cottages) were flooded in the area between the NRR Bridge and the Rail Line Level Crossing.

3.4.6 Millbrook/ Mill Road Lower

Mechanisms of Flooding in Hydraulic Model

There are two mechanisms of flooding relevant to Mill Road between the Rail Line Level Crossing and Park Street and the Millbrook Estate;

A. A large number of residential/commercial properties were inundated along Mill Road due to water overtopping the level crossing to the north and travelling south. It is noted that the head of water over the railway crossing on Mill Road during the event was observed to be circa 400mm-500mm above the rail track.

B. The Millbrook housing estate to the East of the Mill Road is also at risk of overland flow from water overtopping the railway line via the back gardens of a number of the properties in the North of the estate.

C. Water gets out of channel on the right bank downstream of the Rail Bridge at low return period events. This mechanism is not however significant and does not impact on any properties.

These mechanisms are presented in Figure 37.

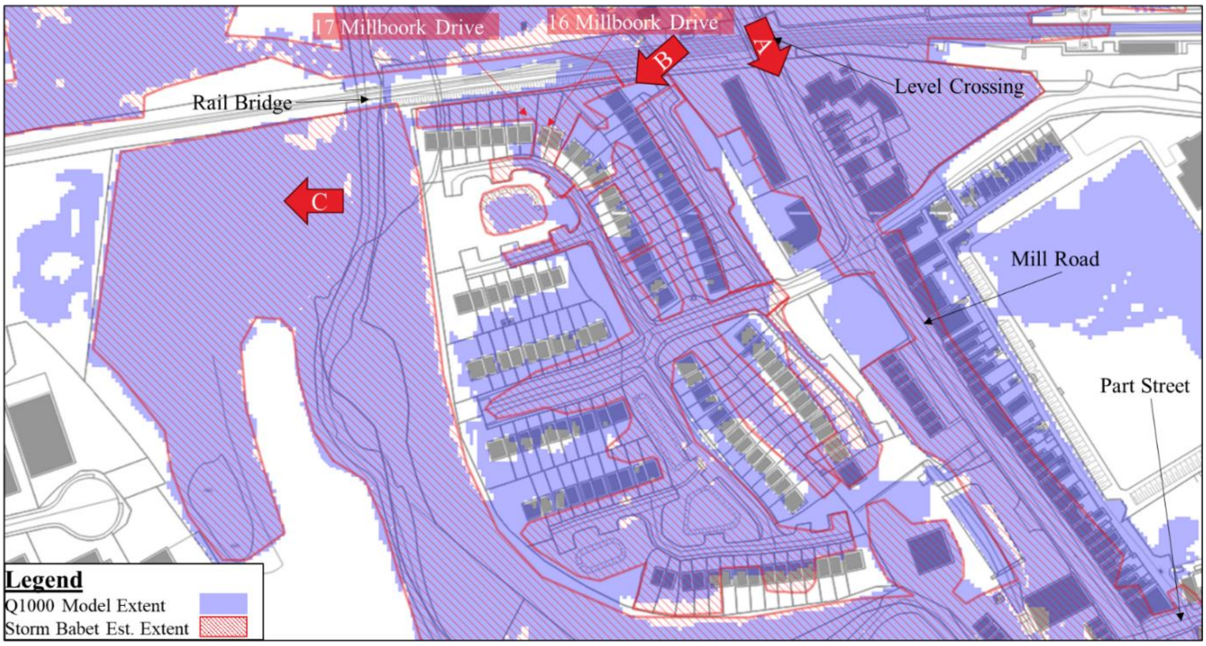

Figure 37: Millbrook/ Mill Road Lower: Existing Flood Mechanisms

Comparison of Modelled vs Observed Mechanisms During Storm Babet

The modelled mechanisms detailed above were all activated during the Storm Babet Event. It was reported by locals that the boundary walls at the back of the gardens of number 17 and 16 Millbrook Drive were severely damaged (location shown in Figure 37) which led water to flow unimpeded into their back gardens and around their properties into the estate (Figure 38). The two houses were also inundated at shallow depths. Once in the estate the water travelled in a southerly direction to the low point in the estate and collected given that it was unable to drain out onto Mill Road.

