ARUP

Cork County Council

Midleton Flood Relief Scheme

Interim Measures Report

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Executive Summary

Arup has been commissioned by Cork County Council (CCC) to develop a Flood Relief Scheme (FRS) for Midleton. The overall scheme will consist of flood alleviation measures that defend against fluvial, tidal, pluvial and groundwater flooding sources of flooding. The required Standard of Protection (SoP) of the Scheme is the 1% AEP fluvial flood event and the 0.5% AEP tidal / coastal flood event.

In parallel with developing this scheme, CCC requested that Arup assess the potential interim measures that may be carried out across the scheme area in order to provide flood mitigation before the scheme is implemented. These measures do not generally provide the equivalent standard of protection offered by a proposed flood relief scheme, but can provide some protection against flood risk for lower return period events (i.e. more frequent but less severe events).

This report details the interim measures which have already been progressed in the aftermath of Storm Babet (18/10/23). The report also recommends a number of interim measures that should be implemented as a matter of urgency as well as measures that require a more detailed assessment to determine their suitability in Midleton. A summary of these measures is listed below.

Recommended interim measures to be implemented as a matter of urgency:

- River channel and drainage system clearance and maintenance works at various locations. This includes the removal of excess vegetation and sediment build up at key locations.
- Removal of gravel deposition from river and floodplain at Moore's Lane
- Repairs to a number of non-return valves
- Installation of additional hydrometric gauges

Recommended interim measures / advance works which require further detailed feasibility studies:

- Implementation of a flood forecasting system for the town
- Implementation of IPP for properties at risk
- Assessment of the impact of advance works being constructed at key locations in the town.
- Assessment of temporary measures for the Woodlands Estate and the impact on flood risk downstream of the estate.
- Feasibility study for the construction of debris screens upstream in the catchment.

1. Introduction

1.1 Introduction

In advance of the construction of the proposed Midleton Flood Relief Scheme, Cork County Council have requested Arup to outline and assess potential measures that may be carried out in order to provide flood mitigation before the scheme is implemented.

The broad range of works that may be considered can be divided into five separate categories:

1. Interim measures
2. Advance works
3. Temporary defences
4. Accommodation works
5. Flood warning system which alerts communities to an impending flood event

Each of these measures are discussed in further detail in the following sections of the report.

1.2 Interim Measures

Interim flood measures refer to any temporary actions, strategies, or interventions that are implemented in a particular area in order to mitigate the risks and impacts of flooding while more permanent solutions are being developed or implemented for the whole of the scheme area. Interim measures are typically put in place to provide immediate relief and protection to communities, infrastructure, and natural environments vulnerable to flooding.

A number of interim measures have been completed since Storm Babet (18th October 2023) and are described in the following section of the report in Section 2.2.

Further possible interim measures which may be considered appropriate for Midleton in advance of completion of the scheme are also discussed in this report.

Interim measures do not generally provide the equivalent standard of protection offered by a proposed flood relief scheme, but can provide some protection against flood risk for lower return period events (i.e. more frequent but less severe events).

1.3 Advance works

Advance works entail progressing certain elements of the proposed main scheme in specific areas in advance of constructing the whole of the scheme. Advance works can include the construction of hard defences (walls/ embankments) and/or conveyance improvements should such measures form part of the main scheme. As advance works are in effect the components of the scheme, they can provide a high standard of protection (SoP) against flooding. In some instances, this can be up to the SoP of the scheme provided the measures are not bypassed by flood water getting in behind the works from either end.

The purpose of advancing elements of the main scheme in a particular area is to reduce the flood risk for that area when there is an urgent necessity to do so.

Detailed assessments of any possible advance works are required in order to understand the impact of implementing the works in advance of the construction of the whole scheme. Based on experience, it is likely that a reduction of floodplain in one area through defending could increase water levels in other areas. In such a situation, CCC and the OPW would need to make a decision on the proposed advance works taking into account the associated risks and benefits.

As advance works may potentially increase flood risk downstream, additional mitigation measures should be examined to address the likely change in risk downstream.

This may involve maintenance, additional conveyance, protection, individual property protection, nature based measures or other suitable measures. A risk based approach may be taken, given the likely duration that any works will be in place and the probability of flooding elsewhere.

An appropriate Statutory Planning Consent Route to deliver these elements of the scheme ahead of the full scheme would need to be considered. Furthermore potential environmental impacts associated with advancing elements of the preferred scheme need be considered in detail. If the advance works are proposed on privately owned land, landowner constraints would also need to be evaluated.

1.4 Temporary defences

Temporary defences refer to works that are put in place for a short period of time in order to reduce the risk of flooding to a particular area. While such defences are very unlikely to offer the target Standard of Protection due to the limited height at which they can defend, such structures can defend against lower return period events and reduce flood risk in an area.

Examples of such works include inflatable flood barriers (which can be filled with water), large sandbags and large-scale demountable defences.

1.5 Accommodation Works

Accommodation works refer to engineering or construction activities that are carried out to facilitate the flood relief scheme. These works are necessary to adapt the surrounding environment or infrastructure to accommodate the scheme.

Accommodation works can include various activities such as:

- Site Preparation: Clearing vegetation, levelling ground, and preparing the site for construction.
- Utilities installation/diversion: Installing or modifying utilities such as water supply, sewage systems, electrical lines, and telecommunications infrastructure to facilitate the scheme.
- Access: Building or upgrading roads, pathways, or access routes to and from the project site to ensure adequate transportation access.
- Landscaping: Landscaping and environmental enhancements to mitigate the visual impact of the scheme and integrate it into the surrounding area.
- Environmental Mitigation: Implementing measures to mitigate any adverse environmental impacts resulting from the project, such as habitat restoration or invasive species treatment.

Accommodation works can contribute to the successful execution of flood relief schemes. They help ensure that the scheme integrates harmoniously with its surroundings and mitigate negative impacts on the environment or existing infrastructure. These will be considered as the scheme design progresses.

1.6 Flood Warning System

A flood warning or flood forecasting system is a non-structural measure that provides advance warning of an impending flood event to communities at risk. Once alerted, communities can undertake measures to mitigate the risk associated with the event such as:

- Install Individual Property Protection (IPP) at properties at risk in order to limit ingress into properties;
- Move vehicles and commercial stock out of areas of risk;
- Evacuate people from vulnerable areas.

Key to the successful implementation of a flood warning system is robust and accurate forecasts issued with a sufficient lead in time. It is noted that it may be possible to provide some advance warning using existing infrastructure and this will be examined by CCC and the OPW.

2. Progress since Storm Babet

2.1 Overview

Since the Storm Babet flood event, the Midleton Flood Relief Scheme steering group has been continuing to progress the design of the scheme as expediently as possible. In parallel, the Steering Group have also been assessing the impacts of Storm Babet on the design hydrology and engineering works required as part of the scheme.

2.2 Interim measures progressed/in progress since Storm Babet

A number of interim measures have already been assessed and implemented across the scheme area since Storm Babet. These measures are detailed in the following table along with the benefit that they have offered.

Measure	Benefit offered
Drone survey of the Owenacurra to identify blockages in channel	Allowed for all the key blockages in the Owenacurra/Dungourney rivers that occurred during Storm Babet to be identified and assessed.
Removal of trees in channel at Moore's Bridge in December 2023	This reduces the risk of blockage in the channel and also ensures the trees do not lead to locally elevated water levels in the channel during any future flood event
Installation of water level gauge at Tir Cluain Bridge in December 2023	Provides data on water levels in the Owenacurra which can be used as part of any flood warning system for the town. The data will also inform on all future further studies on flood risk as part of the Midelton FRS project.
Installation of gauges at Lidl Bridge and pedestrian bridge in People's Park in February 2024	As per the above point
Upgrade of the Ballyedmond gauge to provide real time flow and level data (https://waterlevel.ie/0000019020/)	Provides data on water levels at the gauge in real time which can be used as part of any flood warning system for the town.
OPW and CCC are engaging with Met Éireann in relation to flood awareness, community resilience and preparedness and improving flood forecasting for high risk towns and village, and additional training for CCC staff.	Will be utilised as part of any future flood warning system for the scheme

3. Potential Interim Measures

3.1 Scheme Areas

A number of potential short-term and medium-term interim measures have been identified across the study area and a screening assessment of them has been undertaken.

