

Lower Lee (Cork City) Flood Relief Scheme (Drainage Scheme)

Exhibition Report



Office of Public Works

**Lower Lee (Cork City) Drainage
Scheme**

Exhibition Report

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This report takes into account the particular instructions and requirements of our client.

It is not intended for and should not be relied upon by any third party and no responsibility is undertaken to any third party.

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Executive Summary

Background and Context

There is a long history of flooding in Cork City and the River Lee valley. A number of severe floods have affected the city, most recently in November 2009, February 2014 and winter 2015/16. The event of November 2009 was an exceptionally severe event, with major damage caused to commercial and residential buildings in Cork City. It has been estimated that the damages caused in the 2009 river flood and 2014 tidal flood amounted to €90m and €40m respectively. The 2009 event heightened public awareness of the significant flood risk which exists in Cork City and the need to provide a flood relief scheme.

The Lower Lee (Cork City) Flood Relief Scheme ('The Scheme') was commissioned by the Office of Public Works (OPW) with the objective of delivering a flood relief scheme for Cork City and environs to provide protection against the 1 in 100 year fluvial/1 in 200 year tidal flood events.

The project followed on from the pilot Lee Catchment Flood Risk Assessment and Management (CFRAM) Study which identified the preferred scheme as being a combination of a flood forecasting and warning system, optimised dam operating procedures and raised waterside defences.

Following extensive study and assessment, a proposed scheme has now been developed which consists of a modified version of the measures identified in the Lee CFRAMS, together with a flow control structure on the south channel to rebalance flows between the north and south channels. The scheme was developed in close co-operation with all key stakeholders, in particular; Cork City Council, Cork County Council and the ESB.

The Scheme will run from Inniscarra Dam to the city centre protecting over 2,100 properties, including 900 homes and 1,200 businesses against tidal and river flooding. It will be the largest flood relief investment project ever proposed in Ireland.

In line with international best practice, the standard of protection provided by the scheme is the 1 in 100 year flood from the River Lee and the 1 in 200 year flood from the tide. The scheme is adaptable to provide greater protection in the future in response to climate change.

This integrated and holistic scheme will substantially free the people of Cork from the worry and stress of living with flood risk. It will remove barriers to future private investment and help to reinvigorate the city centre and its environs. It will also provide significant local employment during construction.

The scheme includes €20m of much needed investment in repair of historic quay walls which could otherwise be at serious risk of collapse. It will provide almost 1km of new river walkways, enhancing connectivity to the river and improve public realm spaces in collaboration with the City Council, such as proposed works on Morrison's Island.

The OPW has engaged in an extensive and proactive consultation process in relation to a flood relief scheme for Cork since 2006 when the Lee CFRAMS commenced. This includes numerous manned public days in 2006, 2009, 2010, 2013, 2014, 2016 and 2017. All of the above events were widely advertised to the public in advance through advertisements in local and national newspapers, radio advertisements, the project website, and social media accounts operated by the OPW.

All documents including project reports, posters, brochures, drawings, photomontages and comment sheets that were on display at the public days are available on the project website (<http://www.lowerleefrs.ie/>)

Extensive landowner and stakeholder consultation has been undertaken, including over 100 one-to-one meetings, to ensure that those who are directly impacted by the project remain informed and are provided with the opportunity to provide feedback.

Numerous presentations have also been made to key representative groups including Cork Chamber of Commerce, Cork Business Association, Cork Public Participation Network, ICOMOS and many others, as well as to elected representatives of both Cork City Council and Cork County Council. A presentation was also made in Leinster House to interested Members of both houses of the Oireachtas.

Exhibition Process

The proposed scheme was subsequently brought to Statutory Exhibition stage through the Arterial Drainage Act in late 2016/early 2017 where details of the scheme were available for inspection by members of the public, as well as being available to view online on the project website www.lowerleefrs.ie. An interactive display was also made available in both City and County Hall and received very positive feedback from the public.

As part of the process, a significant number of submissions were received which have all been carefully considered and addressed in the Exhibition Report of which this Executive Summary forms a part.

Alternatives Considered

A number of submissions queried the alternatives considered. Both as part of the Lee CFRAM Study and again in the early stages of the Lower Lee Flood Relief Scheme, a long list of potential measures was considered. The consideration of these measures (and combinations of measures) is covered in great detail in the Lower Lee Options Report.

On foot of the exhibition submissions, a number of Supplementary Reports have been prepared which provide further detail on various alternative proposals considered, which are not viable.

One of these options was a potential tidal barrier. The supplementary Tidal Barrier report addresses at an appropriate level of detail, the queries raised at exhibition, by considering all of the key requirements and constraints for a tidal barrier in Cork. It concluded that a tidal barrier at Little Island had limited adaptability for climate change and so was not the optimum long term location for a barrier. The location also had very significant environmental, navigational, geological challenges which would be difficult to overcome. It would not protect other at risk areas in the harbour such as Midleton and with an estimated cost of €800m, was not economically viable.

It established that a tidal barrier either side of Great Island was likely to represent a better long terms option, as it had greater adaptability for climate change, protected a larger area, had significantly less environmental and geological challenges. However, at an estimated cost of €1.7bn, it too was not economically viable.

In conclusion, it confirmed that a tidal barrier is not currently viable and will not likely become viable for approximately 50 years or more. Low level waterside defences in Cork (as per the exhibited Scheme) are the optimum solution for Cork to meet the short and medium term needs of the city. Such defences are also the first step in a climate change strategy to manage flood risk in Cork and will form an essential part of any future tidal barrier system, to minimise the frequency of and impacts of closures.

Another option queried was the potential for alterations to and modified Operation of the Dams. A fundamental component of the exhibited scheme is revised operational procedures for control of the dams during extreme flood events. These revised rules have been optimised following extensive detailed analysis of all the real-world constraints, to maximise the benefit of the dams. These revised rules result in almost a 40% reduction in peak flows reaching the city, thus meaning that required defence heights can be minimised. However, due to the limited size of the reservoirs, the revised rules cannot on their own provide the required standard of protection.

Having established that the existing reservoirs have insufficient storage to safely manage design events on their own, the option of increasing the storage by physically raising the existing dams, was also considered. A number of options to achieve this have been considered and all have significant shortcomings compared with the exhibited scheme. These include the risk of significant impact on the Gearagh Special Protection Area, a requirement to displace a minimum of 80 residential landowners and families which would likely critically damage communities such as Toonsbridge, a requirement to raise/replace circa 8km of existing roads and bridges, sterilising a minimum of 5km² of substantially productive agricultural.

Even if all of the above was undertaken, it would only eliminate or reduce a small proportion of the overall direct defences as defences would still be in the main City Centre area.

It is therefore evident that such a proposal would have an unacceptable and inappropriate impact on an area and community not currently at risk of flooding,

to protect others. None of the options are cost beneficial and all are less attractive than the exhibited scheme on technical, social and environmental grounds.

The option of Natural Flood Management Measures was also assessed in detail. The detailed assessment of the Lee Catchment concluded that almost 5000 potential interventions combined would still only reduce the 100 year flow at Cork by between 1-4%, i.e. will not significantly alter the need for direct defences. In fact, it identified that there was a risk that NFM measures could give rise to a potential for delayed peak flows on Shournagh which could actually increase flood risk in Cork. Therefore, an NFM solution is not technically viable as an alternative to the proposed scheme.

Technical Concerns Addressed

A number of submissions were received expressing some technical concerns about some aspects of the scheme.

A number of submissions have expressed concerns about direct defence or river containment solutions. However, river containment solutions are well proven both in Ireland and internationally and remain a key part of flood relief schemes all over the world. Irish examples include, Mallow, Fermor, Waterford etc. A recent international example is the award winning Leeds flood alleviation scheme, which like Cork, includes over 4.2km of guarding height direct defences in the city. Cities in the Netherlands (such as Nijmegen) continue to rely on high flood protection dikes as a key element of their flood protection strategy. The scale of defences on the Nijmegen project are significantly greater than those proposed for the Cork Scheme.

The risk of failure/breach of the defences over time is extremely low and is minimised by regular planned maintenance.

The risk of sewer flooding is minimised by designing the scheme to ensure that existing sewers and culverts will not convey flood water from the river into the defended areas by fitting non-return valves and installation of back of wall drainage systems and pumps which will be regularly maintained.

Concerns about groundwater are understandable given the deep glacial valley underlying Cork. However, the existing geology and groundwater regime in Cork is well understood by the design team, and the management of groundwater has been a key part of the design consideration of the Cork Scheme. The design of the scheme has sought to largely retain the existing situation in the non-flood case. In the flood scenario, groundwater levels will only locally be reduced close to the surface. Therefore, the scheme will not negatively impact existing structures and their foundations.

A tidal lag /or dampened effect between groundwater and river/tidal water exists in Cork and combined with the low defence heights required, and the short duration of tidal peaks, it will be possible to manage groundwater levels effectively.

Climate change has been considered in detail in the scheme development. The scheme has been designed both to work as a standalone scheme for the current scenario, but also to be adaptable in the future as part of a longer term climate

change strategy for flood risk management in Cork. For example, the low level riverfront direct defences now proposed will form an essential part of future tidal defences as they will be needed to minimise the frequency of closures of any future tidal barrier, if and when a tidal barrier becomes viable.

Mitigation of Potential Impacts

The design of the scheme has sought to minimise the impact on heritage and where possible to enhance the cultural heritage value, particularly with regard to the historic quays which are a key cultural heritage asset.

A detailed appraisal of the area and its built and natural heritage have informed the development of design proposals, safeguarding and as appropriate restoring existing assets and where possible improving their setting.

Research has informed the proposed approach to interpretation. Through the use of signs/panels and bespoke features/public art, there is an opportunity to explain the significance of existing, retained historical features as well as bringing to life stories about the area, its people, heritage and culture.

Approximately 400 protected structures and 20 structures on the Record of Monuments and Places currently lie within the area of the design flood extents, and will be protected from flooding.

Over €20m of much needed investment is being committed to carefully restore the historic quay walls which are in very poor structural condition, and in many cases are at risk of collapse as occurred at Grenville Place during the 2009 flood event.

Areas containing historic features such as ornate railings, such as at North Mall and Sullivan's Quay are being redesigned to preserve the existing railings and features insitu.

The impact of the scheme on cultural heritage has been assessed in detail in the Project EIS.

The scheme design to date has been undertaken in close collaboration with the relevant architectural, conservation and cultural heritage staff within Cork City Council. The detailed design team includes a Grade 1 Conservation Architect who will ensure that the integrity of the city's rich heritage is preserved and enhanced as part of the scheme.

The design solutions seek to provide the most aesthetically appropriate appearance, whilst fulfilling the technical requirements in terms of flood protection and public safety. Importantly, the appearance is considered within the context of its wider setting, taking opportunities to integrate changes in levels and surface finishes to deliver comprehensive environmental improvements. In the city centre area, the vast majority of proposed defence walls have a solid element no higher than knee height with a light guard railing on top. In some areas on the North Channel, solid river wall heights increase locally to a maximum of 1200mm high, i.e. mid-rift height and so views of the river will be maintained in all cases.

Views of and connection to the river will be significantly enhanced as approximately 1km of new river walkway and cycleway will be created as part of the scheme.

The detailed design of all defences is being completed by a design team including an experienced urban landscape designer, who in collaboration with the City Architect's Department will ensure that the defences are integrated seamlessly into the enhanced public realm spaces adjoining the river.

The project provides opportunities to improve pedestrian/cycle access along/over the River, with strengthened connections to the City Centre/neighbourhoods to either side. This will encourage increased use and appreciation of the environment, by the local communities and visitors alike.

This project will serve as a catalyst for future investment in and development of the city by providing a much higher level of flood protection that will enable the City to develop in terms of amenities, business, tourism and investment potential in the medium and the long-term.

Any short-term negative impact on tourism during the construction period will be offset by the long term benefit of a much improved tourist offering

The impact on flora, fauna and habitats is in many cases temporary in nature and will be minimised by use of mitigation provided.

Significant care has been taken to ensure that tree/vegetation/habitat loss is minimised. Throughout the project area there are opportunities for significant improvement. Invasive species surveys have been carried out and the OPW has already procured a contractor and commenced a programme of eradication and management of invasive species within the study area prior to the construction phase. This will facilitate new planting. Existing vegetation to be retained will be managed (crown lifting, removal of ivy, etc.). Working closely with the proposed project Ecologist, proposals will integrate extensive areas of new landscape, which will strengthen the bio-diversity.

Whilst there will be some disruption during construction, this will be minimised by careful phasing of the works and inclusion of contractual provisions in relation to working times, traffic management, noise and dust management, maintaining critical infrastructure etc.

Proposed Changes to the Scheme arising from Exhibition

As a result of submissions received at Exhibition Stage, it is proposed to make a number of amendments to the Scheme. Some key changes include at North Mall and Sullivan's Quay where revised proposals are now being developed by our landscape architect and conservation architect in consultation with Cork City Council to ensure that the existing historic setting is preserved. These proposals predominantly rely on demountable defences (to be erected only during times of flood) which will allow the historic river edge, historic railing and the setting of the historic terraces to be retained and improved.

The proposals for Fitzgerald's Park and Lee Fields are also being reconsidered by our urban landscape consultants in consultation with CCC. The solution here

will integrate flood protection into the park area, whilst at the same time creating areas for the parks which deliver increased value and pleasure. It is also proposed to raise the ground levels of the riverside walkway between these parks which will ensure that the area is visually well connected and safe. Careful earthworks on the riverside, combined with vegetation management will enhance the biodiversity of the area

The OPW now proposes to protect the Lee Road from flooding and thus provide safe access for residents who rely on the road.

It has also been decided to remove the boardwalk element from the scheme at South Mall properties given that it is not essential to the function of the flood defence scheme. However, the revised design will provide the flexibility for such a boardwalk to be constructed in the future, if appropriate.

Next Steps

Over the course of the next few months, OPW will issue detailed individual responses to all persons who made formal submissions through the exhibition process. The exhibition documentation will be updated to reflect any changes arising out of the exhibition process as well as refinement of the scheme to a greater level of detail, particularly with regard to architectural and conservation detailing. Once this work is completed, it is proposed to submit the documentation to the Minister for Public Expenditure and Reform around mid-2018.

Morrison's Island Public Realm Project (with integrated flood defence)

Cork City Council has had a long term ambition to enhance the south facing quays and create an amenity walkway along Morrison's Quay and Fr. Mathew Quay. These quays are also the lowest lying and are the primary source of regular tidal flooding. Tidal flood defences are therefore a priority for this area in reducing the impact of more frequent flooding.

Given the synergies between both projects and in order to avoid multiple projects in a short timeframe, OPW and CCiC have agreed to co-fund a project which combines the proposed public realm works with integrated flood defences.

Planning design for this project has been undertaken in the last number of months and Cork City Council propose to lodge a Part 8 Planning Application for the project in the coming weeks.

The project will deliver a high quality public amenity space which also delivers the required standard of flood protection in a seamless and integrated fashion. It is considered representative of the integrated approach which will be adopted in the design of the flood relief scheme as a whole.

The proposals for Morrison's Island represent an outstanding opportunity to bring about comprehensive regeneration of this historic area. It will include Plaza spaces at Parnell Bridge and Trinity Bridge and create safe places for people to sit and enjoy as well as pass through, with the potential for them to be used for events/activities.

Materials have been chosen to strengthen the distinctiveness of the historic quayside environment. This incorporates interpretation, including bespoke seats that take their design reference from shipping crates, providing the opportunity to introduce the names of places that goods went to/from and the sort of produce that was being transported.

1 Introduction and Background

1.1 Context

There is a long history of flooding in Cork City and the River Lee valley. A number of severe floods have affected the city in the past, most recently in November 2009, February 2014 and Winter 2015/16. The event of November 2009 was an exceptionally severe event, with major damage caused to commercial and residential buildings in Cork City.

It has been estimated that the damages caused in the 2009 river flood and 2014 tidal flood amounted to **€90m** and **€40m** respectively.

Figure 1: Images of flooding in Cork city in November 2009 and February 2014



The 2009 event heightened public awareness of the significant flood risk which exists in Cork City and the need to provide a flood relief scheme.

1.2 The Design and Delivery Process

The Office of Public Works (OPW) is the state body through which Government exercises its statutory responsibilities in respect of river drainage and flood relief.

The OPW in partnership with Cork City and Cork County Councils carried out a Catchment Flood Risk Assessment and Management (CFRAM) Study for the Lee Catchment and the Final Catchment Flood Risk Management Plan (CFRMP) was published in January 2014.

The Lower Lee (Cork City) Flood Relief Scheme was commissioned by the OPW with the objective of delivering a flood relief scheme for Cork City and environs to provide protection against the 1 in 100 year fluvial/1 in 200 year tidal flood events.

The Lower Lee Flood Relief Scheme is a key deliverable of the OPW National Flood Risk Management programme and will be the largest flood relief project ever proposed in Ireland.

OPW Flood Defence Schemes are generally carried out under the Arterial Drainage Act 1945 and 1995. The OPW either works in association with the relevant Local Authorities or funds Local Authorities directly to undertake flood defence works. With regard to the Lower Lee FRS, the OPW is working in

association with Cork City and County Councils as the local authorities and the ESB as one of the main stakeholders and operators of the hydroelectric dams on the system.

The OPW has engaged extensively with stakeholders including the public on this project.

There are five stages to the project:

- Stage I - Development of a number of flood defence options and the identification of a preferred Scheme.
- Stage II - Public exhibition.
- Stage III - Detailed design, confirmation and tender.
- Stage IV - Construction and
- Stage V - Handover of works.

Currently the scheme is at Stage II and has been publically exhibited. Submissions have been received from the local authorities, statutory consultees and the public, and the scheme is currently being amended as deemed appropriate to address concerns raised where reasonably possible.

The scheme will subsequently be submitted to the Minister for Public Expenditure and Reform for statutory confirmation under the Arterial Drainage Act. When and if, ministerial confirmation is given, this imposes an obligation on the OPW to deliver the Scheme, i.e. move onto Stage III.

1.3 Summary of the Proposed Scheme

The earlier Lee Catchment Flood Risk Assessment and Management (CFRAM) Study identified the preferred scheme for Cork as being a combination of a flood forecasting and warning system, optimised dam operating procedures to reduce and control flows passed down into the Lower Lee catchment and raised waterside defences.

Following extensive study and assessment, a proposed scheme has now been developed which consists of a modified version of the measures identified in the Lee CFRAMS, together with a flow control structure on the south channel to rebalance flows between the north and south channels. The scheme was developed in close co-operation with all key stakeholders, in particular; Cork City Council, Cork County Council and the ESB.

Following the development and assessment of a number of options, the OPW now proposes to proceed with a scheme which consists of the following key elements:

- Flood Forecasting System and Early Warning Service;
- Revised dam operating procedures;
- Washlands upstream of the City;
- Direct waterside defences; and

- Flow reduction in the South Channel.

1.4 Benefits of the Scheme

The Lower Lee Flood Relief Scheme will run from Inniscarra Dam to the city centre protecting over 2,100 properties, including 900 homes and 1,200 businesses against tidal and river flooding. It will be the largest flood relief investment project ever proposed in Ireland.

In line with international best practice, the standard of protection provided by the scheme is the 1 in 100 year flood from the River Lee and the 1 in 200 year flood from the tide. The scheme is adaptable to provide greater protection in the future in response to climate change.

This integrated and holistic scheme will substantially free the people of Cork from the worry and stress of living with flood risk. It will remove barriers to future private investment and help to reinvigorate the city centre and its environs. It will also provide significant local employment during construction.

The scheme includes €20m of much needed investment in repair of historic quay walls which could otherwise be at serious risk of collapse. It will provide almost 1km of new river walkways, enhancing connectivity to the river and improve public realm spaces in collaboration with the City Council, such as proposed works on Morrison's Island.

Figure 2: Benefitting lands within the City Centre

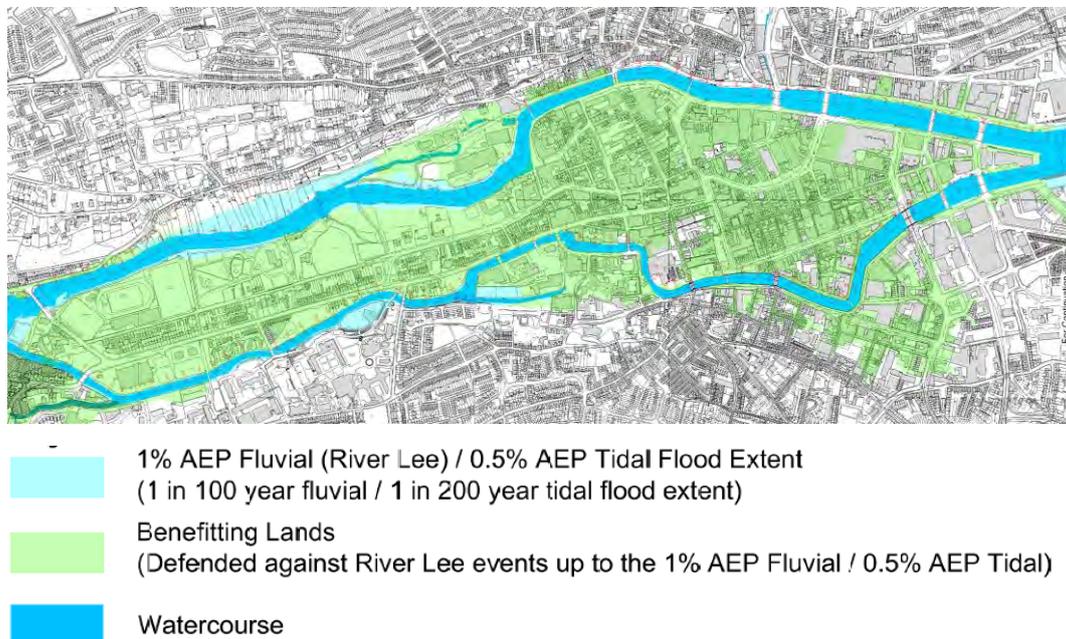
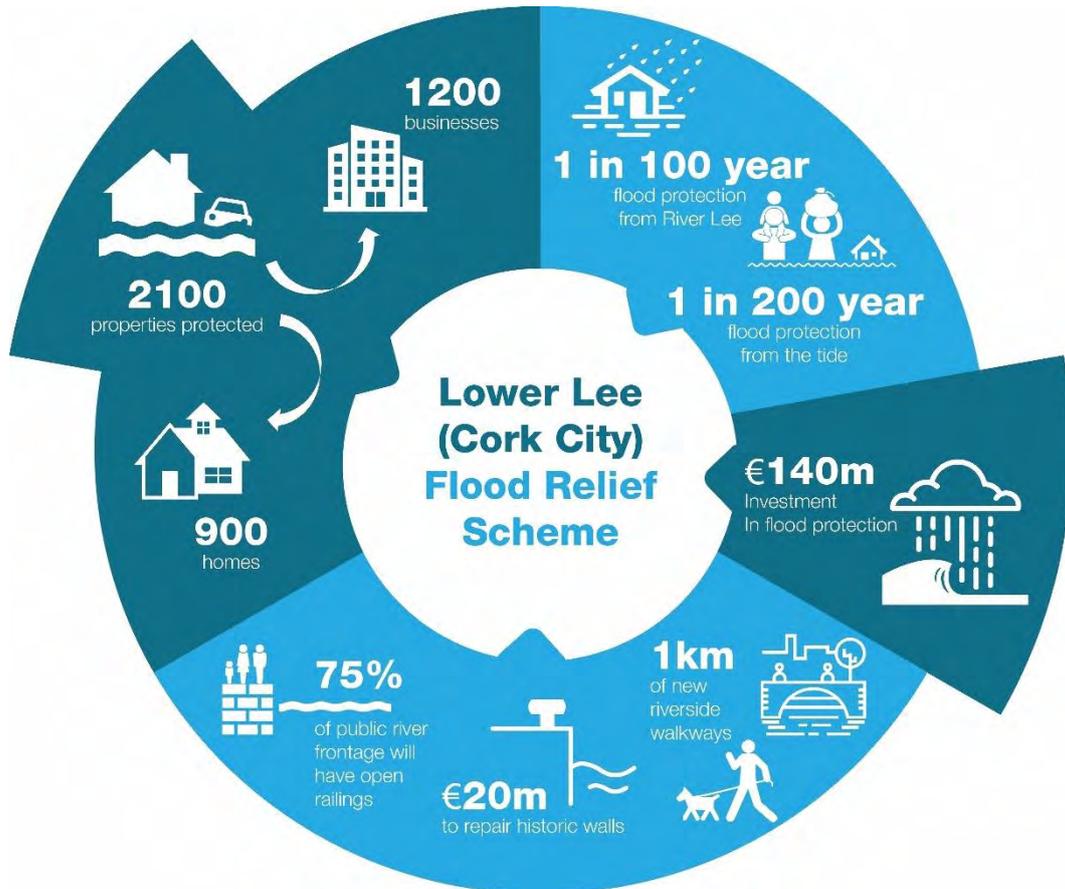


Figure 3: Summary of Benefits of Scheme



1.5 Scope and Structure of this Report

The proposed scheme was brought to Statutory Exhibition stage through the Arterial Drainage Act (as amended) in late 2016/early 2017. Full details of the exhibition are provided in Section 2 of this report.