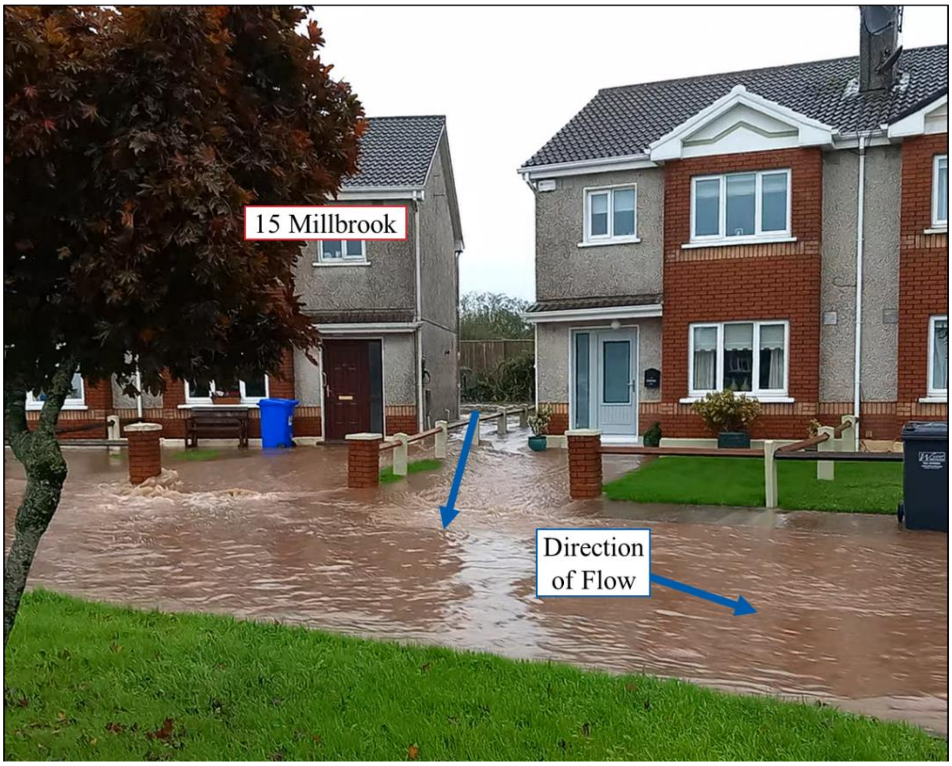

Figure 38: Flow Path of water Entering Millbrook and Travelling South at Shallow Depths. The image was captured at 1.16pm

The witnessed extent of flooding of Millbrook/ Mill Road Lower was slightly less than the modelled Q1000 extent which is likely due to the impact that the property walls had on the localised flow paths and extents. An aerial image from the Guileen Coast Guard shows the extent of flooding in the area. It is noted that the embankment to the Southwest of Millbrook did not over top during the flood event as shown in the Q1000 model.