For the purpose of this report, interim measures for the whole of the study area are first considered. Specific localised measures for the different geographical areas of the scheme (which are aligned with the area breakdown as per the Public Participation Day posters) are then presented.

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

3.2 Potential Measures across the Study Area

The interim measures which could be considered across the whole study area are as follows:

- Individual Property Protection (IPP)
- Ongoing river channel and drainage maintenance

3.2.1 Individual Property Protection (IPP)

Individual Property Protection (IPP) involves defending properties from inundation by blocking all the entrances into the premises that may allow flood water to enter. IPP is undertaken at the property scale and measures are implemented for each property individually.

Individual Property Protection typically involves a combination of deploying flood resistant doors, door barriers, gate barriers, small-scale pumping or the installation of non-return valves to restrict back flow of flood waters.

While IPP can offer protection against flooding, there are a number of constraints:

- This measure requires an advance warning of an impending flood event which ideally would be issued by an early warning/flood forecasting system. Such a system allows homeowners to have a sufficient warning time in order to deploy the defences at their properties;
- The deployment of the defences needs to be undertaken by each homeowner individually and it is recognised that there may be some homeowners who may not be able to undertake this task;
- Leakage of water around and under the various IPP measures once they are in place;
- For most existing properties, the maximum height of flood water that can be defended against using IPP is circa 800-900mm such that in an extreme event the IPP can be overtopped and flood the property.

Discussions between OPW and CCC are now at an advanced stage, and a formal funding application is anticipated in the coming weeks (June 2024).

3.2.2 Ongoing river channel and drainage maintenance

CCC are presently implementing a maintenance programme for the drainage networks across the study area in order to limit the risk of blockages which may increase flood risk during a storm event with low return periods. This work ensures that the full capacity of the drainage network is available to convey surface water during flood events.

CCC do not have a statutory role in river channel maintenance. Monitoring of blockage risk is however ongoing and should such blockages occur, appropriate action will be taken by CCC.

CCC have also issued letters to riparian landowners reminding them of their responsibilities with respect to river channel maintenance and removal of potential blockage risks.

3.3 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 1

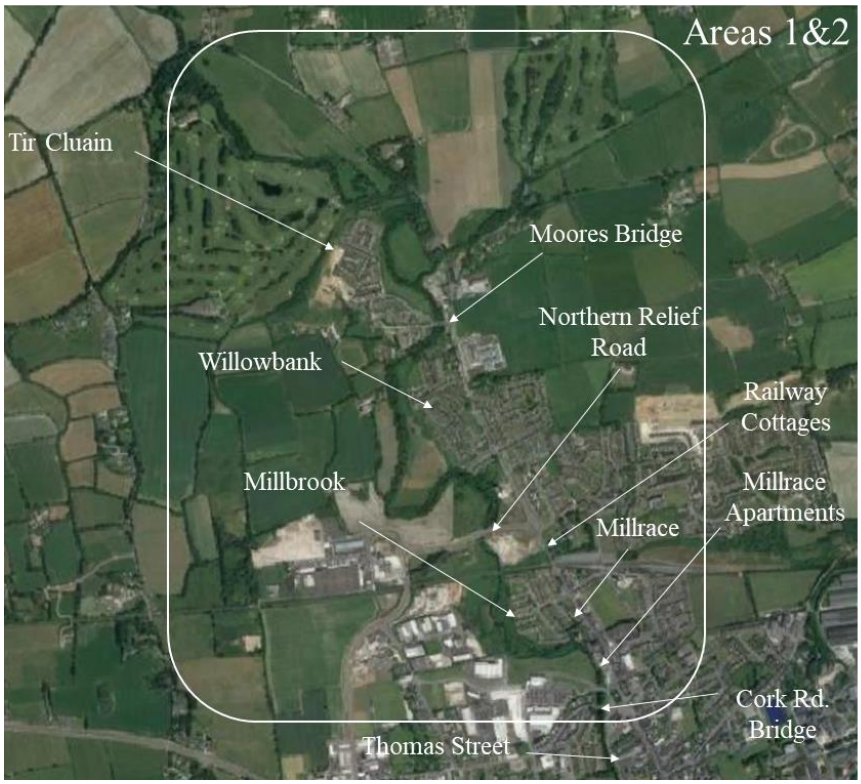


Figure 1 Areas 1 and 2

Within Area 1 and 2, the following potential list of interim measures have been considered and assessed:

- Debris screens upstream
- Removal of gravel deposition in stream
- Removal gravel deposition out of channel
- Installation of gauges
- Removal of blockage risks
- Reinstatement of the bank downstream of Moore's Bridge
- Conveyance improvements on Owenacurra Millrace

Each of these measures are now discussed.

3.3.1 Debris screens upstream

The installation of coarse debris screens upstream on the Glenathonacash Stream will reduce the blockage risk downstream by limiting the passage of large debris beyond the screen. Given the known risk of blockage at Moore's Bridge during recent flood events, this measure will reduce the risk at this location.

An example installed in Ballybrack Woods as part of the Douglas Flood Relief Scheme in presented in Figure 2.

The location of any potential screen must be easily accessed to allow operation and maintenance. Landowner access will need to be managed and due to the in-channel works, the environmental impacts will need to be considered.

Careful regard will need to be taken when selecting an appropriate location of the screen as there will be an increased blockage/ flood risk at the location of the screen during the event, i.e. if a large tree catches in the screen during an event, water levels upstream of the screen will be elevated until the blockage has been removed after the event.

Figure 2 Douglas Flood Relief Scheme - Debris Screen

3.3.2 Removal of gravel deposition in stream

A considerable volume of material was deposited downstream of Moore's Bridge during the Storm Babet event. This has had an impact on channel conveyance through the reach and has increased flood risk to the adjacent properties for low return period events.

Local property owners have reported flooding of their land on a number of occasions in the months following the flood event. Detailed channel surveys have been carried out to assess the volume of deposition and to assess the scale of works required to reinstate the channel geometry to pre-Storm Babet levels.

CCC and Arup have consulted with Inland Fisheries Ireland (IFI) to discuss the environmental impacts and in-stream works window (confirmed as July to September) required to remove the debris. A hydraulics assessment has been prepared to support a derogation licence to carry out in-channel works outside of this window.

3.3.3 Removal of gravel deposition out of bank

A significant volume of gravel was also deposited on the left bank adjacent to the Willowbank Estate as shown in Figure 3. It is recommended that these gravels are removed in order to improve floodplain conveyance and reduce water levels on the floodplain and hence to reduce flood risk. It is noted that there are no seasonal constraints in doing so.

Figure 3 Deposition of material on the left bank and in channel (photo looking upstream)

3.3.4 Installation of gauges

The OPW Hydrometric Team are investigating the installation of another flow gauge on the Owenacurra River as part of the scheme. The assessment of an appropriate gauging location is progressing.

As noted previously, the EPA have upgraded the gauge at Ballyedmond and it is now sending real time data to waterlevel.ie. It is also noted that CCC have installed a water level gauge at Tir Cluain Bridge.

These gauges could potentially be used as part of a flood warning system for the catchment, see Section 5 for further detail. They can also inform future hydraulic assessment of the catchment.