As part of the exhibition process, a significant number of submissions were received which can broadly be categorised under the following headings:

- Queries about Alternative Solutions
- Technical Concerns about Exhibited Scheme
- Potential Impacts of Exhibited Scheme
- Site Specific Issues
- Queries regarding Project Delivery and Governance

This report along with the appended technical reports will form part of the information required under Section 7(3)(b) of the Arterial Drainage Act. This report addresses the queries that were raised in submissions and throughout the exhibition process.

As this report is being made available publically, it focuses on submissions concerned with the proposed Scheme as a whole, including specific issues relating to public areas. Where submissions were received from private landowners which were limited to concerns in relation to their own sites, it is deemed more appropriate to respond to such queries on an individual (one to one) basis by direct written response (and through further consultation if required) with the specific landowner. Such submissions generally related to access arrangements and alignment of flood defences within individual sites

2 Public Exhibition and Open Days

2.1 Overview

The statutory public exhibition for the Lower Lee (Cork City) Drainage Scheme (Flood Relief Scheme) was held between 12 December 2016 and 20 January 2017. In accordance with the Arterial Drainage Acts of 1945 and 1995, in conjunction with the exhibition, interference notices were issued to parties who were identified as owners, reputed owners, or occupiers of land or land related rights which would be interfered with by the scheme. These parties were then invited to comment on the scheme being proposed.

A series of schedules, drawings and plans were displayed at the following venues for the statutory public exhibition, which was extended from the normal four week duration to account for the Christmas holiday period:

- The Foyer, City Hall, Anglesea Street, Cork
- The Foyer, County Hall, Carrigrohane Road, Cork
- Public Library, Ballincollig, Co Cork
- Central Library, Grand Parade, Cork

An interactive display was made available at the public exhibition in both City and County Hall. This received very positive feedback from the public as being a useful tool to better understand the scheme and the proposals.

A series of four open days were also held in the Millennium Hall, Cork City Hall, Cork City to enable members of the public, including persons who had received notices, to discuss issues or raise questions with representatives of the Office of Public Works (OPW) and the engineering design and environmental teams. The open days were held on the following dates:

- Monday 12 December 2016
- Tuesday 13 December 2016
- Tuesday 20 December 2016
- Thursday 19 January 2017

The Exhibition was advertised to the public in advance through a variety of media as follows:

National Newspaper Advertisements:

Newspaper	Advertising Date			
Irish Independent	08.12.2016*	10.12.2016*	17.02.2017**	07.03.2017^
Irish Times				
Irish Examiner				

Iris Oifigiúil	09.12.2016*	21.02.2017**	07.03.2017
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Local Newspaper Advertisements:

Newspaper	Advertising Date			
Evening Echo	08.12.2016*	10.12.2016*		07.03.2017^
Cork Independent			23.02.2017**	09.03.2017^
The Corkman				
Southern Star		10.12.2016*		
The Carraigdhoun		10.12.2016*		

Local Radio:

Radio Station	Advertising Date		
Cork 103FM	09.12.2016*		
Red FM			
Cork 96FM		23.02.2017** (6 slots)	09.03.2017^

*Launch of Public Exhibition

**First extension of submission deadline date to Thursday, 16 March, 2017

^ Second extension of submission deadline date to Friday, 7 April, 2017

Social Media:

Platform	Advertising Date		
Twitter	12.12.2016*	15.12.2016*	
Facebook	20.03.2017	03.04.2017	05.04.2017

*Social Media advertising focused on the Public Exhibition launch & general information rather than the actual Open Days.

Members of the public who attended these open days were encouraged to write to the OPW with their comments and observations on the scheme. This report summarises the key observations and comments received, and sets out the OPW's responses to same.

The deadline for submissions on the proposed scheme was extended from 17 February to 7 April 2017 to allow further time for the public to provide feedback. All submissions received are assessed and considered as part of the public exhibition process to ensure that the public's view on the proposals appropriately influence the Scheme design.

All documents including posters, brochures, drawings, photomontages and comment sheets that were on display at the public exhibition were made available on the project website (<http://www.lowerleefrs.ie/>) for viewing and download by the public. Amendments to the scheme based on the information received from the public will be made during the detailed design stage of the scheme where deemed appropriate and prior to Ministerial Confirmation of the Scheme under the ADA.

In addition to the statutory consultation described above, extensive landowner and stakeholder consultation has been undertaken throughout all stages of the scheme development, to ensure that those who are directly impacted by the project remain informed and are provided with the opportunity to provide feedback. The consultations included site meetings, correspondence, public presentations and community meetings.

Presentations and engagement with various representative groups including Cork Chamber, Cork Business Association, Cork Public Participation Network etc. allowed for in-depth discussion on the proposed scheme. Design workshops were also undertaken with major stakeholders such as Cork City Council to ensure that the progressed design was in keeping with the future objectives for the city.

A number of presentations were made to elected representatives of both Cork City Council and Cork County Council at critical stages of the projects. A presentation was also made in Leinster House to interested Members of both houses of the Oireachtas.

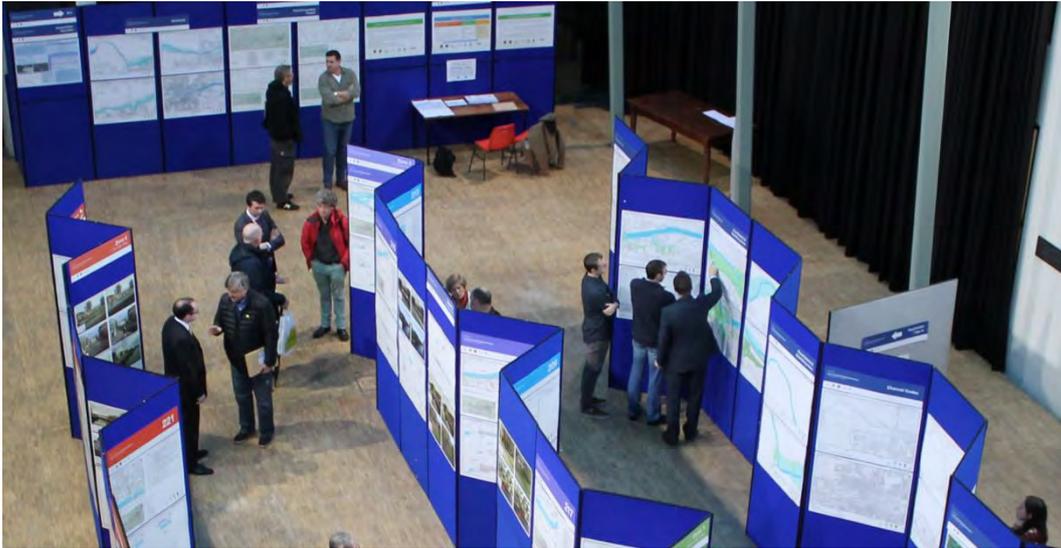
The statutory public exhibition was preceded by two non-statutory information days, held on 17 July 2013 (constraints study stage) and 29 July 2014 (presentation of the emerging preferred option). These information days provided the public with an opportunity to receive information on the process to be followed in the development of the scheme and provide information on their experience of flooding. They also have the opportunity to make suggestions as to possible solutions and to receive an update on the work completed on the scheme to date, in addition to providing an opportunity to provide feedback during the scheme development stage.

2.2 Discussion on Public Exhibition Open Days

A total of 185 people attended the public exhibition open days over the course of the four days. The attendance at the earlier sessions was quite low despite extensive website newspaper and radio advertising, but attendance improved at the latter sessions. 69 people attended the first two open days on the 12 and 13 December, 37 people attended the third open day on 20 December and 79 people attended the fourth open day on 19 January.

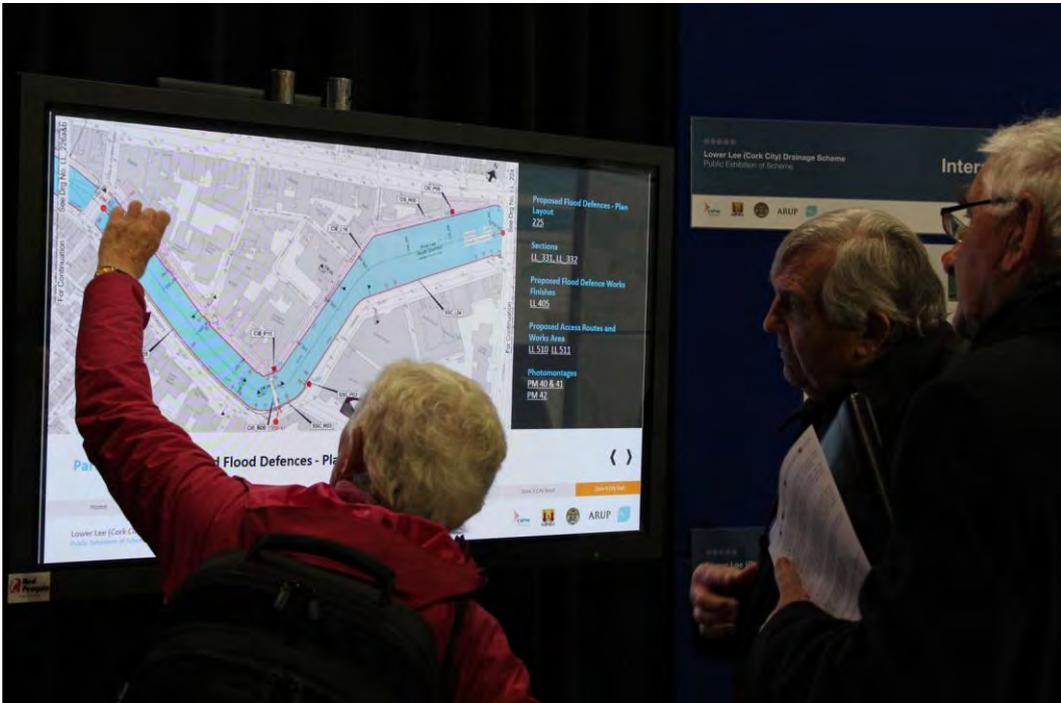
The majority of attendees in the early sessions were landowners who had received interference notices in relation to the scheme, and who had questions in relation to their specific lands/properties. As can be seen in Figure 4, there was good engagement by the public with the engineering design and environmental teams who were available to answer queries in relation to the proposed design.

Figure 4: Public Exhibition – Open Day



As the majority of attendees who raised concerns during the open days were affected landowners discussing their individual plots, the general feedback received in relation to the scheme as a whole was predominately positive. Positive comments were made in relation to the website and interactive mapping as shown in Figure 5.

Figure 5: Public Exhibition – Interactive Mapping



3 Summary Analysis of General Key Issues raised in Submissions

A total of 1,162 submissions were received during the public exhibition period. These submissions have been reviewed and analysed in detail. Sections 4, 5, 6, 7 and 8 sets out the OPW's responses to the key issue raised and Section 9 details the recommended changes to be considered to the scheme.

To understand the key issues being raised and the context of the submissions, a high level analysis was undertaken on various aspects of the submissions as follows:

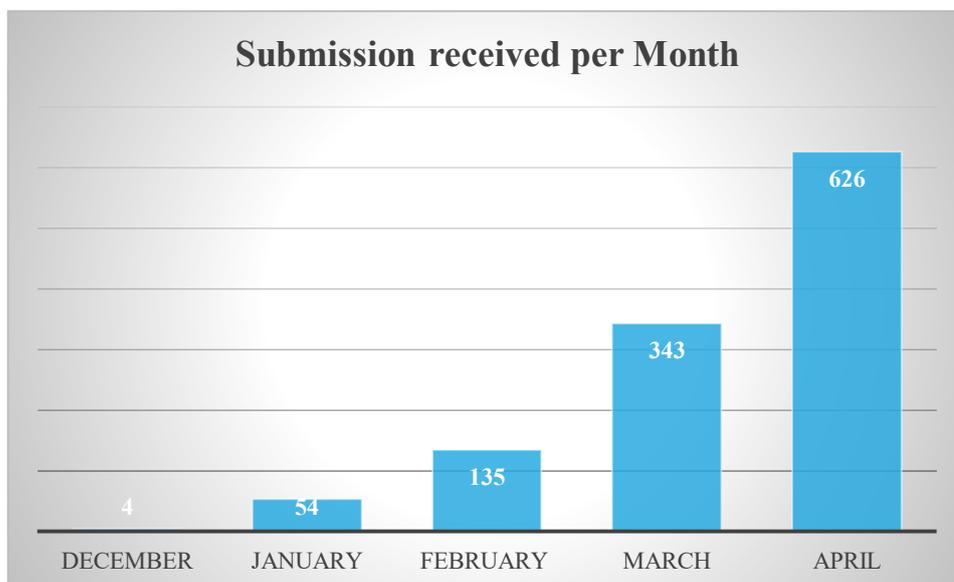
- Format of submissions, e.g. by email, letter, using standard templates etc.
- Chronology of submissions, i.e. when submissions were received relative to dates of various events.
- Origin of submission, i.e. from what origin did the submission come, e.g. business groups, statutory consultees, individual landowners or stakeholder groups.
- Common themes raised in submissions, e.g. alternatives considered, scheme wide concerns or area specific opinions.

These headings are explored in further detail in the following sections.

3.1 Chronology of Submissions

Submissions were received over the course of the public exhibition period ranging from December 2016 to April 2017. As can be seen in Figure 6 the majority of the submissions were received during March and April, closer to the extended deadline for submissions.

Figure 6: Chronology of the submissions received during the public exhibition period.



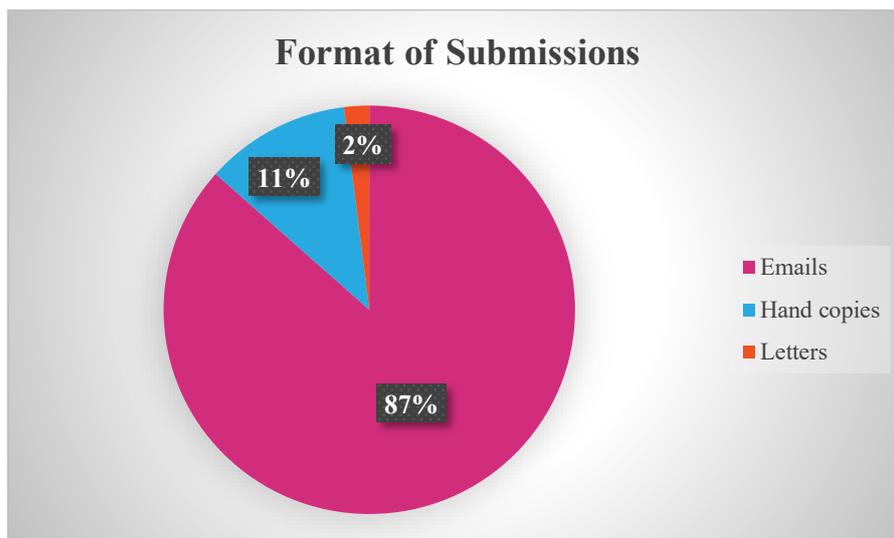
A small number of submissions were received in December and January as the open days and public exhibition display were still ongoing. (The open days were held on the 12, 13 and 20 December 2016 and 19 January 2017). This period also included the Christmas and New Year's holiday period which may have also reduced the number of submission received.

A large number of submissions were received in the days following public events held by specific stakeholder groups. This included 152 submissions received in the 5 days following an event on 10 March 2017.

3.2 Format of Submissions

The 1,162 submissions were received in a number of formats including 1,006 by email, 133 comment sheets (generally completed at the exhibition open days) and 23 letters, see Figure 7 for a graphical display. Comment sheets were provided at the public exhibition and were also available on the project website to provide an easy means of providing feedback in a user friendly format. The brochure provided further information on the email and postage details for comments.

Figure 7: Format of submissions received during the exhibition period



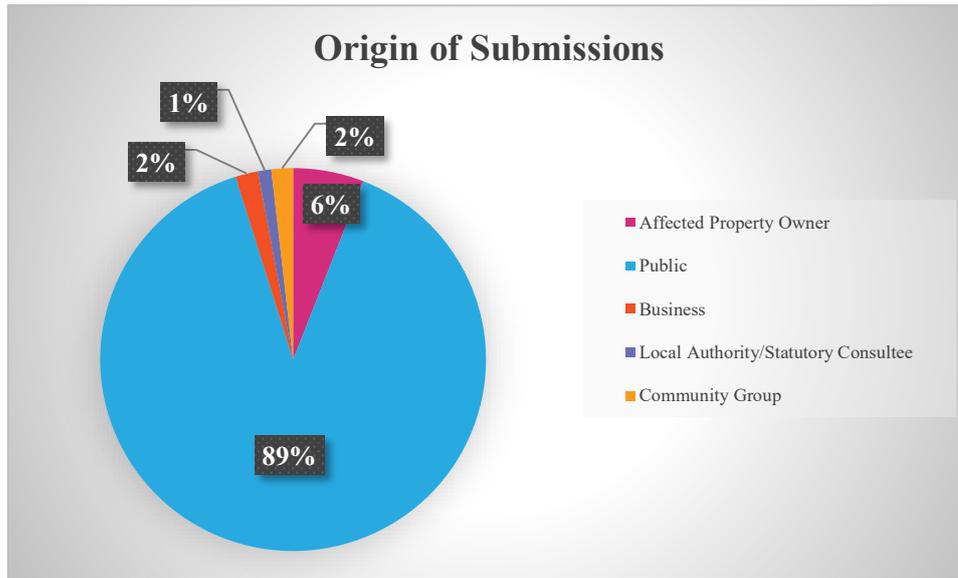
A number of the submissions utilised a standardised template from a stakeholder group, totalling 142 submissions. In some cases, additional personal views were added to this standardised template.

Over 150 submissions were received which contained no specific information other than a general one or two line objection to the scheme.

3.3 Origin of Submissions

The submissions originated from a number of main sources which included local authorities, statutory consultees, business groups, affected property owners and the general public. Figure 8 below shows a graphical representation of the origin of the submissions.

Figure 8: Origin of Submission



3.4 Exhibition Day Attendance vs. Submissions

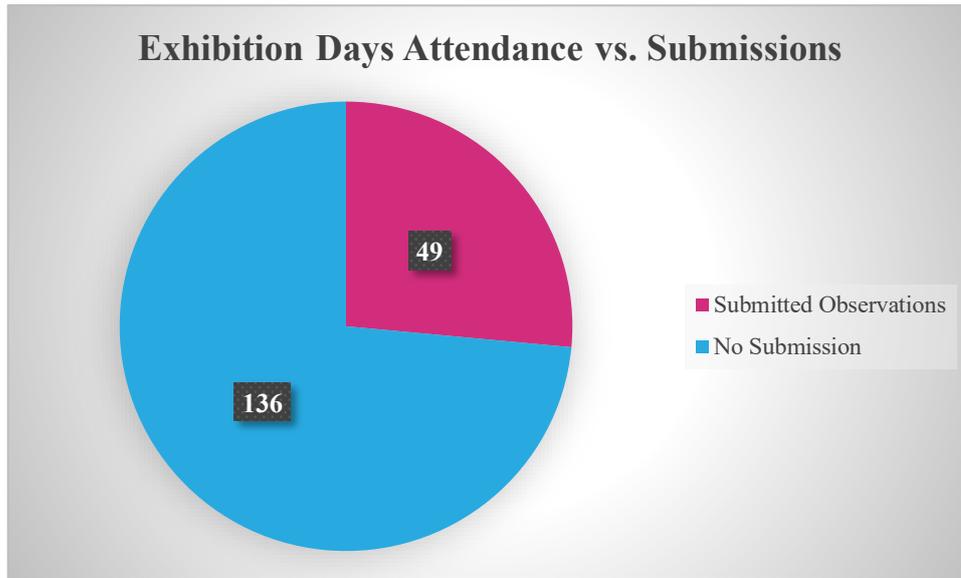
To assist in understanding the context of some of the submissions, the list of those who attended the manned Public Exhibition Days (and signed in) was compared against those who submitted observations in relation to the Scheme.