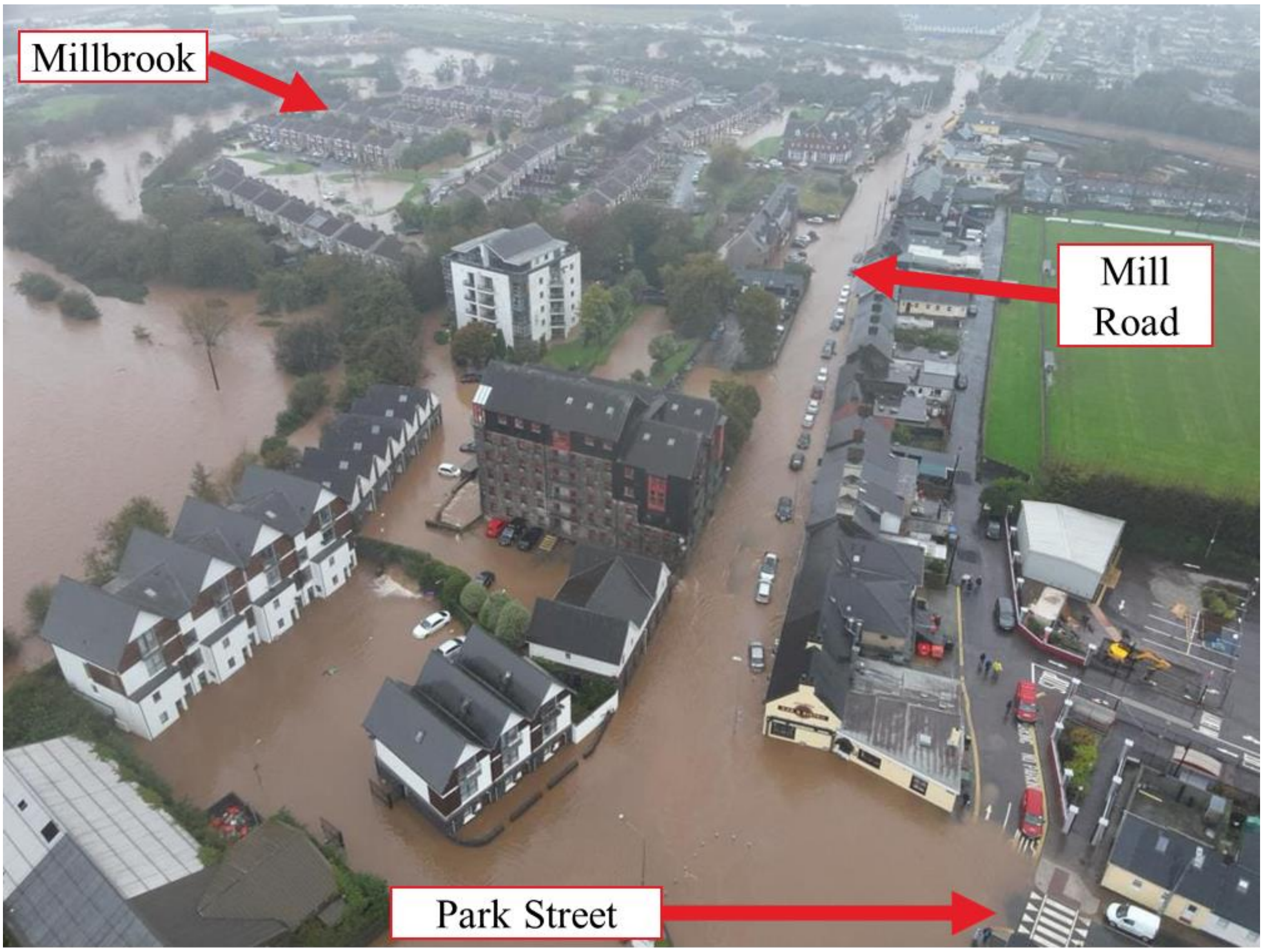

Figure 39: Aerial Image of Millbrook/ Mill Road Lower (Guileen Coast Guard)

It is estimated that 58 properties were flooded on Mill Road (between the Rail Line Level Crossing and Park Street) and a further 26 properties flooded in the Millbrook Estate.

3.4.7 Millrace Apartments / Market Square Area

Mechanisms of Flooding in Hydraulic Model

There are a number of mechanisms of flooding in the area from the Millrace apartments to the top of Main Street/Market Square area. This area includes a number of large commercial properties (Maxol Garage, Hurleys SuperValu, Riversdale Shopping Centre), public amenities (MyPlace, Midleton Garda Station), healthcare facilities (Midleton Community Hospital, Owenacurra Centre) as well as residential properties (Suncourt, Lourdesville Estate and properties on Cork Road). The mechanisms of flooding detailed below correspond to the arrows in Figure 40;

A. As discussed in the previous sections, flood water overtops the railway line and flows south along the R626 road. This is the primary mechanism of flooding for this area for large events;

B. Water overtops the downstream end of the Owenacurra Millrace in the Q100 event and enters the site of the Millrace Apartments block complex. From here it flows out onto the Mill Road and proceeds to flow south towards the Supervalu supermarket.

C. Water overtops the right bank of the Owenacurra upstream of the Market Green Bridge at low return period events but is contained by existing ground levels;

D. Water overtops the left bank of the Owenacurra upstream of the Market Green Bridge in the Q100 event. The volume of water escaping the channel at this location however is relatively minor and flood risk is primarily driven by overland flow coming from the R626 as discussed above.