3.3.5 Removal of blockage risks

There are a number of locations in Area 1 and 2 where existing structures provide an increased risk of blockage and hence elevated water levels during a flood event. It is proposed that measures be taken to mitigate these risks.

CCC are progressing the diversion of existing Uisce Éireann assets under the Carrigogna Bridge. The existing watermain pipe runs under the Carrigogna Bridge on the R626 passing over the Glenathonacash watercourse, a tributary of the Owenacurra (Figure 4). It and a parallel decommissioned watermain are a hydraulic restriction and potential blockage risk to river flows in flood conditions, and these will be removed and/or diverted as appropriate.

Figure 4 Carrigogna Bridge- Watermain passing under bridge

Moore's Bridge was significantly blocked and also partially collapsed during the Storm Babet event (Figure 5). Arup have carried out an assessment of the bridge and it is recommended it be removed as an interim measure in order to reduce blockage/ flood risk locally in this area.

CCC are actively engaging with the relevant landowners in relation to this bridge.

Figure 5 Moore's Bridge Collapse- Image taken post Storm Babet (19/10/2023)

The minor bridge downstream of the Northern Relief Road (Figure 6) was surcharged during the Storm Babet event. Based on inspection of a video captured during Storm Babet and cross referencing it against the surveyed cross sections, the Storm Babet water level was estimated to be circa 9.1mOD at the bridge.

The estimated design water level at this location is 8.4mOD while the surveyed soffit level of the bridge is circa 7.78mOD. As the undersized bridge opening limits conveyance through this section and also introduces a risk of blockage, it is recommended that it be removed.

It is noted that the bridge's existing purpose is very limited as it links two uninhabited sites, both of which have alternative access.

CCC is actively engaging with the relevant landowners to secure agreement for the removal of this bridge.

Figure 6 Bridge downstream of Northern Relief Road Bridge

There is also an existing structure facilitating services crossing the Owenacurra circa 20m upstream of the rail line crossing (Figure 7) The design water level at this location (circa 7.2mOD) is approximately 2.2m lower than the underside of the structure (circa 9.4mOD). Therefore there is a very low risk of debris snagging and causing a potential blockage at this structure.

However its removal as an interim measure (and the services be diverted if still in use) could provide a minor flood mitigation measure. The blockage risk versus the cost of the works should be evaluated in further detail.

Figure 7 Structure facilitating services upstream of the railway line

3.3.6 Reinstatement of the bank downstream of Moore's Bridge

A section of the left bank downstream of Moore's Bridge collapsed (Figure 8) during Storm Babet. An analysis on the benefits of reinstating this section of bank back to pre-Storm Babet levels as part of the potential interim measures has been carried out.

Figure 8 Collapsed Left Bank Downstream of Moore's Bridge

Based on inspection of topographical survey data acquired before the storm event, the edge of bank immediately downstream of the ornamental wall shown in Figure 8 is circa 13.49- 13.33mOD. It is estimated that between 2m and 3m of the bank has been eroded over a length of approximate 15m. Survey taken post Storm Babet shows the edge of bank level is between 13.23 and 13.56mOD. As the ground rises behind the edge of bank, there is no impact on the threshold of flooding due to the erosion caused by Babet.

It is noted that the design water level (1% AEP event) in this area is circa 13.5mOD and is therefore greater than the elevations of certain sections of the bank. It is appropriate to mitigate/ manage further erosion risk in this area and it is recommended that the erosion in this area be monitored, and control measures put in place if required.

3.3.7 Conveyance improvements on Owenacurra Millrace

From our site inspections and assessment of survey data, it is evident that there is a build-up of sediment/ vegetation at the entrance/ exit of the twin box culvert passing under the railway on the Owenacurra Millrace (Figure 9 and Figure 10). This reduces the flow area/ blockage risk which may lead to an increase in water levels immediately upstream and hence the flood risk.

During the design flood event, water overtops the Millrace left bank at this location and travels in the direction of the Railway Cottages.

As an interim measure, it is recommended that the sedimentation/ blockage risk in this area be addressed to mitigate against flooding. The environmental impacts of the removal of sedimentation/ in channel works will need to be considered and carried out at an appropriate time of the year to comply with various environmental constraints.

Figure 9 Photograph of the Millrace railway culvert – upstream face (July 2017, Murphys Surveys)

Figure 10 Downstream face of railway culvert on Millrace

3.4 Area 3 North – Cork Rd Bridge to N25

Area 3 includes Midleton Town Centre, southern side of IDL site, the Baby Walk, People's Park, areas adjacent to Dungourney River and Bailick Road. The area is at risk of fluvial flooding from the Owenacurra and the Dungourney, as well as tidal flooding.

Figure 11 Area 3 North

Within Area 3 North the following potential interim measures have been considered and are assessed in this section of the report.

- Management of in-channel vegetation
- Maintenance of overflow channel
- Non-return valve at Market Green
- Non-return valve at Dwyer's Road

3.4.1 Management of in-channel vegetation

Throughout Area 3, there are a number of locations where appropriate management of in channel vegetation could reduce blockage risk and increase conveyance though the reach and hence reduce water levels during a flood event.

Increasing channel capacity through the removal/management of vegetation will contribute to a reduction in water levels and blockage risk in this area, particularly at the structures downstream.

The area immediately upstream and downstream of the Market Green Plaza Bridge has a number of mature trees and vegetation growing in channel. This vegetation is on a raised area of land between the Owenacurra River and the Owenacurra Millrace outlet which runs parallel to MyPlace.

The right bank immediately upstream and downstream of the Lidl Bridge is heavily vegetated and is encroaching on the bridge opening which may impact the volume of flow being conveyed through the structure.

An inspection of historic Google Streetview images (Figure 12 and Figure 13) suggests that the vegetation build up has increased since May 2009. It is noted however that when comparing historic images, it is important to consider the time of year the images were taken as this will influence the vegetation. Management of this vegetation may increase conveyance through the Lidl Bridge and help reduce water levels during a flood event.

May 2009

August 2022

Figure 12 Comparison of vegetation buildup upstream of Lidl Bridge

May 2009

July 2019

Figure 13 Comparison of vegetation buildup downstream of Lidl Bridge

The environmental impacts of the removal of in channel vegetation will need to be considered and removal carried out at an appropriate time of the year in order to comply with statutory constraints.

It is noted that early in 2024 CCC sought quotations from suitably qualified contractors for vegetation clearance in this area but received no responses. CCC intend to retender these works again in the coming months, taking due cognisance of the seasonal restrictions on vegetation clearance.

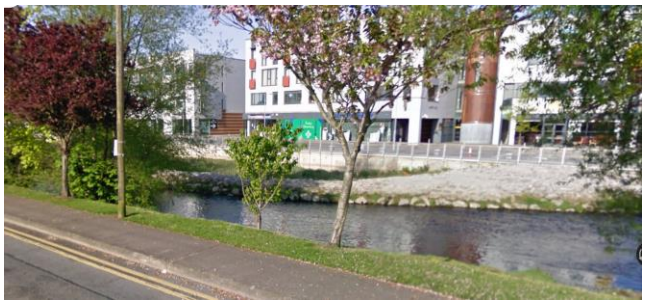
3.4.2 Maintenance of side channel

An existing side channel runs parallel to the Owenacurra river for circa 200m between the Lidl Bridge and the pedestrian Pontoon Bridge, adjacent to the Water's Edge commercial development (Lidl and Aldi).

When river levels are sufficiently high in the main Owenacurra channel, water overtops the spill and enters the side channel.

It is evident that since construction of this overflow system (Figure 14), there has been a very significant increase in vegetation across along the spill which will somewhat limit the volume of water that can overtop the spill. This in turn could limit conveyance in the low flow channel and lead to marginally higher water levels upstream of the spill.