This highlights that of the 1162 submissions received, only 49 actually attended the exhibition days. This means that over 1100 people submitted observations without having had the benefit of engaging directly with the OPW and design team during the exhibition days and having the design team discuss any questions or queries they may have had.

Of the 185 attendees at the Exhibition Days, only 49 submitted written observations, the majority of which were in relation to specific property issues.

This suggests that those members of the public who had the benefit of discussing the scheme through direct engagement with the design team did not subsequently feel it necessary to make a submission and that very few of this group raised an opposition to the scheme. See Figure 9.

Figure 9: Exhibition Day Attendance vs. Submissions



3.5 Potential Influence of Misinformation in Social Media Domain

It has been observed that a significant amount of misinformation about the scheme has made its way into the various social media networks. Examples of this included incorrect assertions that; flood risk would be worsened downstream of the city, that flows through the city would be increased, that historic bridges and quay walls were to be demolished, that the quay wall parapets would be twice the actual height proposed, that views of the river would be removed.

Because of the nature of social media, the rapid spread of this incorrect information is considered to have likely significantly influenced the number of submissions received opposing the scheme.

3.6 Common Themes Raised

There were a number of common topics raised among the submissions which are listed in Table 1 in order of most mentioned.

Table 1: Most common themes raised in the submissions

Rank	Submission Theme	Rank	Submission Theme
1	Impact of Proposed Walls on Heritage and Visual	16	Requests for Peer Review
2	Impact on River Amenity	17	Impact on Ecology
3	Contention that River Containment is an unproven solution	18	Queries on Environmental Impact Statement (EIS)
4	Impact on Tourism/Businesses	19	Concerns regarding Fitzgerald's Park solution
5	Natural Flood Management (NFM) as an alternative	20	Concerns regarding risks of Pumping Station Failures

Rank	Submission Theme	Rank	Submission Theme
6	Construction Disruption Impacts	21	Concerns regarding Flooding through Sewers
7	Public Engagement/Consultation Concerns	22	Potential for Storage Downstream of Dams
8	Tidal Barrier as an alternative	23	Requests for a Multidisciplinary Design Approach
9	Alternative Upstream Storage Options	24	Queries regarding access to Flood Insurance post scheme
10	Consideration of potential impacts of Climate Change	25	Concerns in relation to access/egress at Lee Road
11	Concerns regarding residual Flood Risk Downstream	26	Potential for River Dredging as an alternative
12	Funding Sources for project	27	Potential for Flood Resilience Measures as an alternative
13	Concerns regarding exhibited North Mall solution	28	Concerns regarding exhibited solution at Grenville Place
14	Concerns about residual Groundwater flood risk and changes to groundwater regime	29	Concerns regarding security
15	Queries regarding improvements in Dam Operation	30	Concerns about proposed South Mall Boardwalk solution

Following the assessment of the submissions, queries raised were grouped into common themes to allow responses be prepared in a holistic fashion for each key topic. The themes are as follows:

1. Queries about Alternative Solutions
2. Technical Concerns about Exhibited Scheme
3. Potential Impacts of Exhibited Scheme
4. Site Specific Issues
5. Queries regarding Project Delivery and Governance

The following sections summarise these common themes raised among the submissions.

3.6.1 Alternative Solutions

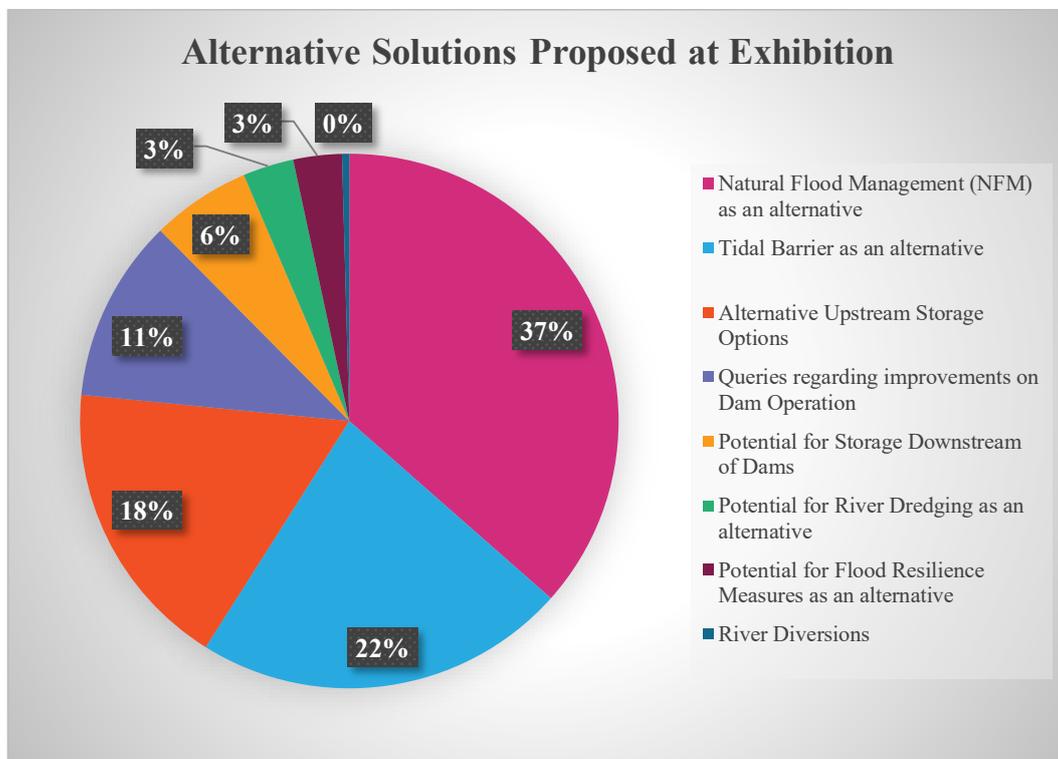
Under Alternative Solutions, the main issues which regularly arose are as follows:

- Concerns that not enough value was given to certain factors during the option selection process and that some potentially viable alternative options weren't considered, or weren't considered in sufficient detail.
- Queries as to why upstream catchment management measures, storage, afforestation, farming the flood, NFM measures etc., were not included.
- Suggestions that the dams could be utilised to solve the fluvial flooding issue in its entirety.

- Concerns that the storage downstream of the dams is being removed by the flood defences.
- Requests that an enhanced flood forecasting system and a reliable early flood warning system be put in place.
- Queries as to why the river is not to be dredged.
- Suggestions that flood resilience measures such as flood proofing of buildings is a suitable alternative and
- Queries as to why a tidal barrage is not to be constructed downstream.

Figure 10 is a graphical representation of the relative proportions of submission received in relation to various alternative solutions.

Figure 10: Alternation solutions submission themes



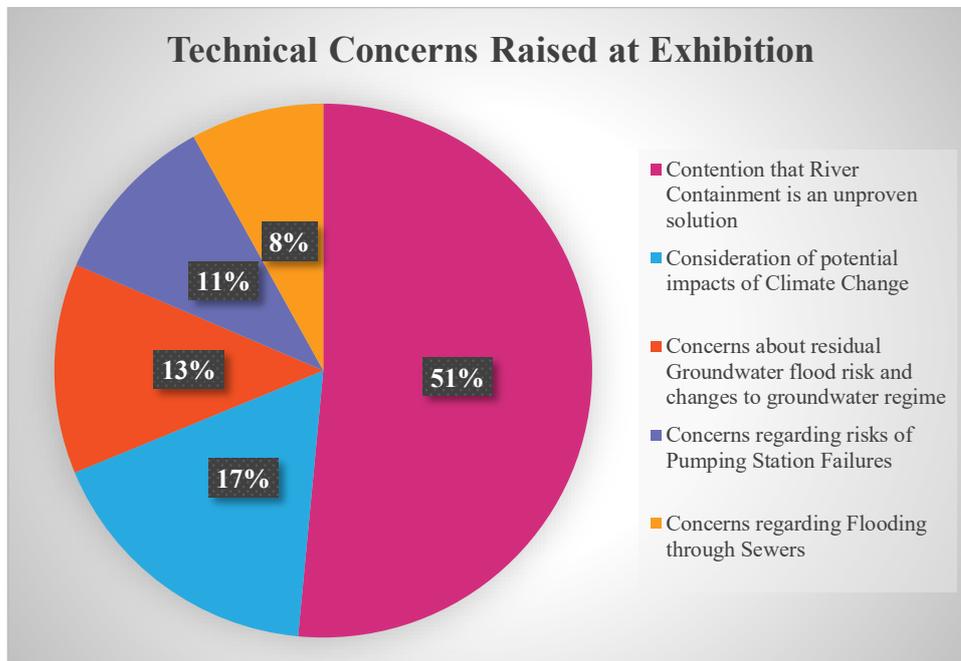
3.6.2 Technical Concerns Regarding the Exhibited Scheme

In terms of Technical Concerns about the Exhibited Scheme, the main issues which regularly arose are as follows:

- Concerns that the solution won't work, that it is unproven, that it doesn't follow best practice and that the higher the wall, the bigger the failure.
- Concerns that direct defences won't solve problem due to groundwater and/or drainage systems flooding from the dry side; and
- Concerns that the scheme solution is short sighted, and doesn't adequately consider climate change and/or the longer term requirements.

Figure 11 is a graphical representation of the relative proportions of submission received in relation to various technical concerns about the exhibited scheme.

Figure 11: Technical concerns regarding exhibited scheme submission themes



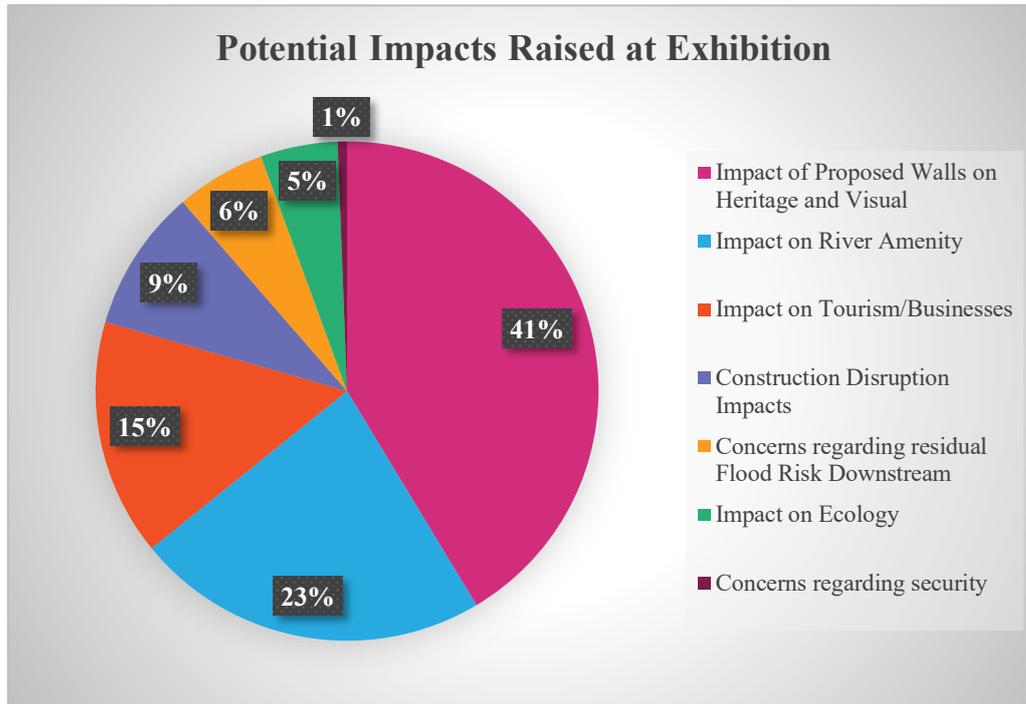
3.6.3 Potential Impacts of the Exhibited Scheme

Under Potential Impacts of Exhibited Scheme, the main issues which regularly arose are as follows:

- Concerns about the impact of the proposed defence walls in the city on cultural heritage, and change to the ‘feeling’ of the city.
- Concerns about lack of access to the river and loss of views of the river.
- Concerns about the impact on ecology.
- Concerns about negative impacts on tourism and the local economy.
- Concerns about security.
- Concerns about construction disturbance, and short term and long term impacts on businesses and
- Concerns that the scheme would worsen flood risk downstream.

Figure 12 is a graphical representation of the relative proportions of submission received in relation to various potential impacts of the exhibited scheme.

Figure 12: Potential impacts of exhibited scheme submission themes



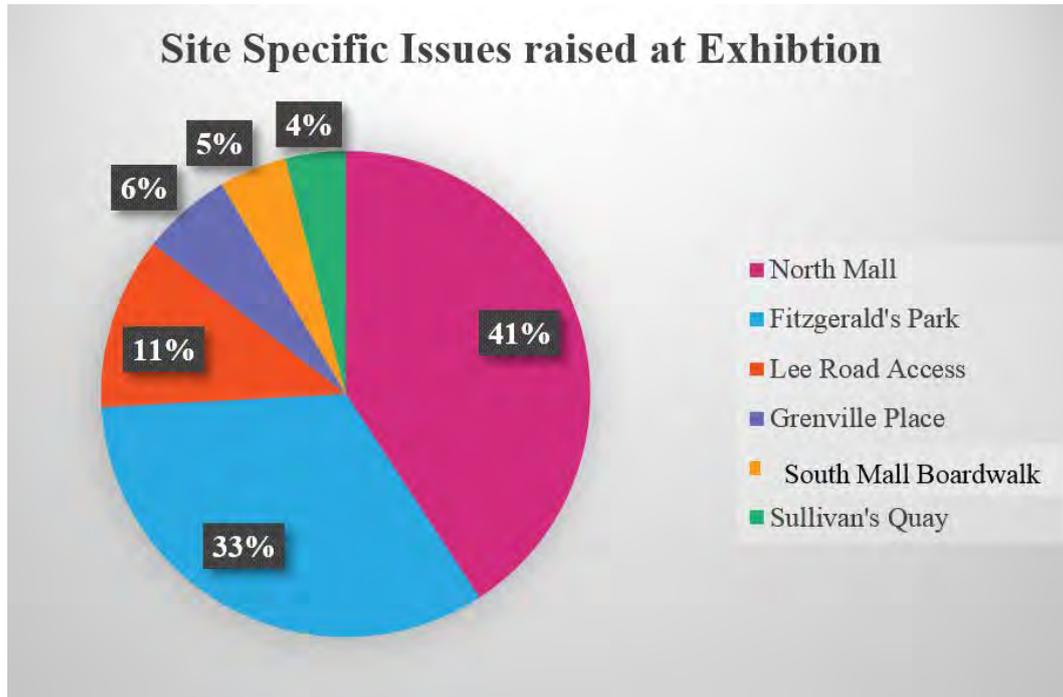
3.6.4 Site Specific Issues

Whilst the vast majority of submissions were general in nature, (providing opinion on the scheme as a whole), those submissions which contained specific commentary on specific areas were generally confined to commentary on a small number of areas as follows:

- North Mall;
- Fitzgerald Park;
- Lee Road Access;
- Grenville Place;
- South Mall Boardwalk; and
- Sullivan's Quay.

Figure 13 is a graphical representation of the proportion of submissions received in relation to specific areas. It can be seen that North Mall and Fitzgerald's Park were the areas of greatest focus.

Figure 13: Site specific issues submission themes



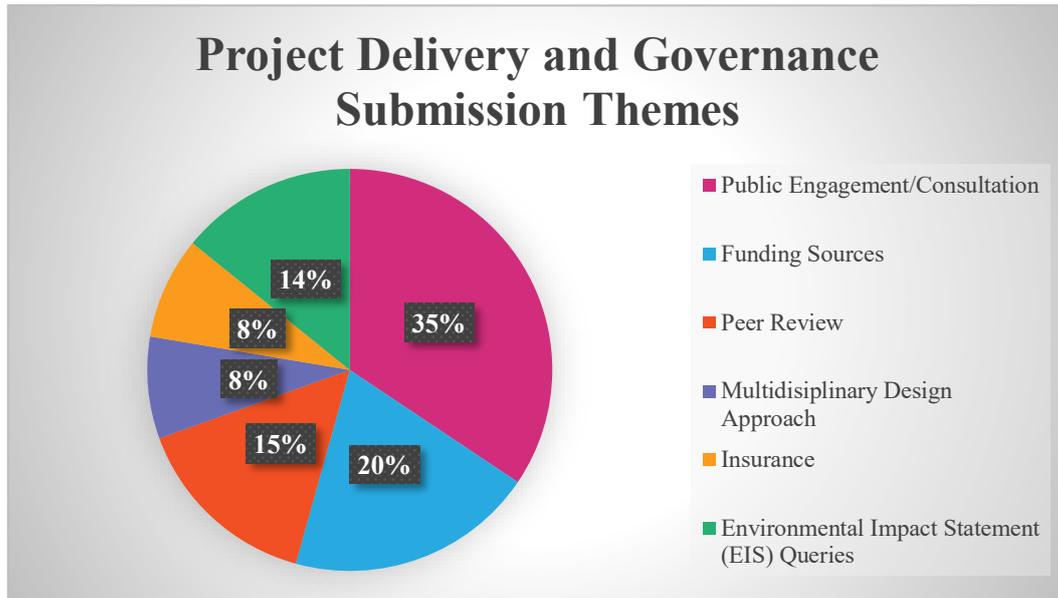
3.6.5 Project Delivery and Governance

In terms of Project Delivery and Governance, the main issues which regularly arose are as follows:

- Opinion that there was inadequate public consultation and queries regarding the appropriateness of the use of the Arterial Drainage Act and the governance of the project.
- Queries on the funding sources, consideration of alternative funding sources and the basis of budget for the scheme.
- Suggestion that an international peer review should be undertaken and queries regarding the qualifications and relevant experience of consultants involved in the project and whether
- Suggestion that there was a lack of a multidisciplinary design approach and queries on how and who formulated the project brief, concerns as to the make-up of the design team.
- Queries on whether flood insurance will be available to all households following completion of the scheme.
- Queries regarding the completeness of the Environmental Impact Statement (EIS).

Figure 14 is a graphical representation of the submission themes for the project delivery and governance.

Figure 14: Project delivery and governance submission themes



3.7 Responses to Key Issues Raised

The following chapters address the key topics raised, providing a summary of the submission and OPW's response to same. Individual responses to specific queries raised will be addressed on a case-by-case basis in response to each submission in the coming period.

4 Response to Submissions on Alternatives Solutions

4.1 Introduction

A number of submissions received raised queries about alternatives considered, why alternatives were ruled out, making suggestions as to possible alternatives and querying the options selection process.

This chapter addresses queries raised in relation to alternatives considered and the option selection process.

4.2 Option Selection Process

4.2.1 Summary of Submissions

A number of submissions have queried the option selection process and cost benefit analysis used in this project. The main concerns include:

- A view that not enough value was given to the impact that the scheme will have on cultural heritage, tourism, traffic, environment and the local economy; and
- A view that alternative options were not investigated at all or in insufficient detail.

4.2.2 Response

4.2.2.1 The Lee CFRAM Study Options Development and Assessment

An initial options development and assessment was undertaken for the wider Lee catchment as part of the Lee CFRAM Study, including Cork City as a particular location for more detailed study.

The purpose was to assess all of the viable flood relief options that could be implemented in the wider Lee Catchment with particular attention paid to a number of urban locations including Cork City and then develop and select the preferred option. The Lee CFRAM Study assessed locations within the River Lee catchment that were considered to be at significant risk of flooding with potentially significant economic, social and environmental impacts, and assessed a range of potential options to reduce these risks.

Initially a screening and assessment of a range of possible flood risk management options was undertaken. Potentially viable options were then taken forward to a detailed options assessment process which included a detailed Cost Benefit Analysis and Multi-Criteria Analysis (MCA).

As part of the MCA process, each option was evaluated in relation to the 4 core criteria: technical, economic, social and environmental, using a detailed multi-criteria analysis (MCA).

To determine the MCA score for each option, the objectives were weighted and the options were scored depending on how well it met each objective. A high level benefit-cost ratio (BCR) of each option was also assessed with a BCR of greater than one indicating that the economic benefit of the scheme outweighs the cost.

The Lee CFRAM Study identified that the preferred option for a flood relief scheme for the Lower Lee including Cork City is permanent flood walls and/or embankments to manage both the tidal and fluvial risk. It recommended that these defences are implemented in conjunction with a fluvial and tidal flood forecasting system and revised operating rules for Carrigadrohid and Inniscarra dams.

The findings of this study are set out in the Lee CFRAMS CFRMP¹ and supporting flood maps².

4.2.2.2 Lower Lee Flood Relief Scheme Options Development and Assessment

The scope of the Lower Lee Flood Relief Scheme was based on the findings of the Lee CFRAMS. Therefore the starting point of the options assessment was a review and assessment of the Lee CFRAMS.

Following this review, a fresh initial screening of an extensive list of possible flood risk management measures was carried out as part of the Lower Lee FRS for all areas downstream of Inniscarra Dam.

Chapter 4 of the Options Report³ outlines in detail the flood risk management measures which were assessed as part of a fresh initial screening process against a predetermined set of criteria in order to determine their viability, and the reasons why some were considered to be non-viable and were not carried forward for further assessment, i.e. were screened out.

Table 2 below lists the initial Flood Risk Management Measures assessed.