E. Water overtops the right bank of the Owenacurra downstream of the Market Green Bridge in the Q100 event.

F. Overland flow from Area 4 (Lauriston Mews/Midleton Rugby Club)

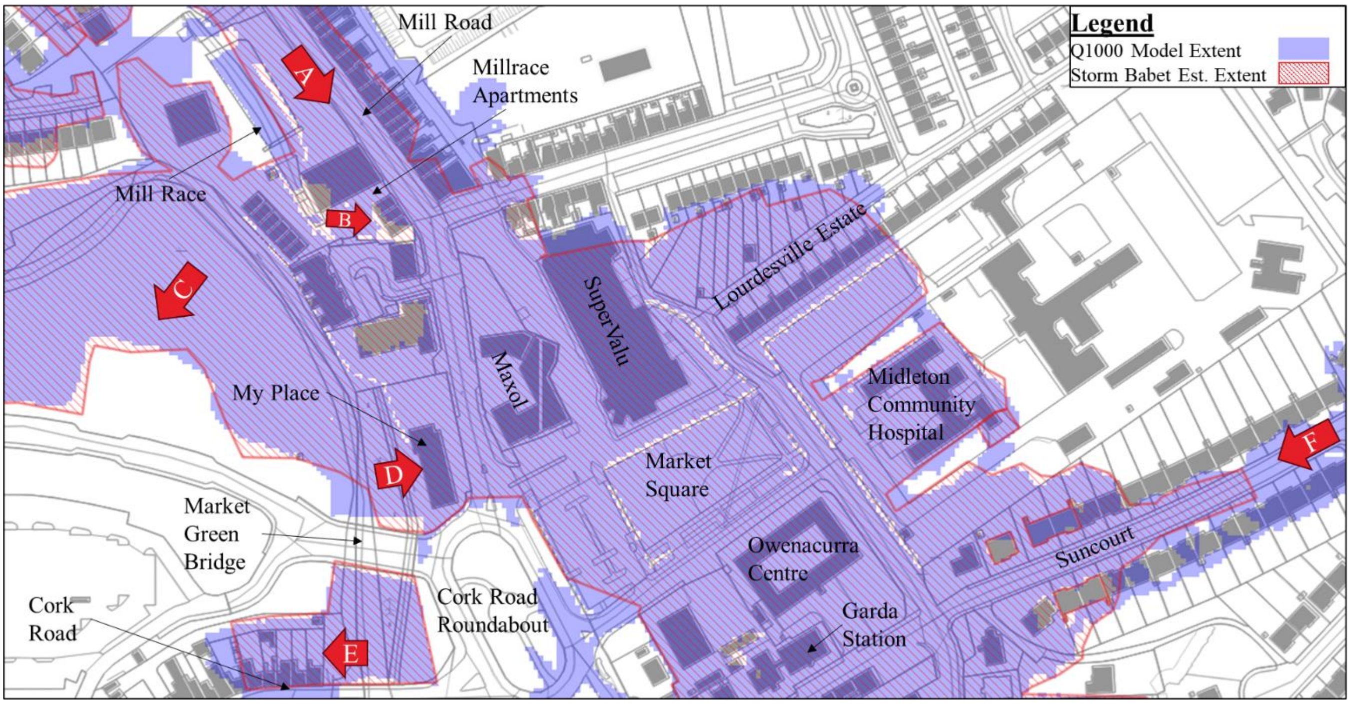

Figure 40: Millrace Apartments/ Market Square Area: Existing Flood Mechanisms

Comparison of Modelled vs Observed Mechanisms During Storm Babet

All of the mechanisms of flooding detailed above occurred during Storm Babet with the exception of flood mechanism F i.e. flow from the East. The Suncourt estate however was flooded due to overland flow from the West i.e. a combination of flood mechanism A, B and D. Figure 41 clearly shows flooding from the Mill Road (Mechanism A) and overtopping of the Millrace (Mechanism B).

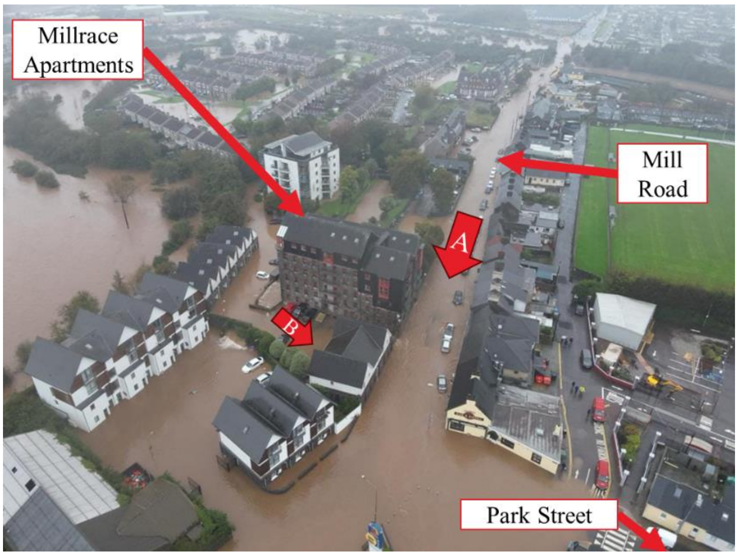

Figure 41: Flooding via Mill Road and the Millrace

Figure 42 shows flooding of the right bank floodplain upstream of the Market Green Bridge (Mechanism C).