Maintenance of this vegetation will marginally improve the hydraulic efficiency of the spill and hence improve conveyance through the reach.



May 2009

August 2022

Figure 14 Comparison of vegetation buildup along side channel spill

3.4.3 Non-return valve at Market Green

Pluvial water from the Market Green area discharges through an existing flap valve located approximately 10m downstream of the Market Green Bridge on the right bank. This is a private asset and is not in the control of CCC (or the OPW). The concrete surround of the flap valve has been undermined and has been detached from the bank as shown in Figure 15. From inspection it is unclear if the damage caused to the outfall allows the flap valve to be by-passed and for an egress of water to travel up the pipe during periods of high flow on the river. It is recommended that an inspection of this outfall be carried out by the appropriate party and repairs be made as required.

The damaged infrastructure also poses a blockage risk to the Cork Road Bridge circa 40m downstream if it were to become disconnected. Any in channel works need to consider potential environmental impacts and may need to be carried out at an appropriate time of the year.

It is noted that a second, smaller drain adjacent runs adjacent to the larger pipe and is secured within the same block.

CCC has engaged with the owners of this asset, who have advised that repair works will be carried out during Summer 2024.

Figure 15 Damaged outfall on right bank downstream of Market Green Bridge (image courtesy of Geoffrey Eastaway)

3.4.4 Non-return valve at Dwyer's Road

As a potential interim measure, it is recommended that the Water Rock Stream outfall into the estuary at the old sea wall be fitted with new non-return valves as the existing flap valves have been removed (see Figure 16).

Figure 16 Existing outfall of Water Rock Stream to Inner Estuary with flood doors removed (image provided by CCC)

It is understood that there is also a storm water outfall from Dwyer's Road/ Bannog Estate discharging to the inner estuary which has been fitted with a non-return valve. The approximate location and an image of this outlet is shown in Figure 17. It is recommended that the condition of this valve be inspected and replaced if required.

Figure 17 Existing outfall of storm water outfall from Dwyers Road/ Bannog Estate (image provided by CCC)

Provision and maintenance of new flap valves will limit tidal waters egressing through the culverts. As the outlet is located close to the Cork Harbour SPA and the Great Channel SAC, environmental impacts of the works must be considered and due consideration to the statutory constraints.

3.5 Area 3 South – N25 to Bailick Rd

Area 3 South includes the estuary and Bailick Road South of the N25 as shown in Figure 18.

Figure 18 Area 3 South

Within Area 3 South, the following potential interim measures have been considered and have been assessed in this section:

- Increasing the threshold of flooding along Bailick Road

- Non-Return valve at Ballinacurra Stream Outlet

It is noted that conveyance improvements in tidal waters have limited effect in reducing peak flood levels because the additional area provided by the conveyance improvements becomes occupied by tidal waters and is not available to accommodate flood flows.

3.5.1 Increasing the threshold of flooding along Bailick Road

A break in the existing wall along the Bailick Road which facilitates access to a boat ramp allows for high spring tides to inundate Bailick Road. An image taken during a high tide is presented below.

Figure 19 Flooding of Bailick Road at high tide (Nov. 2020)

Regrading/changing the levels of the existing spill would increase the threshold of tidal flooding in this area and hence reduce the risk of tidal flooding to the road.

It is however noted that during the Storm Babet flood event, water from the town travelled south along the Bailick Road until it entered the estuary through the opening at the boat ramp. The impact of regrading on flow paths into the estuary for fluvial and pluvial flow would therefore need to be considered in the context of this release mechanism.

It is noted that the Ballinacurra to Midleton Pedestrian/ Cycle Route is planned to pass through this area. Engagement between the Cycleway and Flood Relief Scheme project teams is ongoing. In this area, works adjacent to the Cork Harbour SPA and to the Great Channel SAC will be required. Construction methodology will have to take into consideration these environmentally protected sites.

3.5.2 Non-Return valve at Ballinacurra Stream Outlet

As a potential interim measure, it is recommended that the Ballinacurra Stream outfall be fitted with a new non-return valve. The existing flap valve at the downstream face of the culvert which passes under the Ballinacurra Co-Op Building is in poor condition.

Provision and maintenance of new flap valves will limit tidal waters egressing through the culverts. As the outlet is located in the Great Channel SAC and adjacent to the Cork Harbour SPA, environmental impacts of the works must be considered.

3.6 Area 4 – Lauriston, Rugby Club, East of IDL

Area 4 includes the IDL site, Midleton Rugby Club, Lauriston Estate, Townspark Industrial Estate and the land to the east of the Irish Distillers Limited (IDL) site adjacent to the Dungourney.

Figure 20 Area 4

Within Area 4 two potential interim measures have been considered and assessed:

- Debris screens upstream
- Installation of gauges

3.6.1 Debris screens upstream

Similar to Section 3.3.1 of this report, the installation of coarse debris screens upstream on the Dungourney should be considered for this area and hence reduce the blockage risk. The conditions/ constraints as noted earlier in this report for a debris screen also apply in this area.

3.6.2 Installation of gauges

As per Section 3.3.4 of this report, the OPW Hydrometric Team are investigating the installation of a gauge on the Dungourney upstream of Area 4. The assessment of an appropriate gauging location is progressing. It is noted that the historic gauge location site just downstream of Dungourney Village may be deemed suitable.

3.7 Area 6 – Water Rock

Area 6 covers the Water Rock watercourse area to the estuary. This area includes Water Rock House, North Point Business Park, Castle Rock Estate, the proposed LIHAF Development site, Baneshane and the Wastewater Treatment Plant (WwTP) to the south. The extent of Area 6 is shown in Figure 21 below.

Figure 21 Area 6

Within Area 6, the following potential interim measure has been considered and assessed:

- Reinstate culvert at Water Rock House

3.7.1 Reinstate culvert at Water Rock House

During the Storm Babet Flood Event, the bank upstream of the twin circular culvert arrangement passing under the Water Rock House access road collapsed, as shown in Figure 22. It is recommended that this bank is reinstated as part of any interim works for the scheme.

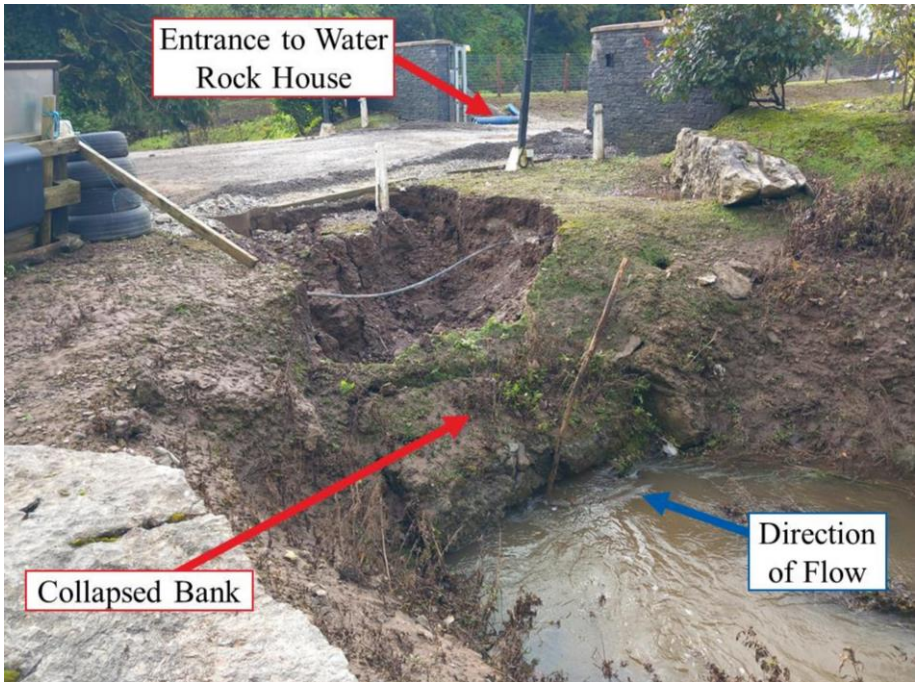


Figure 22 Bank Collapse Upstream of Culvert

4. Advance Works and Temporary Defences

4.1 Overview

Advance works entail progressing certain elements of the proposed main scheme in specific areas in advance of constructing the whole of the scheme. In general, a fundamental principle in the implementation of any advance works is to avoid any significant increase in flood risk elsewhere in the scheme area. There must also be a tangible benefit associated with progressing advance works given that any such works are likely to have a programme impact on implementing the main scheme.