¹ Draft Flood Risk Management Plan for the Lee catchment:

http://www.lee.cfram.com/downloads/documents/REP005_draftFRMP.pdf

² Flood Maps for the Lee Catchment-based Flood Risk Assessment and Management (CFRAM) Study: <http://www.lee.cfram.com/floodmaps/default.html>

³ Lower Lee (Cork City) Drainage Scheme Options Report:

http://www.lowerleefrs.ie/assets/lee_valley/docs/Other%20Documents/LLFRS_Options_Report.pdf

Table 2: Screening of Flood Risk Management Measures - Summarised from Section 4.1 of the Options Report

Possible Flood Risk Management Measure		Applicability	Economic	Environmental	Social	Cultural	Screening Result	Comment
Base-line	Do Nothing	Y	N	Y	N	Y	Not Viable	This option assumes no further work or expenditure on measures to reduce flood risk in the study area. The Do Nothing scenario is defined as the option involving no future flood defence expenditure. The implication is that the existing risk of flooding persists or possibly worsens in the study area. This is not considered to be a viable standalone option as it fails to meet the needs of the residents and business owners.
	Do Minimum	Y	Y	Y	Y	Y	Not Viable	This option provides the baseline for the study and would consist of minor works and maintenance measures, which could include filling in gaps in existing masonry river walls etc. The risk of flooding would remain high. Therefore, this is not considered to be a viable measure as it fails to meet the needs of the residents and business owners. Using this as the baseline scenario, however, allows the benefits of all existing measures to reduce the flood risk to be identified. It places the benefit of these measures into true perspective.
Non-Structural	Modified Operation of Inniscarra and Carrigadrohid Dams	Y	Y	Y	Y	Y	Potentially Viable	Undertake Technical Assessment
	Flood Forecasting and Flood Early Warning System	Y	Y	Y	Y	Y	Potentially Viable	Undertake Technical Assessment

Possible Flood Risk Management Measure		Applicability	Economic	Environmental	Social	Cultural	Screening Result	Comment
	Planning Control	Y	Y	Y	Y	Y	Not viable as a Standalone measure. May be viable as an ancillary measure.	This measure would assist in ensuring flood risk is not increased by future development. The measure would take a long time to implement, and would not reduce the current flood risk to an acceptable level. Therefore, it is not considered viable as a standalone measure. It may still be appropriate to implement along with other measures.
	Building Regulations	N					Not Viable	Long time to implement, and would not reduce the flood risk to an acceptable level. Will however form part of the long term strategy to minimise the potential impacts of climate change.
	Public Awareness Campaign	Y	Y	Y	Y	Y	Not viable as a standalone measure. May be viable as an ancillary measure.	This measure would help to increase public awareness and preparedness for future flood events. However, the measure would not reduce the current flood risk to an acceptable level. Therefore, it is considered unviable as a standalone measure. It may still be appropriate to implement along with other measures.
	Land Use Management	N					Not Viable	Long time to implement, and would not reduce the flood risk to an acceptable level.
Structural Measures	Creation of Washlands	Y	Y	Y	Y	Y	Potentially Viable	Undertake Technical Assessment.
	Direct Flood Defences	Y	Y	Y	Y	Y	Potentially Viable	Undertake Technical Assessment
	Channel Widening	Y	Y	Y	Y	Y	Potentially Viable	Undertake Technical Assessment

Possible Flood Risk Management Measure		Applicability	Economic	Environmental	Social	Cultural	Screening Result	Comment
	Sediment/Debris Control	N						The existing reservoirs remove much of the sediment from the system meaning sedimentation is not a significant issue downstream of Inniscarra Dam. Debris blockage risk is low due to the scale of the river and flows and thus large bridge structures.
	In-channel Flow Regulation	Y	Y	Y	Y	Y	Potentially Viable	This would focus on flow regulation and flow spilt between the North and South Channel of the Lee. Undertake Technical Assessment
	Bridge/Weir Modifications	Y	Y	Y	Y	Y	Potentially Viable	Undertake Technical Assessment
	Local Conveyance Improvements	Y	Y	Y	Y	Y	Potentially Viable	Undertake Technical Assessment.
	Diversion Channels or Culverts	N					Not Viable	The Lower Lee valley through Cork is heavily urbanised and does not contain any potentially viable diversion routes.
	Upstream Flood Storage	Y	Y	Y	Y	Y	Potentially Viable	Undertake Technical Assessment.
	Property Occupier Relocation	N					Not Viable	This measure involves the relocation of people and businesses from properties at risk of flooding to an area with lower flood risk. It is not considered feasible, due to the urbanised nature of the area at risk and the large number of properties at risk.
	Individual Property Protection	N					Not Viable	Not considered feasible due to the large no. of properties located in the Cork City area
	Pumping	Y	Y	Y	Y	Y	Potentially Viable	Localised pumping of surface water will form part of any scheme.

Possible Flood Risk Management Measure		Applicability	Economic	Environmental	Social	Cultural	Screening Result	Comment
	Tidal Barrage	N					Not Viable	Assessed in detail in Lee CFRAM Study. It produced an unsatisfactory cost benefit analysis and has significant environmental impacts.

4.2.2.2.1 Development of Flood Relief Options

The technically viable measures were then taken forward for detailed assessment. They were combined to create potential flood relief options. Most measures, while providing some reductions in flood risk, will not manage the flood risk entirely by themselves. Measures are therefore required to be combined into options so that they will manage the flood risk and achieve the objectives of the project.

The screening identified that a detailed flood forecasting system and revised dam operation rule were prerequisites to all potentially viable direct defence schemes downstream. Management of flows between the north and south channel was also established as offering significant potential to reduce the scale and impact of downstream defences.

4.2.2.2.2 Assessment of Options

All environmental constraints, including cultural heritage, industry and businesses, tourism and traffic (air quality and noise), were established early in the project and are set out in the Environmental Constraints Study⁴.

Each option was then evaluated in relation to the key study objectives (outlined in Appendix B of the Lee Catchment Flood Risk Management Plan⁵) using a detailed multi-criteria analysis (MCA). The MCA methodology used was based on the standard OPW MCA template developed and used nationally as part of the National CFRAM programme.

The objectives were categorised under the following core criteria: technical, economic, social and environmental.

The study objectives chosen for the MCA represent the key objectives of the scheme but do not ignore the other constraints identified.

The objective to “avoid damage to or loss of cultural heritage importance, their setting and heritage value within the catchment of cultural heritage” was included in the environmental criteria due to the importance of cultural heritage as a constraint.

To determine the MCA score for each option, each objective was weighted to reflect their relative importance and/or sensitivity within the scheme, to ensure that they were appropriately considered in the decision-making process. The options were scored depending on how well it met each objective.

⁴ Lower Lee FRS Constraints Study:

http://www.lowerleefrs.ie/assets/lee_valley/docs/2317%20Constraints%20Study.zip

⁵ Office of Public Works (January 2014), Lee Catchment Flood Risk Management Plan, <https://www.opw.ie/en/media/Lee%20Catchment%20Flood%20Risk%20Management%20Plan.pdf>, accessed 22 November 2017

The benefit cost ratio (BCR) of each option analysis was also assessed.

When building up cost estimates for a scheme of this nature, it is important that the expected whole life costs of the works and its management are developed and not just the scheme capital costs. The following list outlines the areas that were considered when developing cost estimates for this project:

- Construction costs.
- Design and site supervision costs.
- Site Investigation and survey costs.
- Environmental mitigation costs.
- Land purchase and compensation costs.
- Maintenance costs.
- Allowance for optimism bias and
- Allowance for Art.

The preferred flood relief option was selected as detailed in Section 17 of the Options Report⁶.

A cost benefit analysis was then undertaken where the benefits and costs for the preferred option were compared with those of the Do Minimum case to provide a convenient common baseline against which the proposed scheme can be assessed. The cost benefit analysis shows that the proposed scheme is cost-beneficial for both the recommended discount rate⁷ of 4% (Benefit Cost Ratio = 1.44) and the more conservative discount rate of 5% (Benefit Cost Ratio = 1.21).

4.3 Alternative Options

4.3.1 Summary of Submissions

A number of submissions have requested that an alternative solution be progressed. The main requests include:

- Non-specific requests for an alternative solution; and

⁶ Lower Lee (Cork City) Drainage Scheme Options Report:
http://www.lowerleefrs.ie/assets/lee_valley/docs/Other%20Documents/LLFRS_Options_Report.pdf

⁷ Discount rate is a component of discounted cash flow analysis, which seeks to estimate the present value of future cash flows. The discount rate adopted for this project is in accordance with guidance from the Department of Public Expenditure and Reform

- Combination of solutions to avoid the proposed flood defence walls and works in the city centre. The most frequently requested combination was a tidal barrier and natural flood management measures upstream.

4.3.2 Response

Flood risk management options for the River Lee have been investigated since the commencement of the Lee CFRAMS in 2006. The key output of the Lee CFRAMS is a set of preferred options to manage flood risk in the Lee catchment. The Lower Lee Flood Relief Scheme utilised, assessed and advanced the work completed in the Lee CFRAMS.

4.3.2.1 Alternatives Investigated

A wide range of alternative flood relief measures were considered and investigated during the screening stage of the project, following on from the work undertaken as part of the Lee CFRAMS. The measures were subjected to a preliminary assessment with regard to their viability in terms of the following criteria:

- Applicability to the area;
- Economic (potential benefits, impacts and likely costs);
- Environmental (potential impacts and benefits);
- Social (impacts on people, society and the likely acceptability of the method); and
- Cultural (potential benefits and impacts upon heritage sites and resources).

A summary of the flood risk management measures which were assessed as part of this initial screening process are contained in Table 2 above.

4.3.2.2 Combination of Flood Relief Measures

As outlined in Section 4.2 above, a large range of alternative flood risk management measures were considered from the onset of the project, following on from the work undertaken as part of the Lee CFRAM. From the assessment there were found to be a number of prerequisite measures that must be implemented in the final design solution, including Revised Dam Operating Procedures, Flood Forecasting System, an Early Warning Service, the designation of washlands upstream of Cork City and direct defences.

The three shortlisted options all included the prerequisite measures to ensure that a holistic, adaptable solution was developed. The chosen option is to provide direct defences with flow reduction on the south channel with only tidal defences on the south channel.

In summary, the combination of solutions proposed for the Lower Lee Flood Relief Scheme is:

- Flood Forecasting System and Early Warning Service;

- Revised dam operating procedures;
- Upland washlands;
- Direct defences; and
- Flow reduction in the South Channel.

This combination provides the best scores in terms of all three of Multi Criteria Analysis (MCA) score, options selection score and MCA Benefit/Cost Ratio. It is the least intrusive scheme from a visual perspective and effects least amount of channel and quays whilst also being the most adaptable scheme from a climate change perspective.

4.4 Alternative Upstream Storage Options

4.4.1 Summary of Submissions

A number of submissions have queried whether alternative storage options upstream of Cork have been appropriately considered. Suggestions for such measures include the following:

- Optimising the operation of the dams;
- Raising the dams;
- Use the reservoirs for flood storage only, i.e. cease hydropower;
- Provide storage at other locations on tributaries and on the Lee upstream of Carrigadrohid; and
- Use Natural Flood Management Measures to ‘slow the flow’.

4.4.2 Response

4.4.2.1 Optimising the Operation of the Dams

Optimisation of the operation of the dams is a key element of the exhibited scheme. The proposed optimised rules are set out in detail in Section 6 of the Lower Lee FRS Options Report. The optimised rules will reduce the 1 in 100 year design flow in Cork from 861m³/s in the present day scenario to 555m³/s, a reduction of circa 36%.

4.4.2.2 Use the Reservoirs for Flood Storage Only, i.e. Cease Hydropower

Using either or both reservoirs as flood storage reservoirs only has negligible benefit in terms of flood relief. This proposal, as suggested in a number of submissions, is predicated on the assumption that the water levels in the dams could be lowered sufficiently so that discharging water from the dam during times of high rainfall and/or extreme tides could be avoided.

However, there are a number of constraints which result in this not being feasible. The minimum levels in the dams are limited by factors such as water supply, top sluices at Inniscarra and environmental issues at the Gearagh. Inniscarra Dam discharges are currently physically constrained by available depth of water over the bottom of the sluices at the top of the dam, which limits the maximum advance discharges ahead of a flood event and sets a floor on the starting dam level. Reducing water levels to a suitable level at Carrigadrohid Dam would have a significant environmental impact in the Gearagh which is an SAC. There are also the limitations of current rainfall forecasting technologies which limits the lead times to ensure there is sufficient capacity available in the reservoirs.

Furthermore, at the current cost benefit ratio of the scheme, it would not be cost beneficial for OPW to take on the operations and maintenance of the dams for flood relief purposes only and to fund the cost of decommissioning one or either of the existing hydroelectric schemes.

Refer also to Appendix B which addresses this issue in further detail.

4.4.2.3 Provide Storage at Other Locations on Tributaries and on the Lee Upstream of Carrigadrohid.

The provision of storage at other locations was assessed in detail as part of both the Lee CFRAMS and the Lower Lee FRS. It is outlined in detail in Chapter 9 of the Lower Lee FRS Options Report.

A total of six possible storage areas were identified on the River Bride and River Shournagh, each of which individually could not be justified. It was also found that even if all of the above storage areas were to be constructed, they would only provide approximately 8% of the total storage volume required to eliminate the need for fluvial flood defences to the west of Cork City (when combined with the proposed operational changes at the existing Lee dams).

In addition, the option of a potential new storage reservoir at Dromcarra was also assessed and is reported on in an addendum to the Lower Lee FRS Options Report. The report found that construction of the Dromcarra storage area could reduce the design flow in Cork by up to 58m³/s during the 1% AEP event (assuming 100% efficiency). Whilst this would represent a significant reduction in peak flow into the city, it would not eliminate the need for direct defences and would in fact only reduce defences heights to the west of the city by circa 300mm.

As these defences are generally set back from the river walkways and are in the order of 1.8m to 2m high, it is considered that this reduction would not fundamentally alter the scale and nature of the defences, and would significantly increase the cost of the scheme.

4.4.2.4 Natural Flood Management

Natural Flood Management (NFM) measures were not considered as a potential option because there is no evidence base to demonstrate that NFM can deliver significant benefits in large catchments such as the Lee and for large floods such as the 1 in 100 year event.

A further study has been carried out in response to exhibition submissions, which has confirmed this view. Refer to Section 4.5 and Appendix E for further details.

4.4.2.5 Raising the Dams

Raising of the dams was not considered as part of the Lee CFRAMS and was outside of the original brief for the Lower Lee FRS. However, following submissions received, OPW and its consultants have since investigated this option to a prefeasibility level of detail. A detailed report on this investigation is included in Appendix B. The main findings of the study area as follows:

- A dam-raising scheme would give rise to significant alterations to the natural regime of the Gearagh Special Protection Area. Accordingly there is a significant risk that a Dam-raising schemes may not gain statutory consent when alternatives exist which do not impact on Natura 2000 sites.
- A minimum of 80 residential landowners and families would need to be displaced due to the increased reservoir area. This could critically damage communities such as Toonsbridge, which is situated relatively close to the existing reservoir levels, and would result in significant compensation costs.
- A minimum of 8km of existing national and regional roads would need to be raised/relocated. Several bridges would also need to be raised / reconstructed. It would also require very significant alterations to the proposed new Macroom bypass.
- A minimum of 5km² of substantially productive agricultural land would need to be incorporated into the “live” reservoir area and as such would be permanently sterilised. This land would need to be purchased or landowners compensated.
- Even if all of the above was undertaken, it would only eliminate or reduce a relatively modest proportion of the overall direct defences proposed in the exhibited scheme. Defences would still be required in the washlands area and independent measures to protect against tidal flooding would still be required in the main City Centre area.
- In the context of the above, it is evident that such a proposal would have an unacceptable and inappropriate impact on an area and community not currently at risk of flooding, to remove relatively modest impacts in the city area which will directly benefit from flood relief works.
- It has been established that such an alternative scheme is less attractive on technical, social and environmental grounds, than the exhibited scheme.
- All of the options considered are significantly more expensive than the exhibited scheme and crucially none of the options are cost beneficial and so would fail to meet the necessary criteria for public funding.

Refer to Section 4.6 and Appendix B for further details.

4.5 Natural Flood Management Measures

4.5.1 Summary of Submissions

A number of submissions have raised concerns that the flood relief scheme has not considered a full catchment wide solution incorporating Natural Flood Management (NFM) measures. Potential measures suggested include:

- Undertaking a land use audit (concerns that recent developments upstream have contributed to the flooding);
- Implementing measures to slow or reroute water upstream;
- Introduce a wetland system;
- Planting woodland buffers upstream;
- Reinstatement of floodplains;
- Planting for greater water absorption;
- Soft engineering;
- Use of the Gearagh for flow management;
- Water harvesting;
- Holistic solution; and
- Implementing more stringent development control measures.

4.5.2 Response

Natural Flood Management (NFM) measures were not considered in detail as a potential option for Cork, because there is no evidence base to demonstrate that NFM can deliver significant benefits in large catchments such as the Lee and for large floods such as the 1 in 100 year event. In conjunction with other storage and land use management options, it was therefore screened out as a potentially viable measure for Cork.

The scale of reduction in design flow needed to avoid the need for direct defences in Cork simply can't be delivered by NFM. In addition, the reservoirs already provide far greater attenuation than can be provided by NFM and would negate any changes arising from NFM measures.

Notwithstanding this, in response to the large number of submissions received, OPW and its consultants have undertaken a review of the applicability of NFM measures in the context of Cork to provide further information to the public explaining why they are not a viable solution. A full report on potential NFM measures is included in Appendix E.

The detailed assessment of the Lee Catchment concluded that the maximum possible number of feasible interventions in the catchment is approximately 5000. However, even if all of these measures were to be implemented and maintained, they would still only reduce the 1 in 100 year flow at Cork by between 1-4%, i.e. they would not significantly alter the need for direct defences. In fact, the

assessment identified that there was a risk that NFM measures could give rise to a potential for delayed peak flows on Shournagh which could actually increase flood risk in Cork.

4.6 Dam Operation Improvement

4.6.1 Summary of Submissions

A number of submissions have suggested that the flooding issue could be solved entirely by the management of the dams. Other submissions suggest that the dam discharges should be managed in conjunction with the tidal cycle. There have also been a few submissions stating that the dams should be used as flood reservoirs only and that they can be used to manage the flood risk entirely.

4.6.2 Response

4.6.2.1 Use of Dams to Provide Flood Relief Solution

The reservoirs have a relatively small capacity compared to the design flood volume. They therefore cannot on their own provide the required flood relief standard and thus direct defences are also required. However the new dam operating procedures proposed in this scheme, as described below, will reduce the peak flow during the design event by almost 40% which crucially allows wall heights in the city centre to be kept at or below guarding height.

As part of the flood relief scheme, new flood operational procedures have been developed for Carrigadrohid and Inniscarra dams, which will be implemented during periods where extreme fluvial flood events are forecasted and which require intervention to safely manage flood risk through Cork city.

The primary purpose of the new rules is to create storage in the reservoirs in advance of a flood that might otherwise exceed the design flow in Cork. This storage will then allow a flood through Cork to be managed by modifying dam discharges in consideration of inflows on the downstream tributaries so that the total peak flow in Cork is limited to less than the 1% Annual Exceedence Probability (AEP) (1 in 100 year) fluvial design flow of 555m³/s at Waterworks Weir.

The new procedures will involve advance discharges to create storage. This has the effect of increasing the frequency of medium flood events, which will result in earlier and more frequent flooding (in medium flood events) of primarily agricultural lands downstream of Inniscarra Dam, in areas termed as 'Washlands'.

'Washlands' are those areas adjacent to the river (and part of the Lee floodplain) which under the Scheme, will be deliberately flooded in advance of a forecasted extreme event, to facilitate pre-emptive lowering of water levels in Carrigadrohid and Inniscarra reservoirs, to create additional storage/attenuation capacity, and subsequently reduce the peak flow during the event.

The new dam operating procedures will also allow dam discharges to be managed optimally in conjunction with the tidal cycle and inflows from downstream tributaries.

4.6.2.2 Roles and Responsibilities

The new operating procedures for the dams will be jointly managed by the Flood (Advisory) Body and the Reservoir Operator (ESB). The Flood (Advisory) Body is the OPW who, through its agents (likely to be Cork City Council), will fulfil the required role under the Lower Lee (Cork City) Drainage Scheme.

Refer to Section 4.8 for details of the Flood Forecasting System (FFS) that will be used as part of the new dam operating procedures.

The Flood (Advisory) Body will operate, monitor and maintain the FFS; confirm when ‘flood conditions’ are in force (based on predictions from the FFS); liaise with the Reservoir Operator, and advise the pre-documented dam discharge strategy to be followed, based on the output from the FFS.

The Reservoir Operator will implement the advised dam discharge strategy and in exceptional circumstances, following consultation with the Flood (Advisory) Body, implement an alternative discharge strategy. It will also control and operate the reservoirs in accordance with its dam safety rules, during a design exceedence event.

4.6.2.3 Details of the Proposed Dam Operation for this Scheme

The following describes the proposed dam operation for this scheme:

- Normal Time - Most of the time, the dams will continue to operate as at present.
- In advance of Predicted Extreme Event - The new procedures will involve increased advance discharges (with graduated increases) to create storage in advance of the flood.
- During Fluvial Event - During the rising flood, continued increased discharges, not exceeding the threshold of flooding, will ensure that dam storage is retained until it is needed at the peak of the flood event.
- During Tidal Event - The New Rules will allow dam discharges to be managed optimally in conjunction with the tidal cycle.

4.7 Storage Downstream of Dams

4.7.1 Summary of Submissions

A number of submissions believe that construction of flood defences will result in removal of floodplains between Ballincollig and Cork City, including at the Mardyke and Fitzgerald’s Park. It has been suggested that removal of these areas could reduce storage capacity for floodwater. A few submissions requested that

any green areas, car parks and public open areas should be allowed flood to provide floodwater storage.

There are also concerns that recent developments on the Lee and Curragheen floodplains have increased the flood risk.

A number of submissions requested that floodplains which have been developed upon should be restored for floodwater storage.

It has also been suggested that a berm could be constructed in the vicinity of the Kingsley to act as a dam and retain a greater volume of floodwater upstream of this point.

4.7.2 Response

As part of the scheme, it is not proposed to remove any significant quantity of existing floodplain storage upstream of Cork City. This can readily be seen by reference to the “Flood Extent and Benefitting Areas” maps included with the exhibition drawings.

The quantity of floodplain storage which will be removed at green spaces in the city centre such as the Mardyke and Fitzgerald’s Park was reviewed during the preliminary design stage, and was found to be negligible in the context of the design flood event. Allowing these areas to flood would have a negligible impact on the flood levels downstream. This has been proven through detailed hydraulic modelling undertaken as part of the Lower Lee FRS project and as reported on in the Lower Lee FRS Hydraulics Report. Note that the effects of any changes to floodplain storage volumes have been taken into account in the hydraulic modelling for the scheme, and in the design of the proposed works.

Some submissions have suggested that any green areas, car parks and public open areas within the study area should be allowed flood, to provide floodwater storage.

While the intent of such options is understandable, the volumes available within car parks etc. are simply too small to have any measurable effect during the design fluvial flood. Also note that in the eastern part of the city centre, the dominant mechanism of flooding is tidal, therefore storage solutions will have negligible effect on reducing the peak flood level.

A number of submissions requested that floodplains which have been developed upon should be restored for floodwater storage. The demolition of existing development in flood risk areas is outside the scope of this project.