Figure 42: Flooding on Right Bank Upstream of Market Green Bridge

Figure 43 shows flooding of the left bank upstream of the Market Green Bridge (Mechanism D).

Figure 43: Flooding on Left Bank Upstream of Market Green Bridge

A wrack mark was recorded by CCC at the rear of MyPlace, the maximum depth of flooding at this location was circa 0.85m as shown in Figure 44.

Figure 44: Wrack Mark at Rear of MyPlace

Figure 45 shows flooding of the right bank upstream of the Cork Road Bridge (Mechanism E).

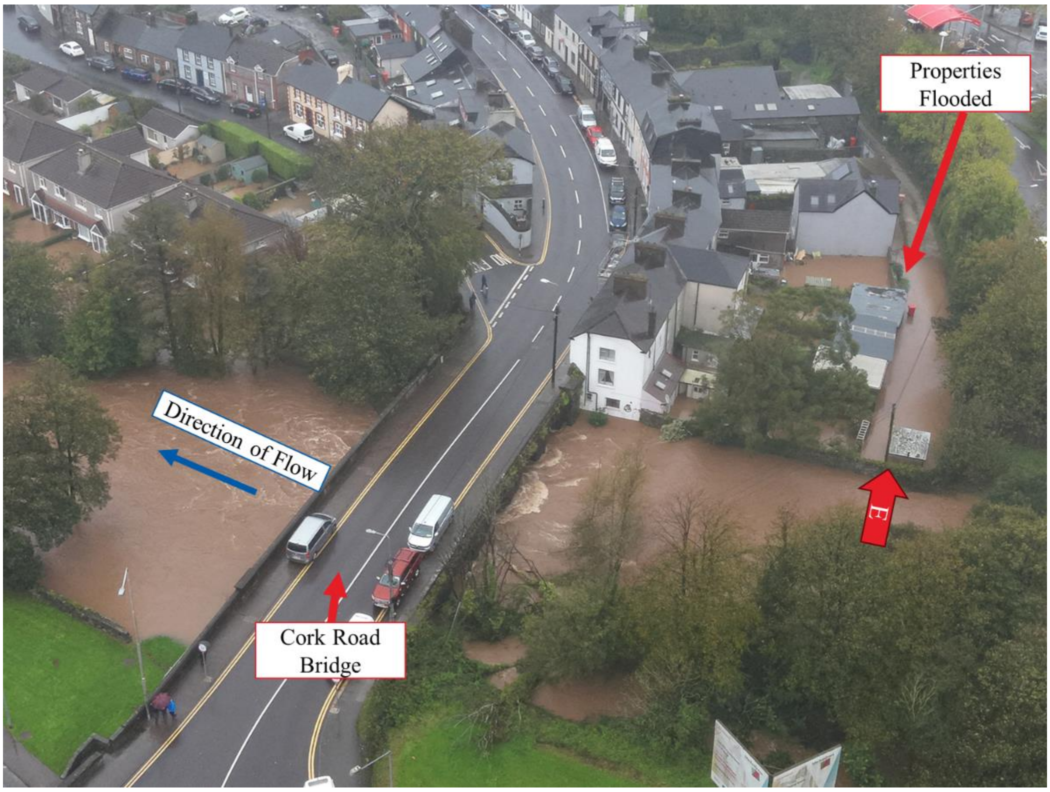

Figure 45: Flooding on Right Bank Upstream of Cork Road Bridge

It is estimated that circa 50 residential properties and circa 13 commercial properties/ public amenities, including the Maxol Garage, Hurleys SuperValu, Riversdale Shopping Centre, MyPlace, Midleton Garda Station, Midleton Community Hospital and Owenacurra Centre were flooded in this area during Storm Babet.