Temporary defences involve deploying some form of flood protection barrier on a temporary basis to reduce the risk of flooding to a particular area. Such a defence may entail deploying a temporary water filled dam and/or large sandbags in a particular area. The logistics of implementing the temporary defences must also be considered i.e. having sufficient warning time to allow the defences to be deployed, ease of access for local authority staff to deploy and remove the defences, access to private lands where relevant etc.

This section provides an overview of the viability of implementing key elements of the scheme as advance works. Temporary defences are also considered. As noted earlier in the report, a temporary defence is very unlikely to provide the target SoP of the scheme but may reduce flood risk for lower return period events.

The logistics of implementing advance works and its impact on the overall programme is also discussed.

4.2 Area 1&2 – Tir Cluain to Riverside Way

4.2.1 Advance works for Tir Cluain

The preferred scheme for Midleton proposes to protect Tir Cluain from inundation through the provision of an embankment behind the estate. Should this embankment be progressed as an advance works package, the estate could potentially be protected from inundation up to the SoP of the scheme in advance of the main scheme.

In order to assess the impact of defending Tir Cluain in isolation from the rest of the scheme (i.e. progressing it as advance works), we have calculated the total inflow into the estate from the Owenacurra for the existing scenario Q100 event.[1] The inflow hydrograph is presented in the figure below. It can be seen from the figure than the peak flow into the estate is circa 1.3m^3/s and the total volume of the hydrograph is circa 26,000m^3. When compared with the total peak flow through the through the reach, the fraction of the flow entering the estate represents circa 2% of the total flow.

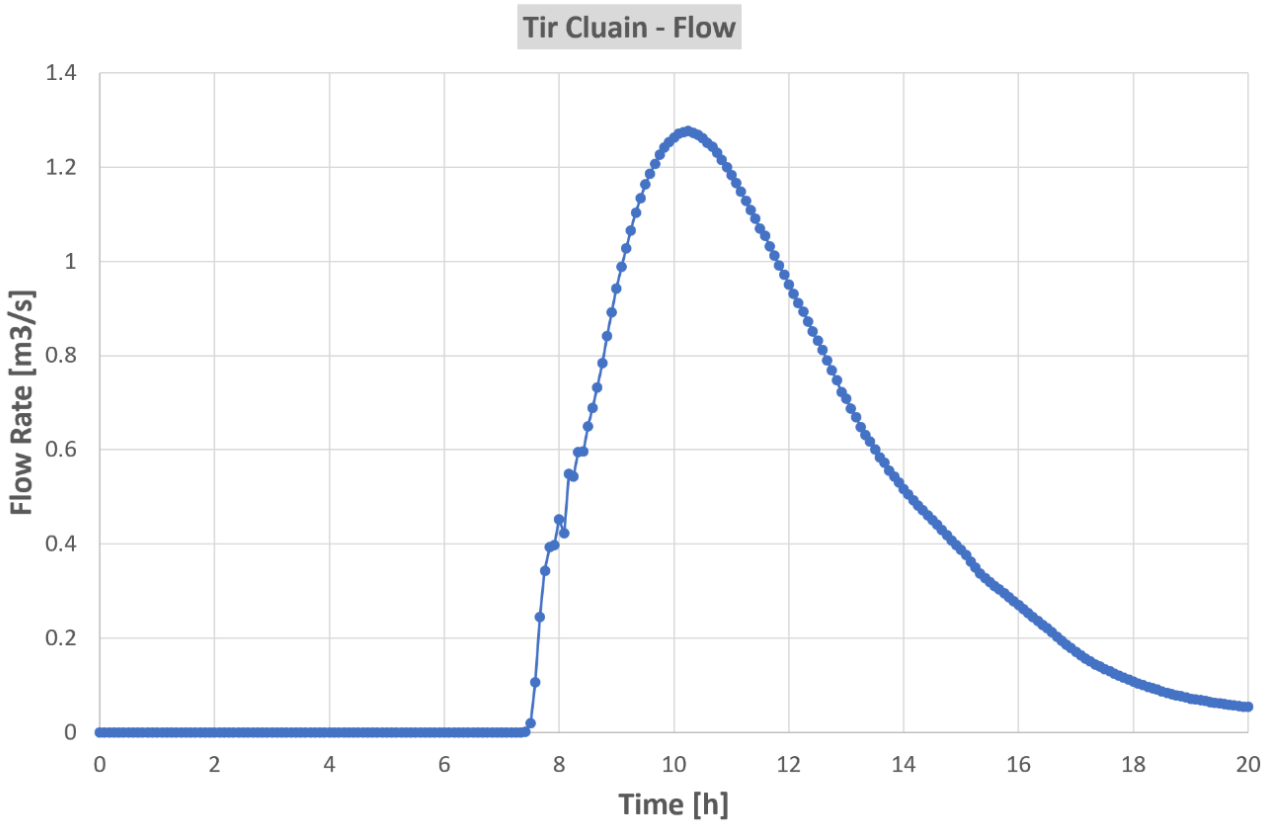


Figure 23 Total flow into Tir Cluain for the Q100 event

It can therefore be seen that while progressing advance works to protect Tir Cluain would offer the estate the SoP of the scheme, flood risk downstream may be increased as the storage offered by the estate would be removed and forced downstream.

As part of this report, we have not undertaken the detailed hydraulic modelling which would be required to quantify the impacts these advance works would have on water levels both downstream and upstream as well as in combination with other advance works which may also be considered. Detailed assessment will be required to determine the viability or otherwise of such measures. Should CCC and OPW wish to progress advance measures at Tir Cluain, it is recommended that this detailed assessment be carried out.

4.2.2 Temporary defences for Tir Cluain

Another potential option for Tir Cluain would be to utilise temporary defences to reduce flood risk. As discussed previously, any such measure also cannot be allowed to increase flood risk downstream or to have any significant environmental impact.

Temporary defences can only defend to a limited height - inflatable dams can generally defend to a height of circa 1m. Temporary defences would therefore not offer the target SoP to the estate but instead would reduce flood risk for low return period events.

Two such measures could be considered for Tir Cluain and for other areas in Midleton:

[1] This was calculated using the results of the existing scenario hydraulic developed as part of the project. The reader is referred to the scheme hydraulics report for a detailed description of the model build and results.

- Large sandbags
- Temporary inflatable dams

Large sandbags set behind the properties in the estate could limit the ingress of water for low return period events. The sandbags would need to be left in place for a fixed duration of time given the difficulty in mobilising them. The bags may therefore be subject to degradation over time and would likely require ongoing maintenance. Use of a polythene sheet wrapped around the bags would limit the ingress of water through the gaps in between the bags.

A temporary water-filled or air-filled barrier could also potentially be used in order manage flood risk. Such a measure is presently used by Galway County Council in Ballinasloe where a water filled temporary barrier 140m in length works in conjunction with a flood wall and the deployment of a demountable barrier to reduce flood risk to a number of properties in the town. An image of the deployed barrier is presented below.