The management of flood risk associated with new development into the future will be managed through the Planning and Development system, which now has a robust set of statutory guidelines in relation to flood risk management for new development. The guidelines require that proposed development is generally avoided in flood risk areas, and where that is not possible that flood risk is managed to a high standard.

It has also been suggested that that a berm could be constructed in the vicinity of the Kingsley to act as a dam and retain a greater volume of floodwater upstream

of this point. This option of additional storage downstream of Inniscarra was reviewed and it was found that there is insufficient storage available to attenuate the design flood sufficiently to remove the need for direct defences in the city centre, assuming that the bund height was limited to prevent any increase in flood risk upstream.

In order to significantly reduce the height of defences in the city centre by providing online storage, extremely high dam structures would be required. This would significantly increase flood levels upstream of the bunds, which would put existing properties and infrastructure at risk. Therefore, this option was ruled out.

A possible alternative means of enhancing the attenuation effect in the context of the 100 year flood, would be to contain floodwater within the channel before the flood peak, and then allow water to be released into the floodplain around the peak of the event. In order to maximise the volume of such storage available around the peak of the event, embankments would be required along the length of the channel. The construction of the required embankments would sterilise large areas of agricultural land. Notwithstanding the above, this option has been ruled out as there is insufficient storage volume available in the reach.

4.8 Flood Forecasting System

4.8.1 Summary of Submissions

A number of submissions have requested that an enhanced flood forecasting system be put in place.

On the other hand, others have raised concerns about the risk of human error when relying on such a system.

4.8.2 Response

The proposed scheme will implement a state of the art Flood Forecasting system.

The Tidal Forecasting element of the System is already in place and has provided very accurate warning of extreme water levels in Cork City over the last number of years. It will be integrated into a combined fluvial and tidal flood forecasting system.

The Fluvial Forecasting element of the System has now also been developed as part of the Lower Lee FRS. It uses forecasted rainfall in the lead up to an event as well as real time rainfall and river flow data during an event. It will run continuously based on predicted rainfall, monitoring for potential extreme events.

It will provide an alarm to the operator a number of days out, when a predicted significant rainfall event or a predicted tidal surge event is above a predefined threshold that could otherwise result in flooding. This will allow dam levels to be lowered at predefined spill rates which won't flood property, in preparation for/anticipation of the extreme event.

It will allow management of discharges in real time (if required) taking account of inflow from the Shournagh/Western Bride and Tide Levels.

The trigger levels for the system will be set conservatively low to ensure that large events are catered for even if this may mean some false alarms.

The system will be dynamic and will grow with the scheme as hydrology data improves, calibration events occur and meteorological forecast resolution and accuracy improves.

The system will include significant redundancy and fail safes to minimise the risk of human error, or false predictions because of mechanical or electrical faults.

Refer to Chapter 7 of the Options Report⁸ for further information on the Flood Forecasting and Early Warning System.

4.9 Early Flood Warning System

4.9.1 Summary of Submissions

There have been a number of submissions with requests from river users for a reliable communication channel that will communicate when (and the magnitude of) increased flow is to be released from the dam and the expected levels/extents at key locations.

4.9.2 Response

The proposed scheme will implement an Early Flood Warning System and will be utilised for a number of purposes:

- Warning of increased advance discharges for recreational users of river and floodplain amenities downstream of Inniscarra;
- Warning to landowners of washland areas to allow livestock to be relocated;
- Warning to Cork City Council to close flood gates if necessary; and
- Emergency Response Planning.

The Flood Warning System dissemination would include the following:

- Direct notification to landowners of washland areas;
- Sirens in public amenity floodplain areas;
- Local Authority websites and social media platforms;

⁸ Lower Lee (Cork City) Drainage Scheme Options Report:
http://www.lowerleefrs.ie/assets/lee_valley/docs/Other%20Documents/LLFRS_Options_Report.pdf

- Local Authority ‘text alert’ system; and
- Radio and television public alerts if necessary.

The following official communication methods will be utilised by the local authorities to communicate any updates:

- Twitter – users can follow Cork City Council ([@corkcitycouncil](https://twitter.com/corkcitycouncil)) and Cork County Council ([@Corkcoco](https://twitter.com/Corkcoco))
- Facebook – Cork County Council <https://www.facebook.com/pages/Cork-County-Council/1032012336817766> and Cork City Council <https://www.facebook.com/corkcitycouncilofficial/>
- Email – users will be able to register to receive updates from Cork City and County Council.
- Website – <https://www.waterlevel.ie> will be regularly updated with water levels at proposed and existing gauges in the Lee Catchment.

4.10 River Diversions

4.10.1 Summary of Submissions

A number of submissions have been made in relation to potential alternative of diversion or partial diversion of the Lee and its tributaries as part of a solution for Cork. The diversions proposed in submissions can be divided into two types as follows:

- Some submissions made reference to a high level concept study entitled Irish Rivers 2040, part funded by OPW, Dublin County Council, Dublin City Council and Cork City Council. In this high level concept study, a group of Dutch architects and landscape architects were invited to share their experiences on potential high level strategies and solutions to flood protection for Irish river systems. One of the case studies included in this project is Cork City. A theoretical option suggested was to provide a by-pass or overflow channel for the River Lee flow (or part of the flow) from upstream of the Waterworks Weir, south of the city, eventually discharging into Lough Mahon. This was a concept and no significant details were provided on the possible routes, scale, capacities, levels etc. The purpose appears to be to provide a reduced flow into the city and thus reduced direct defences.
- There was also a submission proposing to divert the Curragheen and Glasheen along a similar route tying into the Tramore River in the adjacent valley. The purpose of this proposed route was to remove the Curaheen and Glasheen flow from entering the south channel and thus allowing the south channel to be isolated during a tidal event, therefore avoiding tidal defences on the eastern stretch of the South Channel.

4.10.2 Response

The potential diversions noted above were screened out at Options Stage. However, in response to the submissions received at Exhibition Stage, a supplementary report has been prepared to demonstrate why these suggested alternatives are not viable solutions for Cork.

A copy of this River Diversions Report is included in Appendix D.

Items considered in the report include the following:

- Possible routes, including practicalities (elevation change, pumping requirements etc.)
- Channel capacities/existing flood risk
- Constraints on the possible diversion routes
- Likely impacts
- Construction cost estimates

The findings of this report confirm that all of the suggested diversions have significant technical and environmental constraints due to the location, scale and distances involved in the proposals, meaning that all suggested diversions are unfeasible, either technically, environmental or economically.

4.11 Dredging the River

4.11.1 Summary of Submissions

A number of submissions have suggested that dredging of the river or the harbour will increase the capacity and mitigate the flood risk.

4.11.2 Response

The existing reservoirs remove much of the sediment from the system meaning fluvial sedimentation is not a significant issue downstream of Inniscarra Dam. Debris blockage risk is low due to the scale of the river and flows, and thus large bridge structures.

Dredging is only hydraulically beneficial upstream of the tidal reach, it wouldn't have any significant benefit in the city area as this section of the river is tidal and so the tide level dictates water levels rather than the channel bed level. Therefore it would have no benefit in reducing wall heights in the city.

Furthermore, dredging potentially has a significant negative ecological and archaeological impact. The maintenance requirements of dredging are also significant.

Dredging is therefore not a viable flood risk management solution for Cork city.

4.12 Flood Resilience Measures

4.12.1 Summary of Submissions

A number of submissions have suggested that flood resilience measures such as flood proofing of buildings is a suitable alternative to this scheme.

4.12.2 Response

Individual Property Protection (IPP) measures would protect properties on an individual basis and would be used in combination with a flood warning system.

IPP typically consists of demountable barriers that are placed across doorways, which are generally effective to approximately 0.6m flood depth. Above this depth, the water pressure on the walls of typical domestic properties may cause structural damage. The onus for the erection of the flood gates before flood events can be on flood response authorities, but also individuals and businesses. In the event that the flood gates are not installed, flooding of the property may occur with a possible risk to other adjacent or adjoining properties.

The installation of flood gates in doorways is more suited to modern buildings with the retrofitting of existing buildings, particularly protected structures, being particularly difficult. The utilisation of IPP measures as an alternative solution would have high ongoing maintenance costs involved due to the frequency of flooding predicted without the proposed flood walls in place. IPP measures also do not provide protection to infrastructure such as bridges, roads, car parks etc.

IPP measures are small scale measures that are not considered feasible for Cork for the reasons above and also due to the large number of properties at risk and the high predicted flood depths. For these reasons, this measure was ruled out at the initial screening stage. IPP measures were also previously considered and ruled out in the Lee CFRAMS study.

4.13 Tidal Barrier

4.13.1 Summary of Submissions

A number of submissions have queried whether a tidal barrier is the optimum solution for flood relief in Cork – either as the only solution or in combination with other flood defence measures. The main points of the submissions include:

- Suggestion that a tidal barrier is a viable alternative with a number of potential locations being suggested.
- The tidal barrier will be required at a later date to account for increased sea levels due to climate change and it is short sighted not to do this work now.
- There are references to a tidal barrier incorporating a new road crossing to reduce congestion at the Jack Lynch tunnel.

- There are also suggestions that such a barrier could incorporate a hydro power element.

4.13.2 Response

A detailed pre-feasibility report on a Tidal Barrier is included in Appendix A and comprises a pre-feasibility study undertaken on the potential of a Tidal Barrier solution in Cork Harbour. This report has been prepared in response to submissions received through the statutory exhibition process for the Lower Lee (Cork City) Drainage Scheme (Flood Relief Scheme), to provide further information to the public explaining why a tidal barrier is not currently viable and why it was accordingly screened out at the options selection stage of the project.

Four locations for a tidal barrier were considered as follows:

- Jack Lynch Tunnel;
- Downstream of Lough Mahon at Little Island (as put forward by a stakeholder group);
- Either side of Great Island at Monkstown and Marlogue; and
- Roches Point.

4.13.2.1 Barrier at Jack Lynch Tunnel

The Jack Lynch Tunnel can be ruled out as technically unviable as it has insufficient storage upstream even in the current scenario, a situation which would worsen with climate change.

4.13.2.2 Barrier at Roche's Point

The Roche's Point location would require a barrier significantly deeper than any barrier in the world. It could cost up to twice that of a barrier either side of Great Island. Whilst it would be imprudent to rule it out as a future solution for Cork, it is probable that it would be a solution of last resort, only in the scenario where climate change impacts were such that a barrier at Great Island became technically unviable. However, it is not currently a viable option.

4.13.2.3 Barrier at Little Island

The barrier location at Little Island as proposed by a stakeholder group is technically viable in the current scenario (with modifications as outlined below), but has limited storage and thus would have a shorter lifespan than the Great Island barrier in the face of climate change.

Whilst technically viable at present, the site has many challenges in terms of being able to bring the project through a statutory approvals process and construction. It is located immediately adjoining both a Special Area of Conservation (SAC) and Special Protection Area (SPA) and so there are significant environmental hurdles which would have to be addressed. There is potential for significant changes in geomorphology, navigation and marine amenity.

Whilst the location of the barrier as proposed by a stakeholder group is potentially viable, the barrier components and budget cost as set out by the group are not viable or accurate. The barrier alignment, geometry, gate sizes etc. as proposed by the stakeholder group are inappropriate and would require significant modification. A suitably designed barrier at this location (in conjunction with fluvial defences to achieve the design standard of protection) would likely cost in the order of €990m. It is also worth noting that there is a significant risk that this cost would increase if a greater width of navigation gates were needed (versus assumed at prefeasibility stage), for environmental or other reasons, across the 1km stretch of channel.

If constructed as a tidal-only defence, a tidal barrier would have a Benefit Cost Ratio (BCR) of only 0.06, i.e. its costs would be twenty times the benefit.

When combined with fluvial defences as proposed in the exhibited Scheme (thus providing protection to additional properties at risk), it would have a combined BCR of 0.2, still clearly not cost beneficial.

Crucially, it is evident that a tidal barrier at the Little Island location only becomes economically viable if sea level rise of circa 500mm arises, i.e. in Mid Range Future Scenario (MRFS) climate change scenario. However, in this scenario, its location means that at the same point in time, it would start to become technically unviable, due to lack of upstream storage capacity. It therefore does not represent a viable short to medium term option and in all likelihood may well not represent the best medium to long term option.

4.13.2.4 Barrier at Great Island

A tidal barrier at Great Island (Monkstown Marlogue) has also been considered. This location has sufficient upstream storage to cater for the High End Future Scenario (HEFS) and beyond. Technically, it therefore represents a better long term solution in the face of climate change.

Because of the narrowness of channel existing at either side of Great Island, any barrier at this location would need to maintain flow across the full width of the existing channel to ensure continued safe navigation, reasonable velocities, and minimise changes in geomorphology. Gates across the full width have the negative of significantly increasing cost but has the positive of minimising the risk of negative impacts on the SAC and SPA which are located a reasonable distance from the barrier locations. A flood scheme for Cork incorporating a barrier at Great Island is estimated to have a Net Present Value (NPV) cost of almost €1.73bn. The BCR is 0.05 and therefore is not economically viable at present.

4.13.2.5 Findings of Multi-criteria Analysis of Tidal Barrier option

As well as having a very negative BCR, multi-criteria assessments carried out as part of the Lee CFRAMS and this study has established that the exhibited scheme scores better than any of the tidal barrier locations across all the criteria of technical, social, environment and economic.

4.13.2.6 Likely Requirements for Low Level Walls in Cork City as Part of Tidal Barrier Solution.

It is also worth noting that at present, the Mean High Water Spring Tide is circa 1.9mOD. With 1m of sea level rise, this would increase to circa 2.9mOD which is above the current threshold of flooding in the city. A tidal barrier would therefore be required to close over 400 times a year to prevent flooding of the City by Spring tides in the HEFS. Even in the MRFS the barrier would need to be closed approximately 100 times a year to protect the city. These closures would be in addition to any closures required to defend the city against storm surge events that present a risk of tidal flooding. Such a high frequency of closures would have a dramatic impact on navigation and the environment and would significantly increase the operational cost of such a barrier.

Increasing the threshold of flooding in Cork from 2.5mOD to 3.4mOD by low level direct defences (as proposed in the exhibited scheme) would have the benefit of increasing storage upstream of a barrier, reducing the frequency (and cost) of operation of the barrier and minimising the impact on navigation and on the environment. It is therefore evident that a viable tidal barrier solution (if and when the need arises) will require to be undertaken in conjunction with low level direct defences in Cork city.

4.13.2.7 Conclusion

The following can therefore be concluded:

- Low level Direct Defences in Cork (as per the exhibited Scheme) are the optimum solution for Cork in the short and medium term.
- Such defences are the first step in a climate change strategy to manage flood risk in Cork and will form a key component of any future tidal barrier system.
- A tidal barrier is not currently viable and will not become viable for approximately 50 years or more. This eventuality is so far in the future and the timing so uncertain that it should not unduly influence decision making at this time.
- If and when a tidal barrier becomes viable, the optimum location is likely to be at either side of Great Island (at Monkstown and Marlogue), but a full and detailed feasibility study of the options would have to be undertaken at that time.

5 Response to Submissions – Technical Concerns regarding Exhibited Scheme

5.1 River Containment (Unproven Solution)

5.1.1 Summary of Submissions

A number of submissions have raised concerns that the proposed flood defence scheme is an unproven solution and thus will not work. Submissions have asserted the following:

- Scheme is not in line with international best practice;
- High risk of failure of the defences – due to extreme event (overtopping) or failure along the defence line (breach);
- Direct defences will not address the risk of groundwater flooding and/or sewer flooding; and
- Concerns that the glass walls may be subject to vandalism and thus at risk of failure.

5.1.2 Response

5.1.2.1 Other Schemes

The OPW as the leading agency for flood risk management in Ireland, has a proven track record of successfully delivering flood relief projects. Schemes with similar flood relief measures have been implemented nationally, such as in Mallow and Clonmel, and also internationally in the UK, the Netherlands and elsewhere.

Mallow in north County Cork has flooded many times with major floods from the Blackwater River having occurred in 1853, 1875, 1948, 1969, 1980, 1988, 2004, 2008 and 2009. The Mallow Flood Defence Scheme, which protects against a 1 in 100 year flood event, comprised of defence walls and embankments, some demountable defences, pumping stations etc. The effectiveness of the scheme depends on the erection of the demountable defences by Cork County Council staff upon receipt of a flood warning from the Early Flood Warning System developed by the OPW. The scheme has provided the required protection on every occasion since it was commissioned in 2009 and proved effective on six occasions during the bad winter weather of 2015-2016 alone.

Clonmel in County Tipperary suffered severe flooding on a regular basis from the River Suir and also from tributary streams. The most severe flooding occurred in 1995, 1996, 1997 and 2000, 2004, 2008 and twice in 2009. The Clonmel Flood Defence Scheme comprised sheet piled and reinforced concrete walls, building of embankments and pumping stations, alterations and improvements to the drainage system, demountable defences, some channel widening, the replacement of two bridges and repairs to a further bridge.

The effectiveness of the scheme depends on the erection of the demountable defences by Clonmel Borough Council staff upon receipt of a flood warning from the Flood Forecasting System developed by the OPW. The success of this scheme was evident during the heavy rainfall event in February 2014.

OPW has also successfully delivered many other major flood defence schemes throughout Ireland which include an element of river containment (direct defences). Examples include Kilkenny, Waterford, the Dodder etc.

There has been some suggestion that river containment as an overall strategy is flawed and not in line with international best practice. The Dutch “Room for the River” programme has frequently been cited as an example of this move away from river containment, and an exemplar which should be followed in Cork. However, it is important to note that the measures included in the “Room for the River” programme are generally complementary measures, rather than substitute measures. Cities in the Netherlands (such as Nijmegen) will continue to rely on high flood protection dikes as a key element of their flood protection strategy going forward. The scale of defences at Nijmegen are significantly greater than proposed for the Cork Scheme.

The Leeds flood alleviation scheme, winner of the “Large Project of the Year” at the NEC awards 2017, addresses similar issues to Cork in relation to defence heights. The scheme includes the removal of the two main navigation weirs, replacing them with new moving mechanical weirs. These new mechanical weirs will normally be in a raised condition so that navigation can continue and people in the city can still enjoy the closeness to the waterside as at present. However as potentially dangerous flood levels approach, the weirs will progressively lower and reduce the height of the flooding to the lowest practicable level. However, this still necessitates direct defences over an approximately 4.2km reach. Like Cork, however, the defence heights are limited to guarding height.

The concerns related to sewer flooding are addressed in Section 5.2.

The concerns related to groundwater flooding are addressed in Section 5.3.

5.1.2.2 Breach/Overtopping of Defences

Some submissions suggested that there is a high risk of failure of the defences due to overtopping or breach. This is not the case, as the defences will be designed in accordance with best practice guidance, and will be maintained on an ongoing basis into the future.

The defence structures will be designed to withstand the following loading conditions with appropriate factors of safety in accordance with the relevant Eurocode design standard:

- Hydrostatic loading (including freeboard);
- Earth pressure loading;
- Groundwater pressure loading;
- Wind loading;

- Accidental loading such as log/debris impact during a flood event, or vehicle impact where relevant;
- Normal traffic loading where relevant; and
- Allowances for unplanned excavation or scour adjacent to the defences.

The above combination of loads will result in a robust design, which is appropriate to minimise the residual risk of wall failure/breach.

The failure/breach risk associated with demountable defence elements will be minimised by means of the following steps:

- The threshold level of most demountable elements will be set as high as possible, such that in many cases the demountable element only provides defence for freeboard.
- Similar to other flood defence schemes, a detailed operational protocol will be developed in consultation with the local authority. Typically, these protocol documents take into account warning times, available personnel, expected response time etc. This will ensure that the demountable elements will be deployed in a systematic and orderly fashion in advance of a flood.

The risk of failure/breach due to degradation of the defences over time will be managed by the implementation of an appropriate maintenance regime. The maintenance of the defences is a statutory requirement for OPW under the Arterial Drainage Act. Maintenance will include items such as regular ongoing inspections of walls and pump stations, replacement of seals and other perishable items, etc.

During an exceedance event (i.e. the occurrence of a flood larger than the 100-year fluvial/200-year tidal events), the scheme will still provide significant benefit to properties in the defended area, compared with the scenario without the defences in place. A critical element of the proposed scheme is a flood forecasting and warning system. This system will alert the local authorities if an exceedance event is predicted. This will allow the authorities to implement the relevant part of their flood emergency response protocol to minimise risk to the safety of people within the defended areas.

5.2 Flooding from Sewers and/or Pumping Stations

5.2.1 Summary of Submissions

A number of submissions have queried whether the flood risk from sewers will be resolved by this scheme and also queried how water backing up in the sewers due to river water level will be managed.

Concerns were also raised regarding the potential failure of the proposed back of wall pumping stations. The main concern is the capability of the pumping stations considering their infrequent use.

There were also concerns raised about blocked drains causing flooding.

5.2.2 Response

The scheme has been designed to ensure that existing sewers and culverts will not convey flood water from the river into the defended areas. As part of the proposed scheme, all sewer outfalls to the river will be fitted with non-return valves (alternatively, if any existing outfalls are redundant they will be permanently sealed). When the river level reaches the level of the outfall, the valve will automatically close and river water will not be able to enter the drainage network. In this scenario, the normal surface runoff in the drainage network (i.e. from roofs, gullies etc.) will not be able to discharge to the river by gravity. To mitigate the risk of this water causing an issue on the dry side of the defence, an overflow pipe system will be constructed which will discharge to a proposed pumping station. The pumping station will pump the excess water into the river. The proposed pumping stations are distributed along the length of the defences to minimise their overall size and to ensure appropriate sewer falls.

The pumping stations themselves will generally be designed to incorporate appropriate redundancies, including permanent standby pumps and facilities for the stations to be supplied by backup mobile generators in the event of mains power failure. (Note that the risk of power failure caused directly by flooding will be reduced by the presence of the scheme itself).

It is recognised that it will be critical to ensure that the pumps do not fall into disrepair through lack of use, since the occurrence of flood events which would require the pumping stations to activate will be infrequent. Therefore, regular maintenance and test runs of the pumps will be included in the ongoing maintenance plan to ensure their optimal performance during flood events.

It is also proposed to implement a telemetry system which will allow OPW and their agents to monitor the performance of the proposed pumping stations to detect any faults, monitor pumping rates, water levels etc. Note that Irish Water/Cork City Council currently utilise a similar system to monitor the performance of the existing main drainage pumping stations in the city.

The maintenance of surface water gullies and surface water pipes in the defended areas will continue to be carried out by Cork City Council following completion of the proposed scheme, as per the existing situation.