Figure 24 Temporary water filled barrier in Ballinasloe

There would however be a number of difficulties in adopting a temporary barrier to reduce the flood risk to Tir Cluain. These can be summarised as:

- The existing ground levels behind the estate are set lower than the levels within the estate. A temporary defence of 1m high is therefore unlikely to offer any significant reduction in flood risk to the estate as the crest height of the top of the defence relative to existing ground levels is low. The barrier would therefore need to be deployed in the back gardens of the houses in the estate (which are set at a higher elevation) for any meaningful reduction in flood risk to be achievable and such an option is not deemed as viable.
- Residual risk of failure during an event;
- Ongoing operation and maintenance particularly if it is left in place for a prolonged duration;
- Tie in with high ground is likely to only be achieved by deploying sandbags at the end of the inflatable barrier in order to prevent water ingress around the barrier
- The need for an adequate warning time in order to successfully deploy the barrier – an accurate flood forecasting system with an adequate lead in time would therefore be required to be developed as Midelton does not have such a system at the present time. Refer to Section 5 for further discussion on flood forecasting system. It is noted however that this issue could be addressed by leaving the barrier in place for a long duration of time i.e. over the winter months.

For similar reasons, the sandbags option for Tir Clain is also not likely to be feasible as the ground levels around the estate where the sandbags are to be placed are too low for the final height of the bags to offer any meaningful reduction in the risk of flooding.

Temporary barriers for Tir Cluain are therefore not recommended.

4.2.3 Advance works for the site North of the NRR

One of the key mechanisms of flooding of the town centre relates to overtopping of the left-hand side bank of the Owenacurra upstream of the Northern Relief Road. When such an event occurs, water flows overland in a south easterly direction, overtops the railway line and proceeds to flow down Mill Road to the roundabout and SuperValu. The preferred scheme aims to eliminate this mechanism of flooding through the provision of a direct defence on the left hand side of the river. Should this defence be progressed as an advance works package, this mechanism of flooding could potentially eliminated up to the SoP of the scheme in advance of the main scheme.

In order to assess the impact of progressing this element of the scheme as advance works, we have calculated the total overflow hydrograph for the existing scenario Q100. The hydrograph is presented in the figure below. It can be seen from the figure than the peak out of bank flow from the river at this location is circa 4.8m^3/s and the total volume of the hydrograph is circa 55,000m^3. When compared with the total volume of water through the reach the fraction of the flow leaving the river at this location represents circa 5.8%.

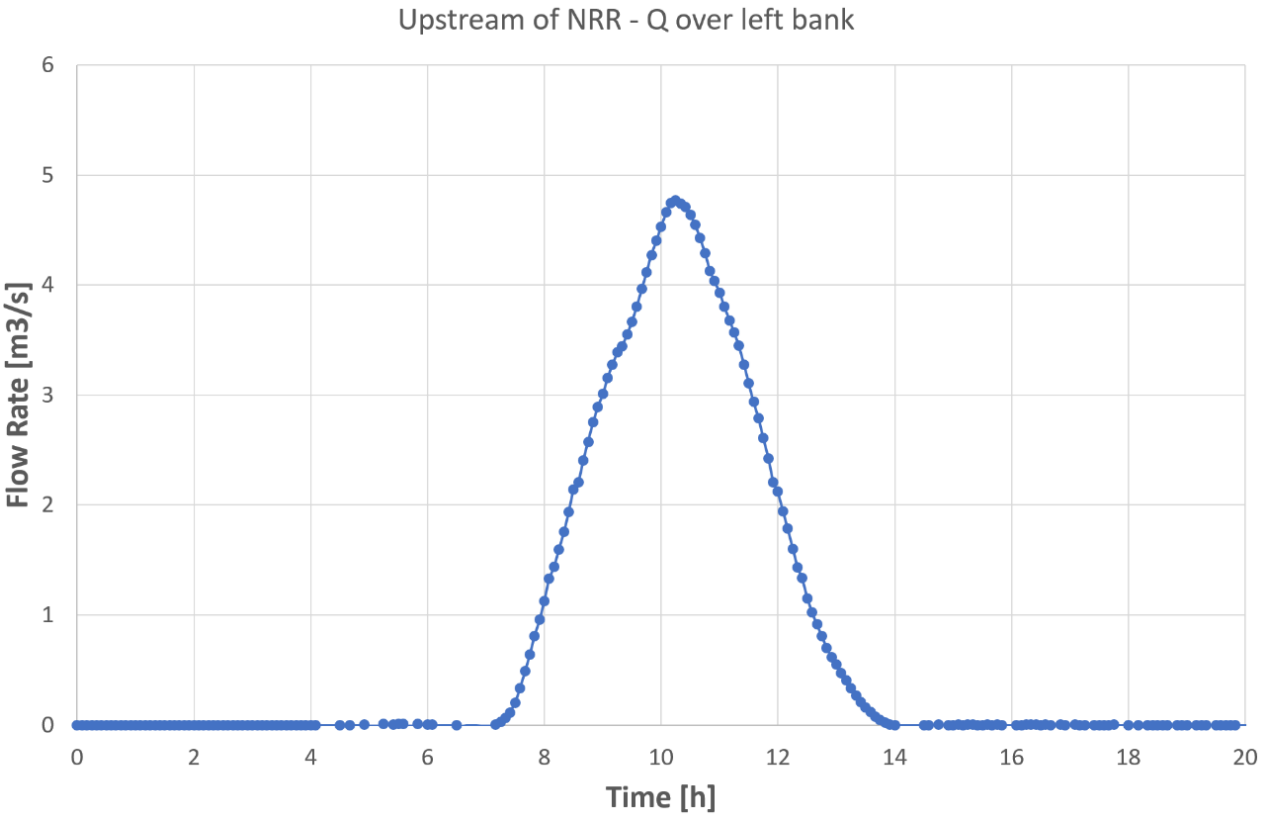


Figure 25 Total flow out of the left bank upstream of the NRR

Due to the removal of the storage offered by the existing floodplain, flood risk downstream may be increased. As noted in the section above we have not undertaken the detailed hydraulic modelling which would be required to quantify the impacts of any such advance works. Should CCC and OPW wish to progress advance measures at this location, it is recommended that this detailed assessment be carried out.

Furthermore, there are multiple mechanisms by which the Owenacurra floods the town centre downstream of the Northern Relief Road[2] such that advancing this element of the scheme in isolation would not fully protect the town centre from flooding. The increase in the water level downstream would in fact likely drive a higher volume of water into the town centre via these routes.

In order for advance works to be viable to advance at this location, works across multiple locations would therefore need to be constructed in parallel. This would also need to be assessed in detail as part of any detailed assessment.

Implementing temporary defences at this location would also require additional assessment due to the potential increased risk of flooding downstream with the temporary defences in place. While the total volume of water forced downstream by the temporary defences would be less than that associated with advance permanent works (i.e. the volume in the design event) due to the full SoP not being offered, the volume may still be sufficient to increase the risk of flooding downstream.

In order to mitigate this risk, temporary defences would be required at all the locations where the Owenacurra gets out of bank downstream. Implementing temporary defences on this scale across Midleton is not deemed viable for operational and maintenance reasons.

It is also noted that the land on which the temporary defences would need to be deployed is privately owned. An agreement with the current landowner would therefore need to be reached regarding the placing of temporary defences on this site given that the land use would be restricted while the defences are in place. It is noted that this constraint would also need to be considered in detail as part of the delivery of any advance works. It is further noted that there is planning permission in place for development of this site; this planning permission includes for land regrading – i.e. the raising of ground levels at this site to a minimum of 9.0m OD.