5.3 Groundwater Issue

5.3.1 Summary of Submissions

A number of submissions have raised concerns about the impact of the proposed scheme on groundwater levels and resulting groundwater flooding/impact on foundations. The main concerns include:

- Impact on groundwater table.
- Flooding on dry side due to increase in groundwater level.
- Impact of rising sea level on groundwater.

- Tidal lag and groundwater.
- Vulnerabilities in the aquitard layer and how it will be addressed.
- Impact on buildings and archaeological features.

5.3.2 Response

The existing geology and groundwater regime in Cork is well understood by the design team, and has been at the forefront of design considerations from the outset of the project. Satisfactorily managing groundwater levels during extreme flood events is a key part of the proposed design.

Significant studies have already been completed and an extensive array of ground investigation works has already been undertaken to supplement existing information on groundwater movements in and around Cork City. Further investigations are currently either planned or underway.

A separate technical report has been prepared on this issue and is contained in Appendix C.

The main findings of this report include the following:

- Significant groundwater data has and is being collected to further enhance our understanding of the groundwater regime.
- It is being assessed and modelled in detail both for the existing and proposed scenarios.
- A tidal lag /or dampened effect between groundwater and river/tidal water is observed across the City Island. Historically, the peak groundwater level in the city is typically circa 1m lower than the peak river water level. As the design tidal level at the east of the city is typically only about 0.5m higher than existing ground level and only occurs for a short duration, it will be possible to manage groundwater levels effectively. This lag/dampening effect reduces the need for pumping during a flood event. Local to the quay walls, the restoration of quay walls will make them less permeable and thus the lag or dampened effect will be increased further. Further west, lower levels in the South Channel (as a result of the proposed flow control structure) will allow the South Channel to assist with maintaining groundwater below ground level in the defended area during flood events.
- The design of the scheme has considered the existing groundwater regime and sought to largely retain the existing environment in the non-flooding case. In the flood scenario, it will only reduce groundwater levels close to the surface. The existing regime will remain largely unchanged and therefore the scheme will not negatively impact existing structures and their foundations.

In conclusion, extensive investigation and design work has and is continuing to be undertaken to ensure that groundwater flood risk is satisfactorily managed as part of the scheme.

5.4 Climate Change

5.4.1 Summary of Submissions

A number of submissions have queried if and how climate change is addressed in the scheme. There are concerns that the potential future wall heights will be substantial, and some confusion about what wall heights are proposed in the current scheme.

A number of submissions note that if measures such as the tidal barrier are mentioned in the Options Report within the context of climate change adaptability, why are they not being implemented at this stage?

5.4.2 Response

The consideration of climate change in the scheme development has been assessed in detail and is set out in Chapter 14 of the Options Report. A summary focussing on the key issues raised in the submissions is outlined below.

5.4.2.1 Long Term Climate Change Adaptability

There are a number of approaches to considering and managing climate change risks. The best approach to adopt is largely driven by the potential increase in flood risk which will be experienced over time, but would also consider the practicalities associated with taking a particular course of action now, or delaying it until the future.

An ‘Assumptive approach’ could be adopted (and has traditionally been adopted) where one assumes that a certain degree of impacts arising from climate change will occur e.g. assume 500mm of sea level rise. This means the scheme would be designed and built (or at least foundations built) now to the levels estimated for the future. Although providing a degree of certainty in protection, the levels are reliant on today's estimates of climate change impacts (i.e. the anticipated increases in river flows or sea level rise) being correct. If the estimates are too high, the scheme would be built to a greater level than necessary, which could be visually intrusive and incur a high level of additional expenditure. Consequently, this has a negative impact on the cost benefit analysis and Multi-criteria analysis for the scheme (higher costs and reduced visual and environmental benefits) making the scheme less likely to be beneficial. Alternatively, the estimates of climate change impacts may be too low, and river flows or sea level rise increase to a higher than anticipated level over a shorter than planned timeframe. This means the scheme would still not be sufficient to defend against the climate change levels and would still need to be reviewed in the future.

An alternative, and now more common approach is to adopt an ‘adaptive approach’ which provides a great level of flexibility into the future, allowing the scheme to be adapted as estimates improve, or increased evidence of climate change emerges.

Planning to increase defences in the future would require additional investment in the foundations of the scheme, but would allow easier 'up-build' in the future.

The works to build the new, or in-fill, walls and embankments highlighted above would still be required in the future, but more certainty on the location and heights of these assets would develop over time. However, the scheme now would need to be designed to allow future construction to tie in to the current scheme.

In the case of the Lower Lee Flood Relief Scheme, it is proposed that a combination of the approaches are implemented to manage the climate change risk and provide for a scheme that is adaptable to future conditions, including:

- Minimise increases in flow arising from climate change by further changes to the dam operation and/or improvement in forecasting, in conjunction with increased defences downstream. The revised dam operation proposed in the current scheme is optimised to manage floods up to the current 1 in 100 year event, based on current hydrological knowledge, current rainfall forecast resolution and accuracy. As these change into the future, the dam operation will require alternative operation to optimise the use of the assets for the future scenario.
- More dynamic management of discharges offset from the tidal peak.
- Adaptive direct defences, as described below.
- Tidal barrier, only as a long term option, should sea level rise of between the MRFS of 0.5m and HEFS of circa 1m occur, subject to it becoming cost beneficial at the time.

In terms of adaptability of the direct defence elements to be constructed as part of the proposed scheme, the following is proposed:

- Direct defences between Inniscarra Dam and St. Vincent's Bridge to be designed to be adaptable for a future 1m increase in levels (demountable defences).
- Direct Defences in the tidally dominated city centre areas to be adaptable to be raised to a defence height of 1.2m above dry side ground level or 4mOD.

5.4.2.2 Future Wall Heights

The adaptive approach for direct defences allows for flood defence walls to be designed so that they can be extended in the future to take account of the potential effects of climate change. It does require additional investment at the beginning of the scheme in the construction of the foundations of the walls, however it provides some flexibility in the future to economically extend the standard of protection (with minimum disruption) as the impacts of climate change are felt.

In this flood relief scheme, it is considered appropriate to take an adaptive approach for the direct defences to manage the climate change risk, either by allowing for an increase in wall height in some areas and/or the potential future installation of demountable defences in other areas, as discussed below.

In terms of the tidal defence walls, the majority of direct defences in the eastern reaches of the city are only 0.6m high or less. These heights are driven by tidally dominant events.

Therefore, subject to suitable public realm design, the logical, least expensive and most environmentally sensitive means of dealing with the Mid-Range Future Scenario (MRFS) increase of 0.5m in sea level would be to increase the height of these defences. For this reason, these defences will be designed for potential future raising to a height of 1.2m to allow for an increase in tidal protection. As discussed in Section 14.2 in the Options Report, it is considered likely that in future, dam discharges could be further limited or avoided during the tidal peaks, thus minimising the hydraulic gradient across the city during extreme tides and therefore minimising the required defence heights.

In some areas, the scheme flood defence walls are proposed to heights which are near or at their practical or physical limit and cannot sensibly or practically be extended on a permanent basis. In the current scheme, flood gates have been kept to an absolute minimum due to the residual risk associated with the need for their operation during an event and the insurance industry's current reluctance to provide insurance in areas protected by flood gates or demountable defences. However in the future, should significant increases in sea level arise, it is likely that demountable defences may become a more viable and acceptable option along greater lengths of the city quays.

For example, at Grenville Place, road re-grading forms part of the proposed scheme so that the relative defence wall height is limited to guarding height of 1.2m. Given the proximity of the Mercy Hospital as well as heritage assets like Boole House, there is little opportunity to further alter ground levels in the future and therefore further raising of wall heights above guarding height would impact the connection with the river. In this scenario, demountable defences may well be the only acceptable solution. For this reason, it is proposed that all new defence walls within the fluvially dominated reach will be designed to be able to be extendable in the future to resist a total hydrostatic load of 2.2m above dry side ground level. (In practice, this would likely be a 1.2m high permanent defence wall supporting a further 1m height in demountable defences).

5.4.2.3 Tidal Barrier

Increased tidal defences are likely to be a necessary precursor to any future tidal barrier which may become viable if sea level rise were to approach or exceed 1m.

The Lee CFRAMS concluded that with a mean sea level increase of 1m and a 30% increase in inflows, a typical daily tidal peak of circa 2.8mOD would occur in Cork City. Extensive flooding of Cork City occurs at 2.8mOD (similar to 2014 flood event). This would therefore mean that in the absence of direct defences, the tidal barrier may need to be closed several times a week. It is estimated that the closure time would need to be somewhere between 5 and 9 hours per tidal cycle, (or between 10 and 18 hours per day). Such a scenario, would fundamentally alter the use of the harbour in terms of both shipping and use of pleasure crafts.

It is also likely to have very significant effects on the SAC and SPA designated areas in Cork Harbour, including effects on harbour flows and velocities, sediment transport and salinity.

Based on the above, it is considered likely that in the HEFS, a tidal barrier could only work in tandem with direct waterside defences on the city quays which would have the benefit of reducing the frequency and duration of required closure of the barrier.

Refer to Section 14.3.2 in the Options Report⁹ and Appendix A for more information on the tidal barrier.

⁹ Lower Lee (Cork City) Drainage Scheme Options Report, Section 14.3.2 Tidal Barrier, Page165:
http://www.lowerleefrs.ie/assets/lee_valley/docs/Other%20Documents/LLFRS_Options_Report.pdf

6 Response to Submissions on Potential Impacts of Exhibited Scheme

6.1 Heritage Impacts on Existing Quay Walls

6.1.1 Summary of Submissions

There have been numerous concerns raised in relation to the impact the scheme may have on the heritage of the existing quay walls within in the city centre. The main concerns are as follows:

- Damage to existing quay walls which are part of the city's heritage;
- Proposed materials and finishes of the walls;
- Replacing/changes to existing parapet walls/railings; and
- Concerns regarding the height, width and scale of the proposed walls.

6.1.2 Response

6.1.2.1 Benefit to Historic Quay Walls

The scheme will provide circa €20m of much needed investment in the repair of historic quay walls, many of which are in poor structural condition and which are in danger of collapse as occurred at Grenville Place in the 2009 flood event. The remedial/strengthening works is being carried out to facilitate the installation of the proposed flood defence parapet walls on the quays. Figure 15 below shows a typical section through a quay wall proposed to be remediated as part of the scheme. It can be seen that any reconstruction works will be limited to the vicinity of the parapet, and the main body of the quay wall will be preserved with appropriate remedial and strengthening works carried out. The remedial works will generally include of the following work items:

- Repointing of the joints between the existing quay wall facing stones
- Local stonework repair as necessary
- Grouting of the wall, soil backing zone and foundation zone, which will improve the structural strength of the wall

Quay wall strengthening measures will be designed to take account of site-specific conditions, but may include:

- New concrete backing wall
- Installation of stitching bars
- Etc.

Note that none of the proposed strengthening measures will impact on the physical appearance of the wall from the river side.

Figure 15: Typical Section of Proposed Quay Wall Works

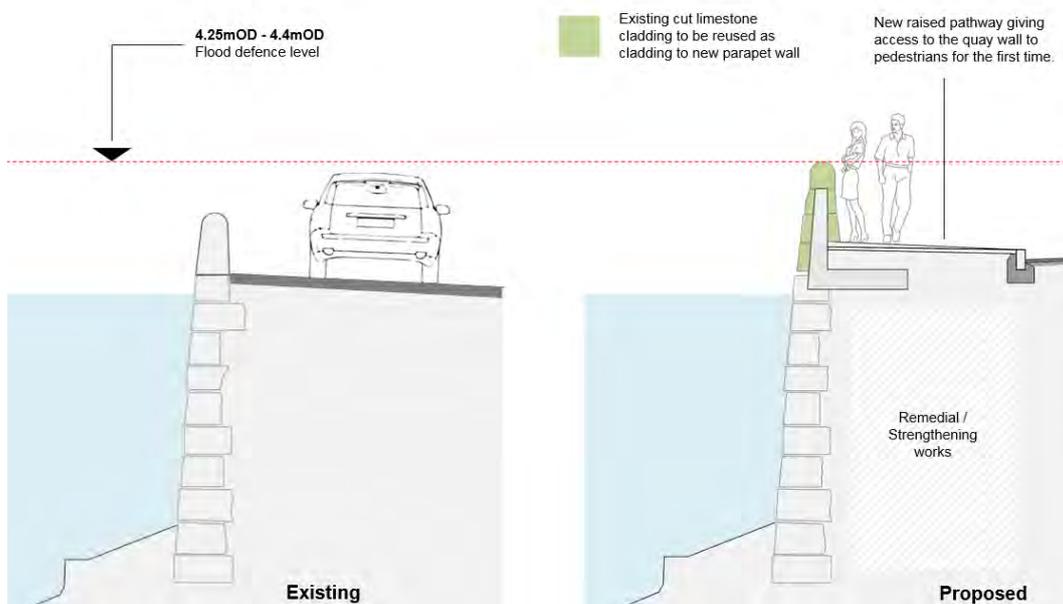


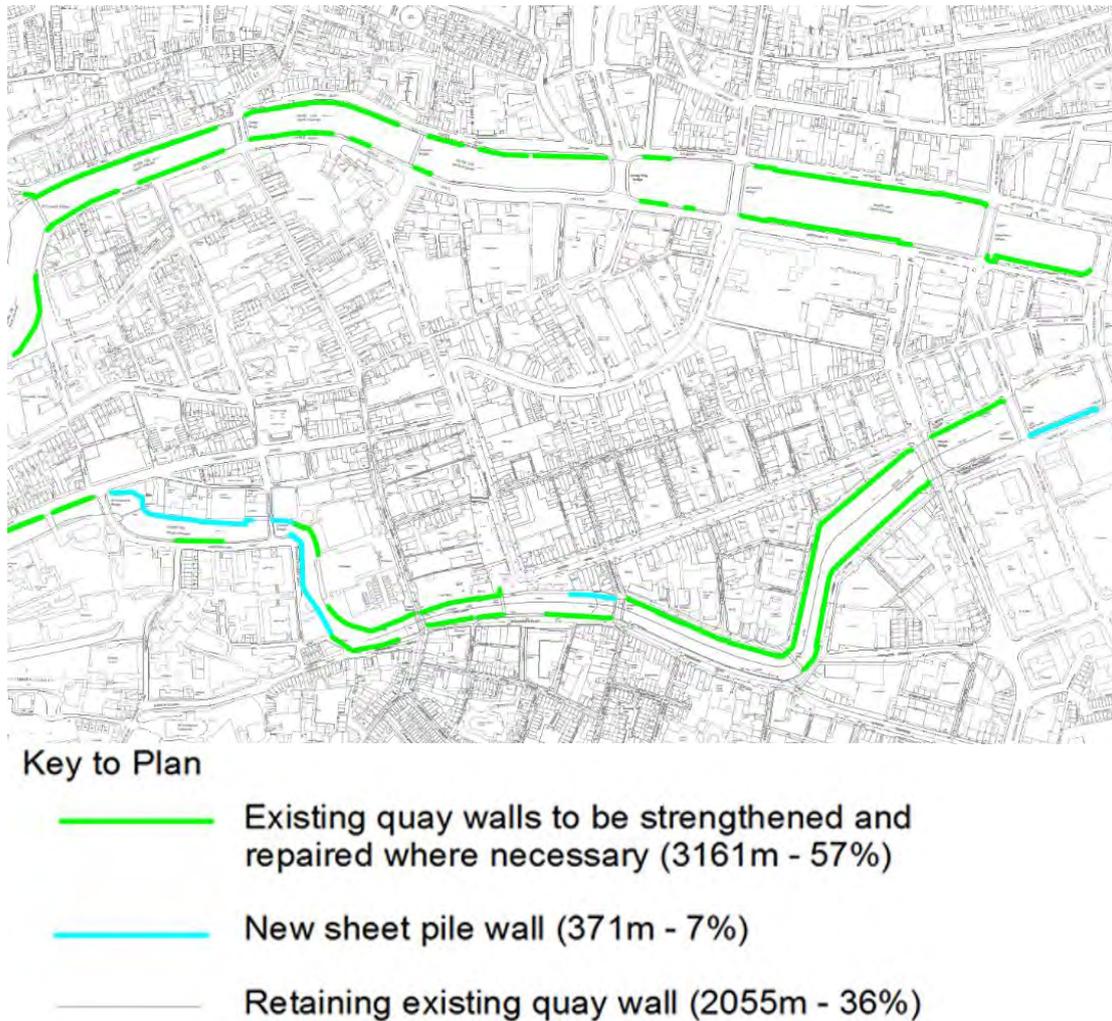
Figure 16 identifies which quays will be strengthened and repaired (57%), which quays will be retained with no remediation (36%) and where new sheet piled wall will be required (7%).

It can be seen that the vast majority of historic quays are being retained and remediated. The only locations where new quay walls are proposed are in areas where it is not considered feasible to remediate the quay wall. Examples include Albert Quay where the existing wall and wharf are in a dangerous condition and require a new wall, south of the South Mall properties where a new defence line is required south of existing properties which cantilever over the existing quay wall.

Following the appointment of The Paul Hogarth Company and Alastair Coey Architects (Conservation Architects) there has been a comprehensive appraisal of the heritage of the area. This has facilitated discussion in relation to how best to safeguard the existing heritage assets and opportunities for restoration and improvement of settings.

The team has also undertaken research that will facilitate incorporation of interpretation. This will allow the stories of the area, including its history to be introduced through signs/panels and through bespoke features/public art. This will facilitate improved understanding of the heritage assets that exist as well as bringing to life the relevance of things which are no longer present/visible. Good interpretation will provide value for both local people and for visitors.

Figure 16: Extent of proposed works to quay walls



6.1.2.2 Materials and Finishes

A large number of submissions are concerned that the historic quay walls will be replaced with concrete walls.

Where existing historic cut limestone parapet walls have insufficient strength to withstand the hydrostatic forces during a flood, they will be carefully taken down and reconstructed with a concrete core finished on each face with the salvaged stone from the original parapet and capped with the original coping. This will ensure that the scale, colouring and detailing will remain comparable to the existing.

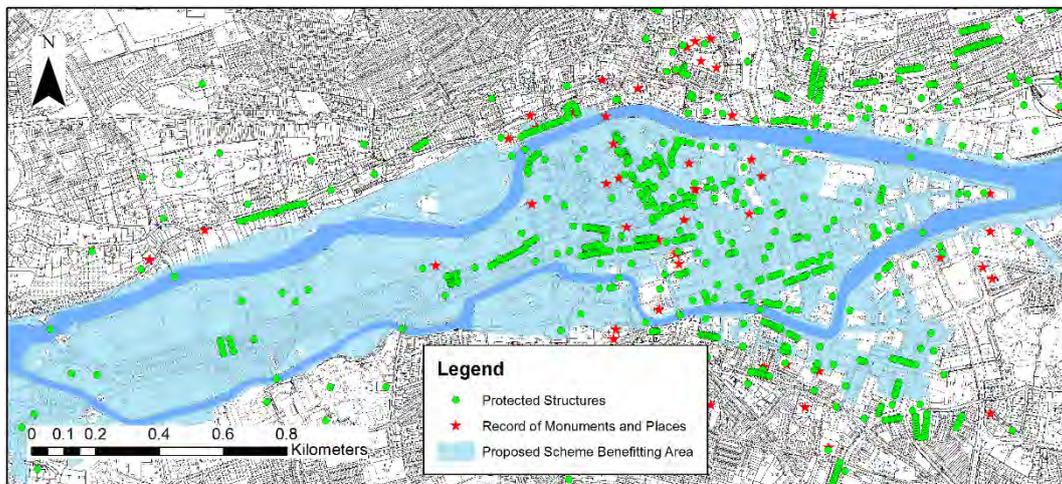
In recognition of the significant number of submissions received from the public, in relation to the two areas where some historic railing was to be altered or replaced, i.e. North Mall and Sullivan's Quay, revised solutions are currently being developed to allow the existing railings to be maintained insitu. Further details are outlined in Sections 7.4 and 7.5.

Further detail on the visual impact/finishes of the proposed defences is provided in Section 6.2.

6.1.2.3 Benefits to Protected Structures

It should be noted that there are 393 protected structures and 20 structures listed on the Record of Monuments and Places within the benefitting area of the city centre, as identified in Figure 17 below, and many are therefore at risk of flooding. These important structures and monuments will be protected by the scheme.

Figure 17: Protected structures and RMPs



6.1.2.4 Areas of Particular Historic Significance

The assessment of significance and level of impacts on Cultural Heritage Assets incorporates various guidelines published by the National Monuments Service (NMS), the Environmental Protection Agency (EPA), The International Council on Monuments and Sites (ICOMOS) and the National Roads Authority (NRA). The design of the proposed scheme has endeavoured to minimise negative impacts on elements of the archaeological and architectural heritage resource wherever possible. Where it has not been possible to avoid all potential adverse impacts, mitigation measures are proposed, for example:

- There will be in situ recording/cataloguing in areas of historic significance prior to commencement of construction works.
- Any existing cut limestone parapet walls to be replaced as part of the scheme will be salvaged (e.g. Bachelor's Quay, Kyril's Quay, Coal Quay, Lavitt's Quay). The existing stone will be re-cut and re-used at the same location as cladding material for the proposed flood defence parapet walls. In addition, it is envisaged that the existing cut limestone coping stones will be salvaged intact and will be reinstated on top of the proposed walls.

As part of the environmental surveys undertaken in the preparation of the EIS, extensive surveys were undertaken during 2016 of the riverside and dryland areas to be impacted by the proposed scheme.

A photographic record of the survey was compiled and extracts are provided in Appendix 10B of the EIS¹⁰.

A licensed underwater archaeological survey of the entire length of the river channel adjacent to the proposed scheme was undertaken by the Archaeological Diving Company (ADCO). The in-water archaeological assessment comprised a c. 7km stretch of the River Lee, encompassing a 500m stretch of the waterway at Ballincollig, and both channels of the river as they flow through the centre of Cork. The assessment recorded riverbed topography and provides a detailed account of the existing riverside environment. On-site work comprised systematic non-disturbance underwater and waded inspection of the river channels, their attendant quayside structures, and any associated riverine features, including bridge structures (piers and foundations), weirs, culverts, river-walling, and any natural features encountered. This work followed consultation with the Underwater Archaeological Unit of the Department of Arts, Heritage, Regional, Rural and Gaeltacht Affairs.

The majority of the impacts associated with the proposed flood defence work to the city's quays are limited to street-level interventions. The level of impact and proposed mitigation for these street-level interventions has been undertaken separately by John Cronin and Associates, Archaeology, Conservation, Heritage and Planning Consultants. Proposed interventions to the lower components of each quay structure constitute, in the main part, localised maintenance and repair of the quay-façade and the insertion of micro-piles along their foundations. This intervention work does not have a significant impact on the existing structures, and can be considered to have a slight positive impact.

Mitigation measures, both at pre-construction and construction phases, will be undertaken in compliance with the EIS.

It has been agreed with Cork City Council that the following areas are of particular significance and detailed mitigation plans are required to be agreed with the City Archaeologist who will be consulted prior to the finalisation of the detailed design:

- Crosses Green Quay and Culvert – Full archaeological excavation required as well as a measured survey of the wall and culvert.
- Albert Quay Timber Wharf – Archaeological monitoring and recording to include a measured survey.
- Quay wall and associated features on North Mall – Preservation in-situ or by record will be required.
- Alderman Reilly's Bridge – Archaeological recording (pre-construction) and monitoring.

¹⁰ Lower Lee (Cork City) Drainage Scheme Environmental Impact Statement, Chapter 10 Cultural Heritage, Page 10-1: http://www.lowerleefrs.ie/assets/lee_valley/docs/Main%20Report.pdf

ICOMOS have been consulted with in relation to the exhibited design to provide further feedback on the heritage impacts. The OPW Project Archaeologist will review the detailed design before finalisation.

6.2 Visual Impacts of Proposed Flood Defence Walls

6.2.1 Summary of Submissions

There have been numerous concerns raised in relation to the visual impacts of the proposed flood defence walls in the city centre. The main concerns are as follows:

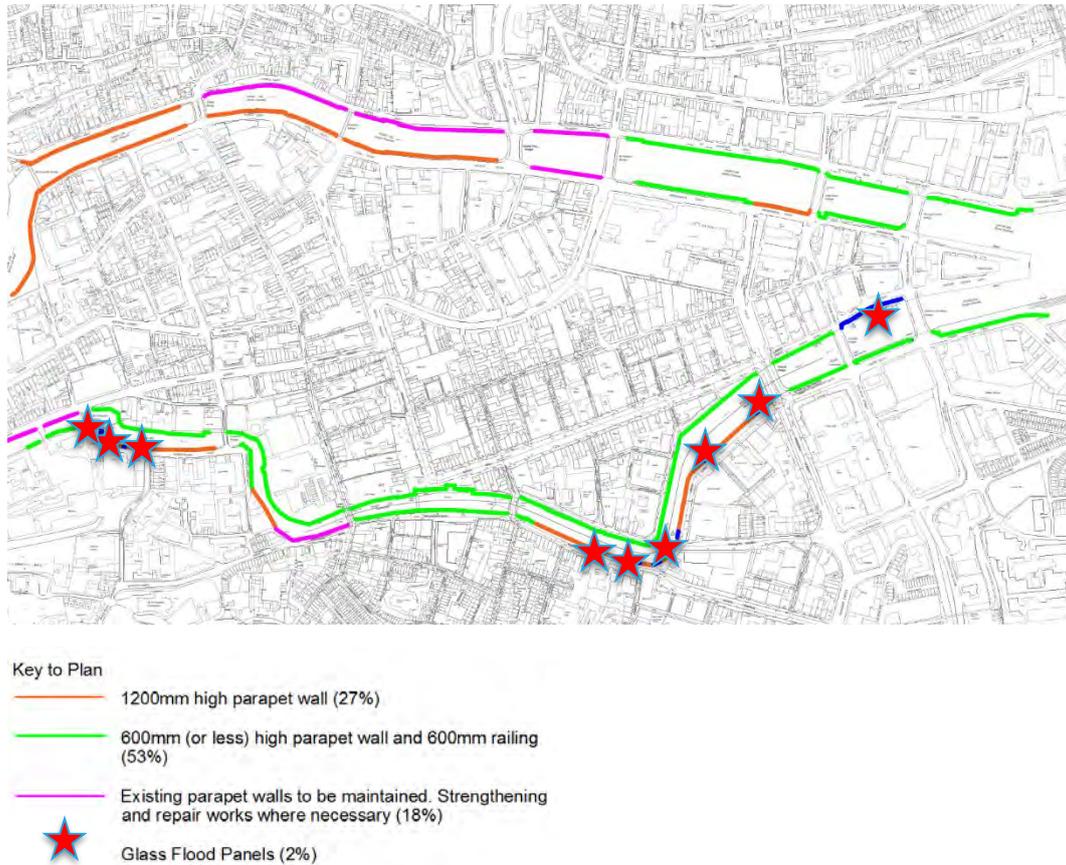
- That walls will create a physical separation and disconnection with the river, inhibiting clear views;
- Concerns regarding the height, width and scale of the proposed walls; and
- Proposed materials and finishes of the walls, changes to existing parapet walls/railings.

6.2.2 Response

6.2.2.1 Height of Parapet Walls

The following graphic identifies the proposed wall heights within the city centre as exhibited.

Figure 18: Height of walls as exhibited



It can be seen that only 27% of the proposed walls will be 1.2m above adjacent ground level, i.e. safe guarding height.

This is the maximum height of the proposed flood defence parapet walls along the city quays and will only be implemented in places where necessary.

The maximum wall height of 1.2m above adjacent ground level was selected to balance safety concerns (suitable guarding height) and impact on views of the river. To put the wall heights in context, the average height for an Irish male and female is 1.79m and 1.65m respectively. Even the 1.2m high walls will allow adults to easily and comfortably view the river channel.

In some areas, where the flood defence water level would otherwise require the wall height to be greater than 1.2m high, such as Grenville Place, the footpath and roadways adjacent to the walls will re-graded to ensure that views are not restricted. There may however be an impact on the view from the other side of the river. This impact will be mitigated wherever possible.

It is also shown that approximately half of the proposed flood defence walls are 600mm high or less with a 600mm railing on top. The rest of the defences consist of the existing parapet walls to be maintained and some new glass barriers. The impact on the views of the river have been mitigated where possible and are not considered significant.

As part of the scheme, new public realm areas will be created including a public plaza at Grenville Place and a riverside walkway at Morrison's Island. The scheme includes the provision of an additional 1km of riverside walkway. These areas will encourage riverside activities and increase people's enjoyment of the river.

The OPW is working in close collaboration with Cork City Council on the development of the proposals for the flood defence scheme and the Council is a member of the Project Steering Group. The public opinion at the 2014 Public Information days expressed the importance of the river to the city. It is the OPW's and the Council's view that the Scheme will not cut the city off from the river and indeed it was very much to the fore of the Design Team to ensure that this did not happen.

Subsequent to the exhibition process, following a tender competition, the Paul Hogarth Company together with Coey Architects have been commissioned as part of the design team to develop the design of the architectural, public realm and heritage aspects of the project.

Development of the design of the parapet walls has included careful consideration in relation to the safeguarding of heritage assets.

Proposals clearly and elegantly differentiate between the historic quay walls with their stone facing and cope and associated timber fenders. The new elements combine a stone cope and pillars, between which stainless steel guardrails will be fixed. These will ensure that views to the River are maintained. Views from the other side of the river have been carefully considered. The existing concrete upstands, and tubular steel railings will be removed.

The increased height of the proposed floodwall will be detailed to be complementary to the historic structure below which whilst higher than the existing, will be more sympathetic to the heritage than the existing arrangement, taking the opportunity to set the new floodwall back where historic steps/bollards can be retained and restored.

6.2.2.2 Width of Parapet Walls

There are concerns that in situations where existing limestone walls are being rebuilt with a reinforced concrete core, this will result in walls that are significantly thicker than those that exist at present. In this regard, we would note that the concrete core of the walls is proposed to be a maximum of 300mm thick at the base, and will be tapered towards the top, so that the existing limestone copings can be reinstated flush with the wall cladding material.

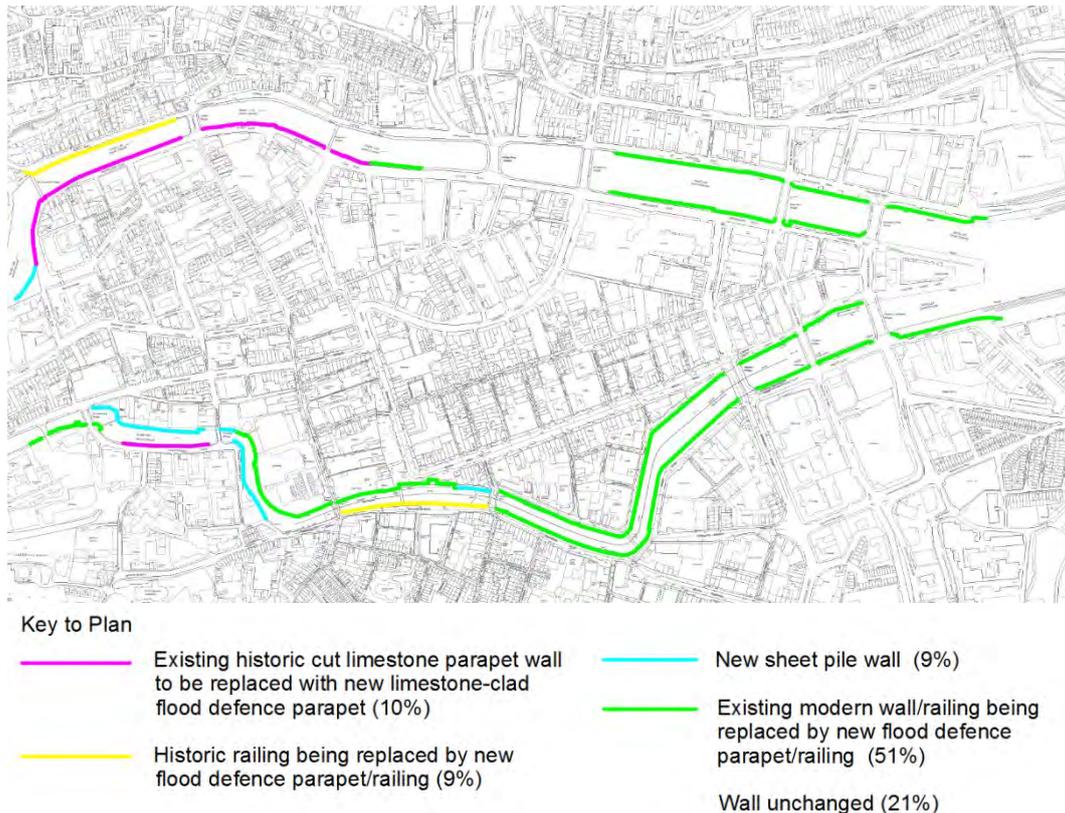
6.2.2.3 Materials and Finishes of Proposed Walls

Figure 19 below identifies the proposed finishes on the city centre parapet walls as exhibited. The proposed finishes, as displayed at Exhibition, on all of the walls and railings were chosen through agreement of Steering Group. The finishes will include a suitable mix of salvaged cut limestone, new cut limestone, suitably

finished concrete, glass defences and/or other finishes, taking cognisance of the setting.

The proposed finishes are outlined in further detail in the sections below. However, as noted above, a team of landscape and conservation architects have joined the design team to further develop and refine the finishes of the proposed walls at detailed design stage, as outlined in further detail in Section 9.10.

Figure 19: Proposed wall finishes as exhibited



As can be seen, the majority of the existing parapet upstand walls and railings to be replaced are modern and will be replaced by an architecturally designed wall and railing combination which will take into consideration the existing aesthetics within the city.

6.2.2.3.1 Limestone Walls

Any old limestone walls that are being replaced or strengthened will be finished in salvaged cork limestone to match the existing situation.

All limestone removed from quay walls as part of this project will be salvaged and used in the reconstruction of the quay wall parapets. If upon completion of the project, there is any unused limestone it will be retained by Cork City Council for use in future projects.

6.2.2.3.2 Modern/Concrete Fair Finish Walls

Where a new wall is to be erected it may be constructed in fair faced or textured finished concrete, a finish that had already been used a number of years ago in the vicinity of Christy Ring Bridge. The finer detail is to be developed by the design team's architects in conjunction with the City Architect's Department.

6.2.2.3.3 Rubble Walls

The cladding of the proposed rubble walls (Wandesford Quay, Crosse's Green Quay and Sundays Well Road) will match the existing stonework.

6.2.2.3.4 Glass Walls

There are some short stretches where the use of glass walls was deemed appropriate. Cost is certainly an important factor in considering the use of glass walls. A concrete parapet wall is estimated to cost about €950 per metre and a glass parapet wall is estimated to cost about €2,000 per metre.

Cost is not the only consideration however. Glass walls require considerably more maintenance and can become shabby looking in a short time, if neglected. Though robust there have been instances where they have been damaged by vandalism. Where glass walls are expected to defend to their full height they require quite large supports that can be robust in appearance even on relatively short stretches. In some cases, glass barriers were considered inappropriate because of the historical setting.

6.2.2.3.5 Sheet Piles

All proposed sheet piles will be clad. The sheet pile flood defence wall at Sundays Well Tennis Club will have a "green wall" finish. A green wall is a wall partially or completely covered with greenery that includes a growing medium such as a soil or substrate. The wall proposed here will comprise of trellis and planting.

6.2.2.4 Railings

The City Architect in consultation with the project Landscape Architects are currently finalising a family of bollard and railing details suitable and appropriate for Cork. Landscape Architects 'The Paul Hogarth Company' have been integral to the design process for the bollards and railings. The stone bollard detail takes its design reference from existing historic bollards elsewhere in the City Centre, such as Sullivan's Quay, ensuring the proposal will be in fitting with the local environment. The open railings will maximise the view of the river.

This detail reflects the historic past of many quays where mooring bollards were historically located. This detail is considered to represent a significant improvement on many of the existing modern upstand walls and railings. It is envisaged that the design of this bollard and railing may evolve and develop further during the detailed design process.

6.3 River Amenity

6.3.1 Summary of Submissions

There are concerns that the proposed works will diminish the public's connections with the river. These concerns include:

- Views of the river will be altered and in some areas lost.
- River access will be negatively impacted - accesses should be maintained for safe access and egress in emergency situations.
- Corks status as a riverside city will be diminished.
- River sporting, leisure and tourist activities will be negatively impacted.
- Importance of the river for well-being, feeling of being connected to nature and
- Queries regarding the flow control structure at the head of the South Channel.

6.3.2 Response

6.3.2.1 River Connection

The scheme design has aimed to minimise the impact to the views of the river by a combination of measures, depending on the location, including raising footpaths and utilising glass barriers where appropriate.

Comprehensive proposals will create a riverside environment that is better connected with the rest of the city centre and with adjacent neighbourhoods. This will facilitate increased local use of the riverside as a place of beauty, for a range of leisure uses. This increasingly attractive environment, incorporating interpretation throughout will be a place that is visited by tourists. The design of places for sitting, for events and to admire views will all contribute to this.

The river itself has significant potential to be more actively used. In that respect, access for canoes/kayaks, etc. will be retained/introduced.

Increased quality of environment and increased numbers of people using the riversides will create opportunities for businesses, particularly those associated with hospitality, leisure, etc.

The scheme has included a number of measures to maximise leisure and tourist based activities. In total, 1km of new river walkways will be created, that include:

- Land reclamation at Grenville Place – creating a public plaza;
- New quay side public walkways at Morrison's Island and at Bachelors Quay.

Although every effort was made during the design process to minimise the impact on the river views, a number of further design changes will be made to address some specific concerns regarding river views following a review of the submissions received. These design changes are described in Section 9.

The detail of the new walkways and public realm areas will be developed in conjunction with the project landscape architect (The Paul Hogarth Company) during the detailed design phase. The finer details were not included in the design shown at the public exhibition to allow for feedback from the public to inform the detailed design. The detail of finishes will be discussed and agreed with the OPW and Cork City Council. The design will have regard to the objectives set out in the Cork City Development Plan.

Concerns have been raised regarding the impact on the river views due to the height of the walls and footpath railings. While every effort has been made to reduce the height of proposed structures, there is a health and safety requirement to provide a safe guarding height from ground level to the top of a barrier (wall or railing), to reduce the risk of falls.

In the majority of locations (53%) the defence is to be provided by a low wall of 0.6m height, with a safety railing on top and in other location where there is a wall, the maximum height is only 1.2m which can easily be looked over by the majority of adults.

The new barriers and railings will provide a safer environment and therefore facilitate the increased use of the riverside/quays for spectators and amenity users. This scheme provides an opportunity to be consistent and provide a higher quality solution.

6.3.2.2 River Access Points/Navigation

There are numerous existing slipways or stepped access points to the river along both banks from Waterworks Weir to Custom House Quay.

It has always been an objective of the Scheme to ensure that river access and amenity is preserved and if possible enhanced, and it is not the intention of the scheme to limit use of the river in any way.

During the exhibition design and subsequently, river user groups including Meitheal Mara and Naomhóga Chorcaí provided valuable information in relation to critical access points which were taken under consideration and subsequently retained as part of the scheme. The design team reviewed all existing access locations located along river channel.

As part of the proposed defence works, the majority of these accesses will be maintained, but with some alterations required. The alteration works are required to incorporate the accesses into the proposed scheme, and will include measures such as providing additional steps up to the flood defence level.

The most challenging aspect of incorporating access steps into the proposed scheme was working with the existing ground levels and ensuring the access steps maintain a small footprint along the quay so as to not disrupt pedestrian flow or negatively impact public realm spaces. As step access details throughout the city are generally consistent with one another, the design team was able to generate typical solutions for maintaining river access and minimising visual disruption.

These solutions commonly involved the extension of steps to Flood Defence Level (FDL) on the wet side, along with the addition of steps on the dry side to gain access over the defence parapet safely. Typical plans and elevations of these solutions are provided below in Figure 20 to Figure 23.

Figure 20: Typical Plan #1 showing access steps being maintained

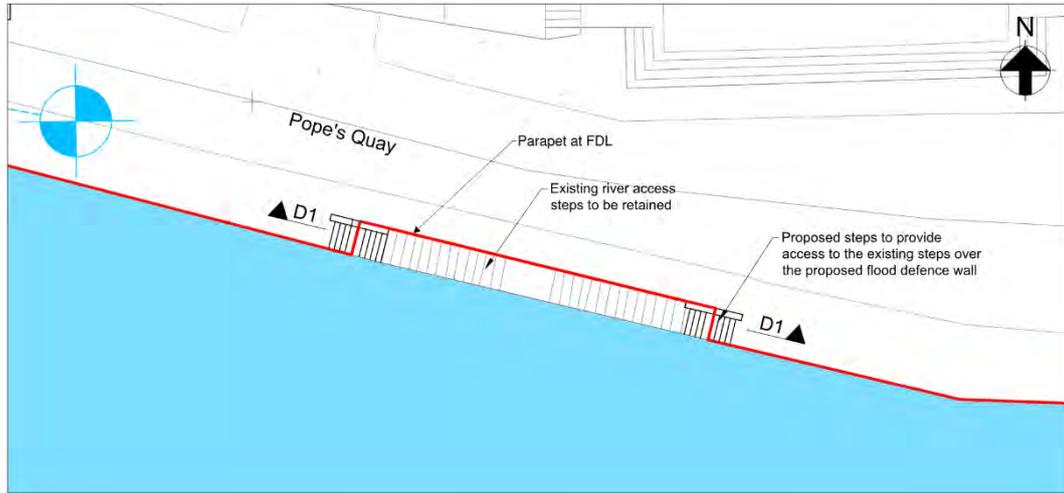


Figure 21: Typical Elevation #1 showing access steps being maintained

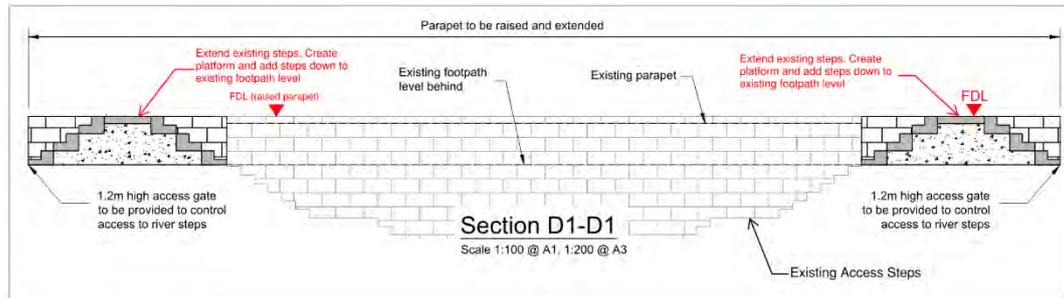


Figure 22: Typical Plan #2 showing access steps being maintained

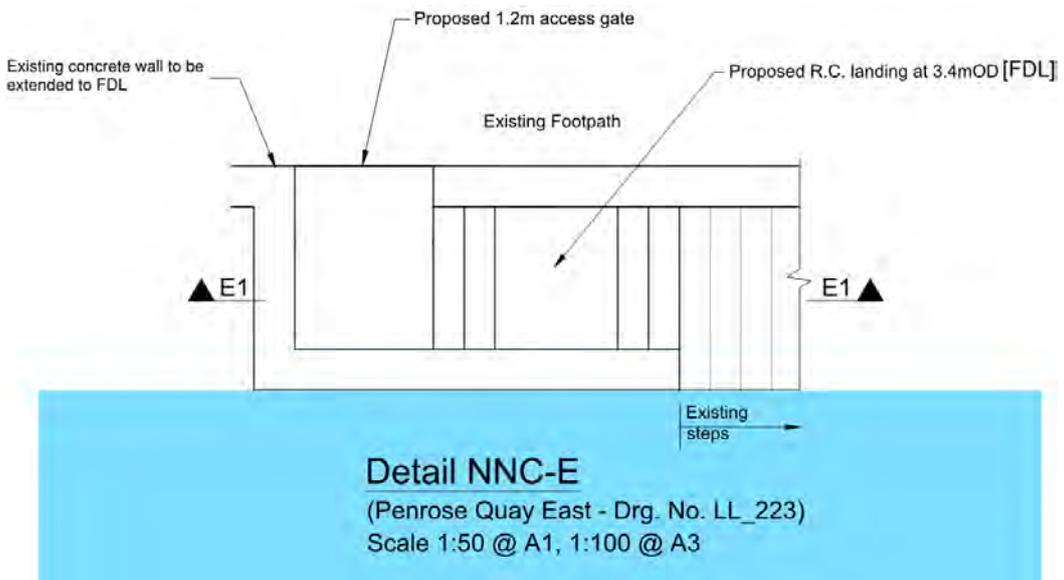
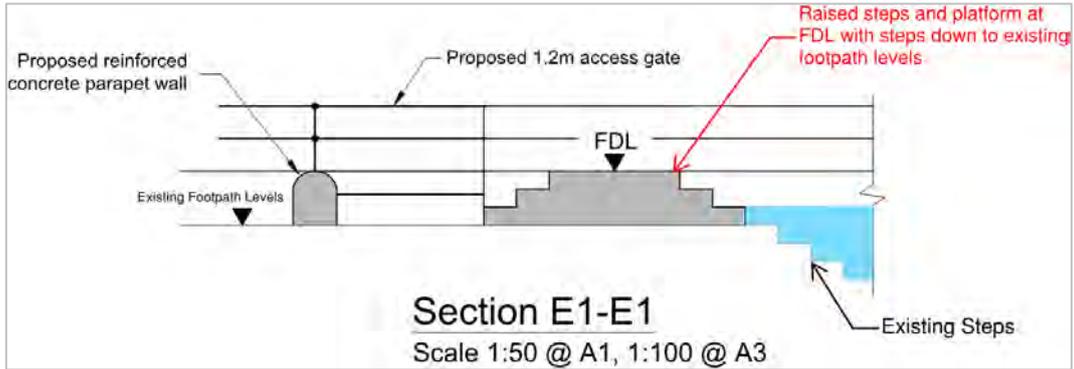


Figure 23: Typical Elevation #2 showing access steps being maintained



However, a small number of these existing access routes are currently partially or fully obstructed, whilst others are in close proximity to alternative access points along the quay. In collaboration with Cork City Council, some of these particular access points were deemed to be unnecessary. Consequently, a small number were proposed to be extinguished where evidence presented pre-exhibition suggested that such access points were no longer in use or needed. For health and safety reasons, the decision was made that where step access was being extinguished, a ladder access route was to be installed in its place.