4.2.4 Flow Control Structure on Owenacurra Millrace

As part of the preferred scheme, it is proposed to install a flow control structure at the Owenacurra Millrace entrance north of the Northern Relief Road to limit the water flow entering the Millrace given that water overtops the downstream end of the Owenacurra Millrace in the Q100 event and makes its way out into Mill Road and into the town centre.

Implementing advance works for the Millrace would not achieve the SoP for the area in isolation. However it may provide some reduction in flood risk downstream, due to the removal of the mechanism of flooding directly from the Millrace. Given that this mechanism is not the biggest contributor of flooding to the town centre, there may be limited advantages of implementing this measure by itself as the town would still be at risk of flooding from the other mechanisms (refer to footnote 2).

4.2.5 Advance works for the site south of the Northern Relief Road

Advance works on the site south of the Northern Relief Road are not deemed as viable in isolation as the town centre would still be at significant risk of flooding from other mechanisms (refer to footnote 2) if these works were progressed in isolation. Should CCC and OPW wish to progress advance measures at this location, it is recommended that this detailed assessment be carried out.

4.3 Area 3 North – Cork Rd Bridge to N25

The Woodlands estate is at risk of flooding from the Owenacurra, and it is therefore proposed to defend the estate with direct defences as part of the scheme. The area immediately downstream on the opposite side of the bank is also at risk.

Any advance works and/or temporary defences for the Woodlands estate may therefore need to be implemented in parallel with defences for the areas at risk further downstream in order to avoid increasing flood risk to these areas.

[2] These are listed as: downstream of the NRR on left bank, at the downstream end of the Mill Race, at My Place, on the left bank upstream of the Lidl Bridge and also at the confluence with the Dungourney.

Temporary defences could however be considered for the Woodlands Estate as they would reduce the flood risk to the properties. The logistics of implementing the measures, as well as ground conditions and levels, are likely to be manageable.

The key constraint on such measures relate to implementing temporary defences in the other areas downstream that are at risk given that the logistics are not as favourable in these areas. This feasibility of this option is however being currently considered in further detail by CCC/OPW.

4.4 Area 3 North – Dungourney

Beechwood estate and Oakwood Lodge are at risk of flooding and defences are proposed to defend these properties as part of the main scheme.

As part of the GAA grounds redevelopment works, it is understood that an informal earthen embankment was placed parallel to the rear wall of the Beechwood and Oakwood Estates. This embankment offers protection for low return period events. However, there is a low point of circa 15m in this embankment between the South of Beechwood Drive and the North of Oakwood Lodge as shown in Figure 26. Arup conducted a site walkover to confirm the location of this low point. As an interim measure, it may be possible to undertake works to infill the low point and increase the standard of protection of the embankment. This would reduce flood risk to the estates in the present day.

Figure 26 Low point of existing GAA informal embankment

Temporary defences are not likely to be high enough in order to defend the properties in these estates and for this reason are not deemed to be viable.

Advance works for this area are also unlikely to be suitable given the likely impact on the flood risk in the town centre downstream.

Further downstream in this area, the Dungourney is tidally dominated and any advance/temporary works in this area to the target SoP of the scheme are not practical to implement given that the whole area would need to be defended in order to avoid bypassing of the defences by the tide. However, a reduced SoP maybe

achievable by increasing the threshold of flooding in specific areas e.g. Choctaw Park. An inspection of detailed topography could be carried out to identify these low lying areas.

4.5 Area 3 South – N25 to Bailick Rd

Advance works in this area are not practical and would be difficult to implement given that the predominant flood risk is tidal. The whole area would therefore need to be defended in order to avoid bypassing of the defences by the tide. Defences of this scale and magnitude are difficult to justify as advance works. However some local regarding, although would not achieve the SoP for the area, may provide some reduction in flood risk for properties most at risk. The town centre would also remain at risk from fluvial flooding.

Temporary defences are also not deemed to be viable given the scale of works required.

4.6 Area 4 – Lauriston, Rugby Club, East of IDL

Advance works in this area are not deemed as critical given the relatively high threshold of flooding in the area. Therefore it is not recommended that advance works be progressed.

4.7 Area 5 – Ballinacurra

Advance works in this area are not deemed as critical given the relatively high threshold of flooding in the area. Therefore it is not recommended that advance works be progressed.

4.8 Area 6 – Water Rock

Further investigations into potential flood risk management measures that may provide flood mitigation (albeit not to the target standard of flood protection) in the Water Rock area upstream of the cave system are under assessment.

Temporary measures are not deemed to be viable given the lack of warning time available on the small catchment to be able to erect any such measures.

5. Flood Forecasting System

5.1 Introduction

One of the key items of feedback from the public after Storm Babet was the lack of any warning for the event and, consequently, the inability to take preventive measures to manage the impact of the event at the property level. It remains a significant item of concern for the public in the management of any future flood events.

The implementation of a flood forecasting and associated warning system would therefore be beneficial in the management of flood risk in the town until such time as the scheme is constructed.

The benefits offered by a Flood Forecasting System (FFS) are listed as:

- Mitigation measures can be implemented and installed in a timely manner upon receipt of a warning from a Flood Forecasting System (i.e. erecting demountable defences, flood gates etc);
- Vehicles and commercial property stock can be relocated to avoid flood damage;
- Relevant authorities and trained personnel who are tasked with implementing any emergency response plan have sufficient time to alert homeowners and property owners and, if necessary, undertake emergency evacuation of people from vulnerable areas;
- In the event that a forecasted flood is due to exceed the design standard of existing flood defences, advanced warning can be crucial in implementing emergency response plans such as evacuations. This function is not however relevant to Midleton at the present time.

5.2 General requirements

There are a number of conditions which must be met in order for a Flood Forecasting System (FFS) to be effective and worthwhile. These are listed as:

- There must be a tangible benefit in implementing a Flood Forecasting System for a town. As an example, being able to implement an emergency response plan on receipt of a flood forecast which mitigates against flood damage is a clear benefit to having a Flood Forecasting System in place. A specific example of this would be deploying Individual Property Protection (IPP) for certain residential properties.
- The forecast from any FFS must be accurate and robust and provide information on either the predicted flood flow or the flood water level at certain locations in the area of interest. A FFS cannot be effective if it is unreliable and untrusted in the community, i.e. if the FFS produces inaccurate forecasts, either predicting a flood event and no event occurring or failing to predict a flood event.
- There needs to be a meaningful lead time provided which is sufficient to implement any emergency response plan.
- There must be sufficient resources and infrastructure to communicate any flood forecast to the impacted communities and also to implement any emergency response plan.

5.3 Midleton Flood Relief Scheme

The proposed flood relief scheme for Midleton is a passive system for the most part and will not require significant active management before or during a flood event, e.g. deployment of demountables on a large scale. A FFS scheme for the town will therefore not be required as part of the main scheme.

Therefore it should be noted that, if considered feasible, a FFS for Midleton would only be developed as an interim measure in advance of the implementation of the full scheme. Once the scheme is in place there will be very limited requirement for a FFS and it would largely become defunct. We note that a flood forecasting system developed for Bandon was decommissioned once the flood scheme in Bandon was completed.

In Midleton however, any FFS could still be retained in order to forecast design exceedance events which may require emergency planning.

5.4 Feasibility Screening Assessment for Midleton as an Interim Measure

It is not within the scope of this report to provide a detailed appraisal of a flood forecasting system for Midleton. A high level feasibility assessment is instead presented by considering the following items:

- Response times
- Peak flood travel times
- Existing monitoring infrastructure.

5.4.1 Response Times and Peak Travel Times

Figure 27 below presents the recorded rainfall at Moore's Park and the flow at Ballyedmond gauge from Storm Babet. The time at which the flood peaked in the town centre (derived from CCTV footage at the AIB) is also shown.

It can be seen from the figure that the flood wave at Ballyedmond (shown in red) started to rise at circa 10:30am on the 18th October and peaked at 12.15pm. The time to peak was therefore less than 2 hours. This rate of rise is extremely rapid and aligns with the experiences of property owners during the event who stated that the onset of flooding was extremely rapid leaving them with no time to prepare.

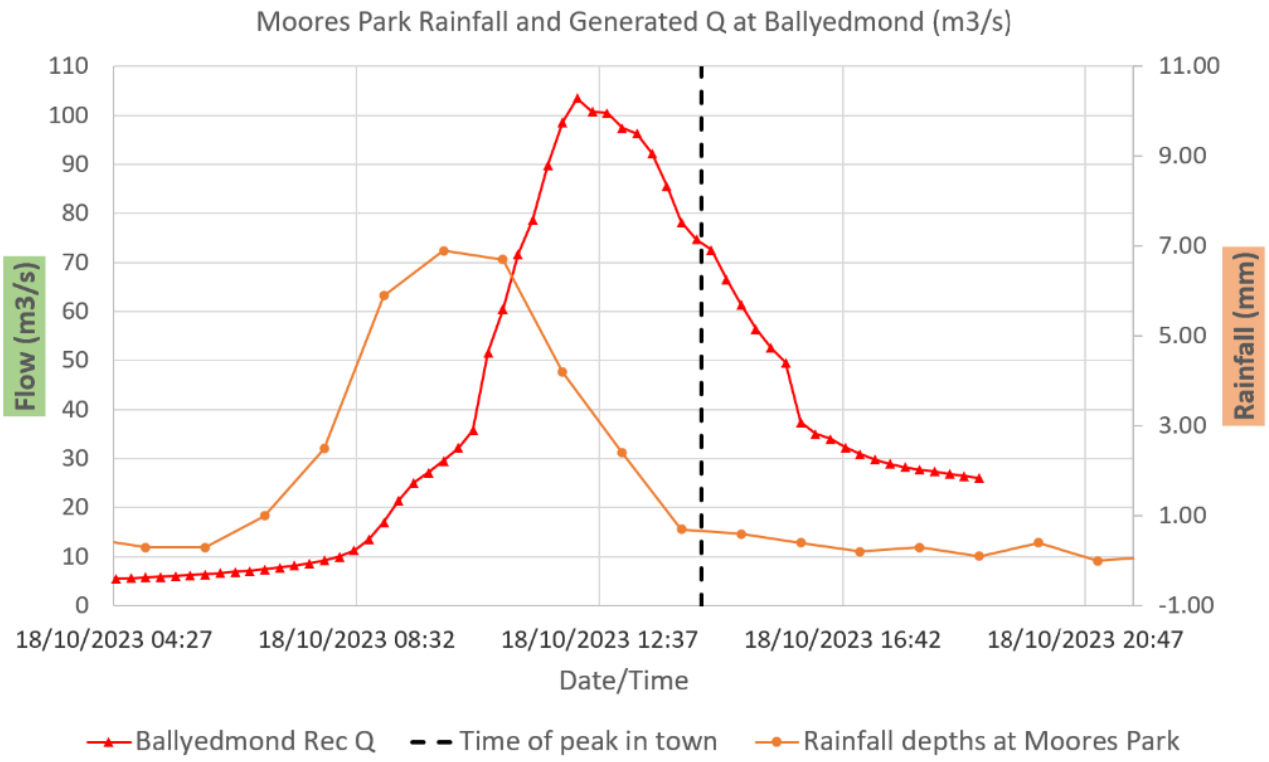


Figure 27 Rainfall at Moore's Park, Flow at Ballyedmond and the time of arrival of the flood peak in Midleton Town centre

As also indicated on Figure 27, the event peaked in the town centre at circa 2.20pm. The time of travel of the flood wave from the Ballyedmond gauge to the town centre is therefore circa two hours.

Based on these findings it can therefore be concluded:

- The very rapid rate at which water levels rise in the Owenacurra, as well as the very short time it took for the flood wave to travel from Ballyedmond to the town, demonstrates that a flood forecasting system based directly on real-time data from the river will have limited benefit for Midleton, i.e. by the time water levels in the river trigger a warning there will be limited time to prepare for the event and enact any emergency response.
- Gauges located further up the catchment than Ballyedmond are unlikely to significantly increase the lead time and make a forecasting system based on real time data feasible;
- For any flood forecasting system to be viable in Midleton, reliably forecast rainfall therefore needs to be an essential component of the system. This adds a level of complexity and detail to the system that needs to be carefully considered when evaluating the feasibility of any such system.

5.4.2 Existing monitoring infrastructure

At present there is very limited monitoring infrastructure in the catchment which can provide data for a forecasting system. Various rainfall and river flow gauges would therefore need to be installed in the catchment. Real time data from these instruments would then need to be combined with (1) forecast rainfall data and, (2) data on the antecedent conditions in the catchment, in order to inform the hydrological and hydraulic models which would underpin the forecasting system.

Met Éireann's existing forecasting system HARMONIE can provide a 6 hour weather forecasts based on a 2.5km grid, with a 54 hour lead time. This forecast is the best available for the Owenacurra/Dungourney catchments and is the most frequently updated model on the finest grid with the longest lead time available.

5.4.3 Specific requirements

The following items also need to be considered for Midelton:

- The development of a catchment specific flood forecasting system based on forecast rainfall is a sizeable body of work and would take time to develop and implement. It would likely be a number of years before any such system would be operational.
- Once operational it would further time for sufficient data to be acquired to allow model calibration and for the appropriate data processing and cleansing techniques specific to the Owenacurra/Dungourney catchments to be developed. This constraint could however be addressed by using hindcast data to calibrate the catchment model.
- There are considerable capital costs associated with the setup of such infrastructure.
- Extension of the FFS for the Lower Lee Flood Relief Scheme to incorporate the Owenacurra/Dungourney catchments could be considered but it is noted that the operational logistics in doing so are significant.

5.5 National Flood Forecasting System

Met Éireann are currently developing a National Flood Forecast Warning Service. Stage 1 of the development of this service is now complete. It is understood that a full roll out of this system is a number of years away. A Flood Forecast Centre has been established in Met Éireann, manned by hydro-meteorologists. This FFC is tasked with maintaining a fluvial and coastal flood watch over the country.

A key element of the NFFWS is the provision of flood forecasts, flood advisory services, hydrological observations, and daily flood guidance statements to local authorities and the National Directorate for Fire and Emergency Management. CCC use the guidance provided by Met Éireann to inform operational preparedness, as part of the Flood Emergency Response Plan for Midleton, and the County as a whole.

CCC and the OPW are continuing to engage with Met Éireann in relation to the NFFWS and are in discussions around the provision of targeted observational information for key locations, including Midleton.

5.6 Summary

In summary, any system based on real time data from the river is likely to be of limited benefit, given the very short lead in times. An assessment of potentially viable options for provision of a warning/alert system for Midleton has been requested by CCC, in advance of the completion of the National Flood Forecast Warning System.

6. Recommendations

It is recommended that the following interim measures are implemented as a matter of urgency in Midleton:

- River channel and drainage system clearance and maintenance works at various locations. This includes the removal of excess vegetation and sediment build up at key locations.
- Removal of gravel deposition from river and floodplain at Moore's Lane
- Repairs to a number of non-return valves
- Installation of additional hydrometric gauges

It is also recommended that more detailed feasibility studies of the following items are also undertaken immediately, as a matter of urgency:

- Implementation of a flood forecasting system for the town
- Implementation of IPP for properties at risk
- Assessment of the impact of advance works being constructed at key locations in the town.
- Assessment of temporary measures for the Woodlands Estate and the impact on flood risk downstream of the estate.
- Feasibility study for the construction of debris screens upstream in the catchment.