Figure 24 & Figure 25 below identify the exhibited alterations to access routes along both the North and South Channel.

Figure 24: West of City River Access Points

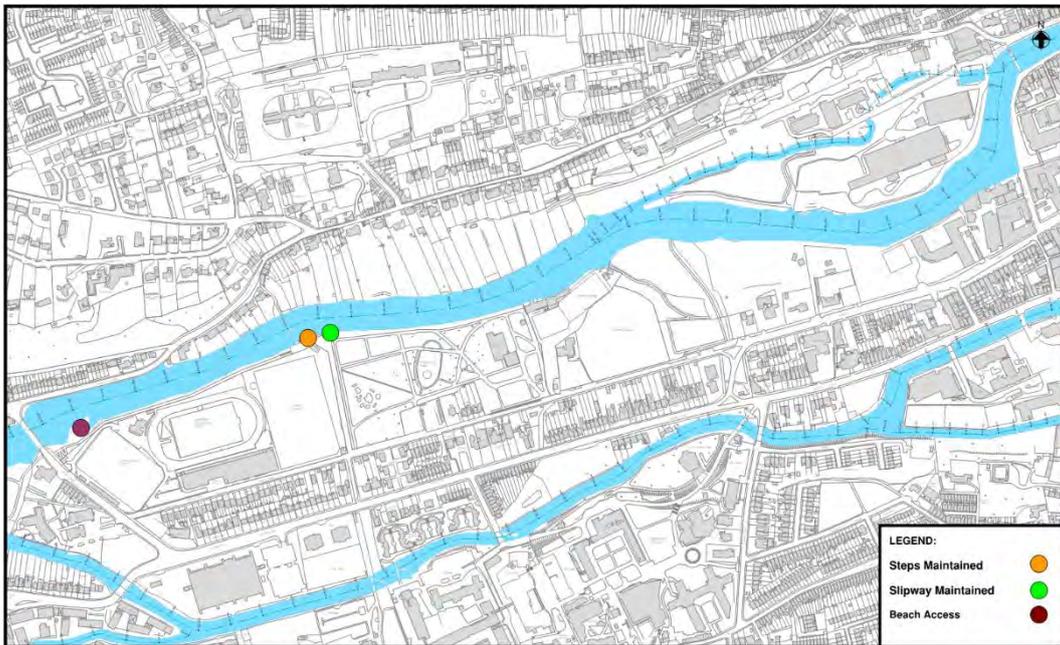
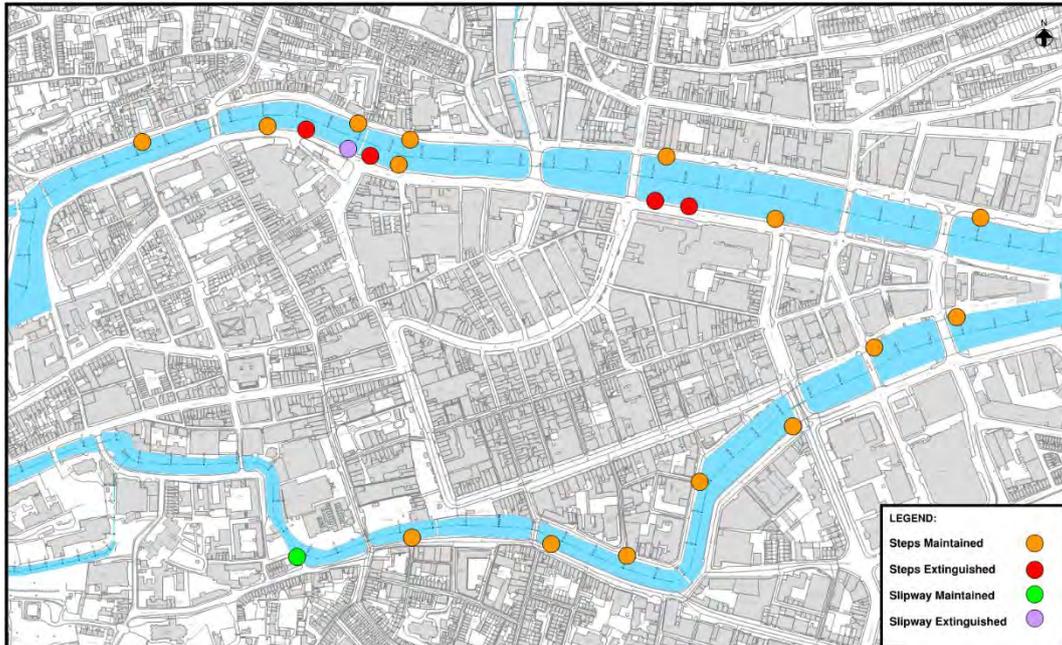


Figure 25: City River Access Points



In the exhibition documentation, it is acknowledged that there were some errors or ambiguities, and as a result it was not clear what was proposed at a small number of these access points.

Since exhibition stage, a number of submissions have been received and in conjunction with river user groups it is proposed to increase and improve the number and type of access routes to the river. Details of the proposed changes are set out in Section 9.2 of this report.

6.3.2.3 Wellbeing

If the proposed development were not to proceed, the existing river channel would remain as it is, thus retaining many of the same potential impacts on human beings as have occurred previously. The opportunity to protect those areas of Cork City surrounding the River Lee from future flooding events would be lost, as would the opportunity to create employment during the construction phase.

The impact on people and communities as a result of the stress and trauma of being flooded, or even of being under the threat of flooding, can be immense. Long-term impacts can arise due to chronic illnesses and the stress associated with being flooded and the lengthy recovery process. The ability of people to respond and recover from a flood can vary. Vulnerable people, such as those who are elderly, disabled or have a long-term illness, are less able to cope with floods than others. Some people may have difficulty in replacing household items damaged in a flood and may lack the financial means to recover and maintain acceptable living conditions after a flood. The construction of the proposed scheme will reduce the risk of flooding from the River Lee and the tide to below the 1 % AEP (Fluvial) or 0.5% (Tidal) levels. Therefore the negative experience of flooding in the areas benefiting from the works will be significantly reduced.

Cork is a recognised river city and as part of the scheme, the existing quay walls and parapet upstand walls and railings will be refurbished thus enhancing the river side aesthetics. Access to the river and river walks is being provided as part of the scheme, therefore the wellbeing benefits of having access to the river will not be compromised and will in fact be enhanced.

The provision of connected riverside pedestrian/cycle routes, which are linked into the City Centre and adjacent neighbourhoods will encourage Active Travel, and healthier lifestyles. The parkland and public realm will be good, safe, accessible places to walk, run, cycle, scoot, etc. for people going to work, school, university or simply for leisure. Improved access to the river itself will provide additional water-based opportunities. Interpretation will add to the wellbeing value, extending the length of time that people will stay outdoors and facilitating an increased awareness of the value of the environment.

6.3.2.4 Flow Control Structure at Sacred Heart Bridge

The proposed flow control structure at Sacred Heart Bridge offers a number of benefits to the scheme. It will be closed (or partially closed) when the River Lee is in flood to prevent (or reduce) flow entering the South Channel and divert a greater proportion of the flow to the North Channel, which has greater capacity.

This offers a number of benefits to the scheme as listed below:

- By reducing the flow to the South Channel, water levels are greatly reduced between the Eamon De Valera Bridge and Western Rd. The reduction in water levels will be between 0.1m to 0.8m, which will reduce the required height of flood defences along the South Channel.
- There is no requirement for construction of new high and visually intrusive defences along the Curragheen River. It is also not required to divert the Curragheen or Glasheen River during flood events as the South Channel has sufficient capacity for these flows once the flow control structure is in operation.
- However, the diversion of flow to the North Channel results in the requirement of slightly higher flood defences in the North Channel West. There is little impact at the eastern end of the North Channel where defence levels are tidally driven.

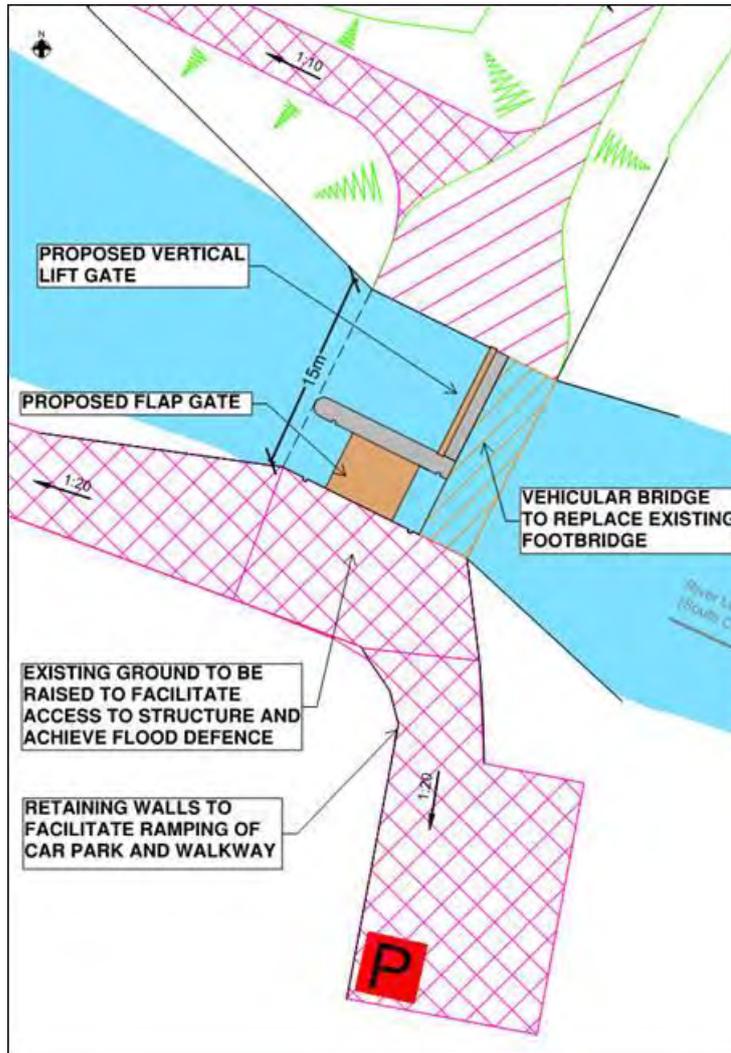
The following should be noted in relation to the proposal:

- The proposed structure will replace the existing Sacred Heart Pedestrian Bridge and so will incorporate a replacement bridge as part of its structure.
- Whilst the detail design is still being developed for the structure and there are a number of variations in how the final structure will look, the current proposal is that the flow control structure will consist of two different key elements. Two thirds of its width will take the form of a traditional penstock type sluice gate (which would be raised above water level in its normal open position) with the final third consisting of a 'bottom up' flap gate (i.e. would be hidden below the water in its normal open position).

- There were a number of concerns raised as part of submissions regarding the geometry of the structure and how it will affect river navigation.
 - The proposed solution retains safe passage for canoeists, kayakers and similar amenity users. Whilst the width of the relevant sections will be maximized in balance with other flow constraints – additional features such as guide rails will be incorporated to allow all relevant boat users ease of passage. Guide posts will be incorporated to direct river users toward the flap gate section where navigation head room is ensured. Consultations have been held with the various relevant river user stakeholders to ensure their requirements can be accommodated where possible.
 - The design of the proposed structure is being developed so as to ensure it will not significantly impact low flows on the South Channel and thus the environmental habitat will not be affected. This can be ensured via a combination of adjustable opening positions on the main structure together with assessment of back water influences from the Curraheen River.
- Consultation has also been held with the relevant environmental and fishery bodies to ensure their requirements in relation to safe fish passage and minimal environmental impacts (in terms of flows and flora/fauna) are ensured.
- It is proposed that all moveable mechanical elements will be automated with localized manual backup and will be remotely controllable as well as being linked to the flood forecasting system and river gauges on the Lee and Curraheen Rivers. This will allow both sufficient safe-guarding of the control of the structure as well as ensuring live data is available to the relevant stakeholders who require it.
- There is an opportunity for this structure to become a feature in its own right and a positive part of the public realm. Due to the anticipated vegetation removal, users would benefit from views up and down the south channel and particularly towards the built heritage around the Old Cork Waterworks.
- Through detailing and materiality, a more visually congruous form for the structure will be considered and could include interpretation based on the flood control measures, wildlife, the river and engineering themes. The threshold areas and landscape treatments will also be given careful consideration at detailed design stage.
- Proposals will integrate approaches at both sides of the river which are appropriate in relation to universal access. Consideration is also being given to the implications associated with facilitating access for maintenance vehicles.
- The design of the Flow Control Structure will include elegant parapet/handrail details, will be integrated into the wider landscape and will be considered in terms of views to/from it.

Figure 26 below shows a plan view of the proposed structure as exhibited. The exhibition documentation also contains further sections and a photomontage of the proposed structure.

Figure 26: Plan of Proposed Flow Control Structure as exhibited



6.3.2.5 River Users and Communication

There have been requests from river users for a reliable communications channel. This will be provided and is outlined in more detail in Section 4.9.

6.4 Impact on Ecology

6.4.1 Summary of Submissions

A number of submissions raised concerns regarding the impact of the scheme on ecology. The main concerns are listed below:

- Suggestion that the EIS does not fully take account of impact on flora and fauna.
- Suggestions that impacts are underestimated in EIS and under researched.
- Impact on movement of salmon.

- Impact on otter, eels, marine mammals, birds including kingfisher, cormorants, egrets, heron, sand martin, salmon and trout, seals etc.
- Impact on natural river banks, floating river vegetation, riparian woodland, trees wet grasslands, parkland, mixed woodland, tree lines in urban environments, intertidal habitats.
- Spread of invasive species.
- Impact on the Gearagh SAC and upstream and downstream SACs and SPAs; and
- Insufficient mitigation for otters and loss of habitat, should provide for replacement otter holts, bird boxes, bat boxes and ledges.
- Requests for further detail regarding potential fisheries impact associated with the proposed flow control structure. In particular, there were requests for confirmation of the sill level of the structure, confirmation of predicted water levels downstream of the structure when the gates will be closed, and a request that the proposed structure would not obstruct fish passage or endanger fish viability

6.4.2 Response

Chapter 5 of the EIS¹¹ details the impacts of the proposed scheme. Much of this is based on detailed specialist surveys that were carried out by independent, reputable and suitably qualified specialist ecologists at the appropriate time of year over the extended period of preliminary design. The report was carried out as per the relevant EIA legislation and Guidance.

Specialist reports include:

- Lower Lee (Cork City) Floating River Vegetation Survey (2016)
- Lower Lee (Cork City) Invasive Plant Survey (2016)
- Lower Lee Bat Faunal Survey (2016)
- Lower Lee Electro-Fishing Survey and License Return Report (2016)
- Sea lamprey (*Petromyzon marinus* red) survey (2016)
- Lower River Lee & Tributaries Biological Q Sampling Report (2015)
- Habitat mapping of the Lower Lee and Tributaries (2016)
- Lower River Lee & tributaries Kingfisher (*Alcedo atthis*) Surveys 2014-2016
- Lower Lee (Cork City) Drainage Scheme Otter (*Lutra lutra*) Survey 2014-2016

¹¹ Lower Lee (Cork City) Drainage Scheme Environmental Impact Statement, Chapter 5 Flora and Fauna, Page 5-1: http://www.lowerleefrs.ie/assets/lee_valley/docs/Main%20Report.pdf

Chapter 5 of the EIS addresses the impact on Flora, Fauna and Habitats. Where possible, impact on habitats and species was avoided. The impact on Flora, fauna and habitats is in many cases temporary in nature and will be minimised by use of mitigation provided. Where the impact is considered permanent further mitigation has been proposed and identified in Chapter 5 where feasible.

The Report identifies the need for a Project Ecologist to be on site for the duration of works to ensure minimal habitat loss, disturbance and implementation of mitigation. Pre-construction surveys will be carried out during design stage. The findings of these surveys may identify specific mitigation measures for mammals and birds which can be designed into the scheme and carried out prior to or during construction.

Any disturbance to nests, resting or breeding places will require a derogation licence from NPWS, the conditions of which will be included within the design (if required). Where possible landscape design will ensure replantation of vegetation and habitat creation.

The scheme design is being carried out in consultation with Inland Fisheries Ireland (IFI) with particular regard to the flow control structure, fisheries habitat and movement of fish within the channel.

Invasive species surveys have been carried out for the EIS. In addition, the OPW has procured a contractor to commence eradication and management of invasive species within the study area prior to construction phase.

An Appropriate Assessment Screening Report was carried out for the proposed scheme in relation to European Sites (SACs, SPAs).

6.4.2.1 Flow Control Structure

The sill level of the proposed structure will generally be set below the existing bed level, to ensure that the impact on the existing hydraulic regime and possible knock-on impacts on fish life will be minimised.

In order to assess the risk of the bed drying out downstream of the structure while the gates are closed, detailed low flow hydraulic modelling of the relevant reach of the South Channel has been undertaken for various scenarios. The results of the model indicate in an adverse scenario (flow control structure closed, low flows on the Curraheen (25% Q_{med}), low tide), a minimum water depth of 0.3m will be maintained downstream of the flow control structure. This depth is deemed sufficient to ensure fish viability is not adversely impacted when the barrier is closed.

Further consultation with Inland Fisheries Ireland will take place during the detailed design phase to ensure that impact on fisheries is minimised.

6.5 Impact on Tourism and the Local Economy

6.5.1 Summary of Submissions

Submissions have raised concerns that there will be a permanent impact from the proposed works on tourism. There is a belief that Cork will lose tourists for the following reasons:

- The river side city will no longer benefit from existing views.
- Negative impact on heritage and Georgian quays.
- Negative impact on the leisure uses of river: walks, rowing etc.
- Negative impact on the local economy as a result of the scheme and
- Disruption during construction.

6.5.2 Response

Please refer to the respective sections for a detailed response to the listed concerns which are summarised in the response below:

- Heritage impacts on existing quay walls – Section 6.1.
- Visual impacts of proposed flood defence walls – Section 6.2.
- River Amenity – Section 0.
- Construction Disruption – Section 6.7.

6.5.2.1 Tourism Benefits

While the EIS predicts that there may be a temporary slight negative impact on tourism during the construction period, no permanent impact on tourism is predicted. This section gives further detail on tourism-related issues and potential benefits associated with the scheme.

Currently, flooding is a major threat to tourism and businesses in Cork City. Flooding can occur at any time of the year and can result in significant damage to the local economy, environment, infrastructure and property. The flood protection works will provide direct protection from this threat which can improve confidence in Cork as a destination.

The proposed phasing of the construction works has been designed to ensure that the incremental reduction in flood risk will be maximised with each phase. Upon completion of the scheme, the city will benefit from a much higher level of flood protection that will allow the city to develop in terms of amenity, business, tourism and investment potential for the medium and long term.

The implementation of a temporary Traffic Management Plan and Environmental Management Plan for the construction phase will indirectly help to minimise the impact on tourism. The construction works will be designed to minimise impacts upon the amenity value of the study area during the construction period.

Mitigation will include measures to minimise pollution of the river, minimise impacts on fish, limit working hours and prevent un-necessary damage to bankside habitats.

The improved public realm areas and riverside walks, which are to be constructed as part of this scheme, can have a positive impact on tourism by increasing the opportunity to engage with the river. The quays as a connector in the city will spread the benefits and stress of current tourist centres at peak season. The installation of street lighting and new walls/railings adjacent to the river will also improve the safety for pedestrians and river users on a day to day basis.

Tours and walking trails of the quays could encourage people to stay longer, go further and stimulate economic benefits wider than the traditional tourist centres.

The investment in remedial works to the historic quay walls will ensure that they can continue to be enjoyed as a heritage asset for many years to come.

Street/Path lighting will ensure that the areas are attractive to visit and use after dark as well as through the daytime.

The environments that will be created will be increasingly attractive to local people and visitors. The connected routes along the Rivers will encourage walking, cycling, running, etc. as well as access to the river itself. The increased footfall in the areas, combined with improved quality of environment will promote investment in adjacent properties. One example of this is Morrison's Island, where the south-facing buildings will benefit from an improved riverside aspect and increased footfall, which is likely to result in interest for cafes, cultural and other leisure-related activities.

Creation of places where activities and events can take place, such as Parnell Bridge Plaza and Grenville Place Plaza will strengthen the tourism offering of the city.

The interpretation that is proposed throughout the project will combine signs/panels, with bespoke elements/public art. This will facilitate an understanding of stories about the area, its history, people, culture, and environment. This will add to the interest and enjoyment for local people and visitors, particularly the 'culturally curious' who are one of Cork's target groups.

6.6 Security Concerns

6.6.1 Summary of Submissions

Concerns have been raised in relation to the security implications of the proposed scheme. These mainly focus on the reduction of passive security due to wall heights.

6.6.2 Response

The concerns in relation to the loss of passive security have been noted.

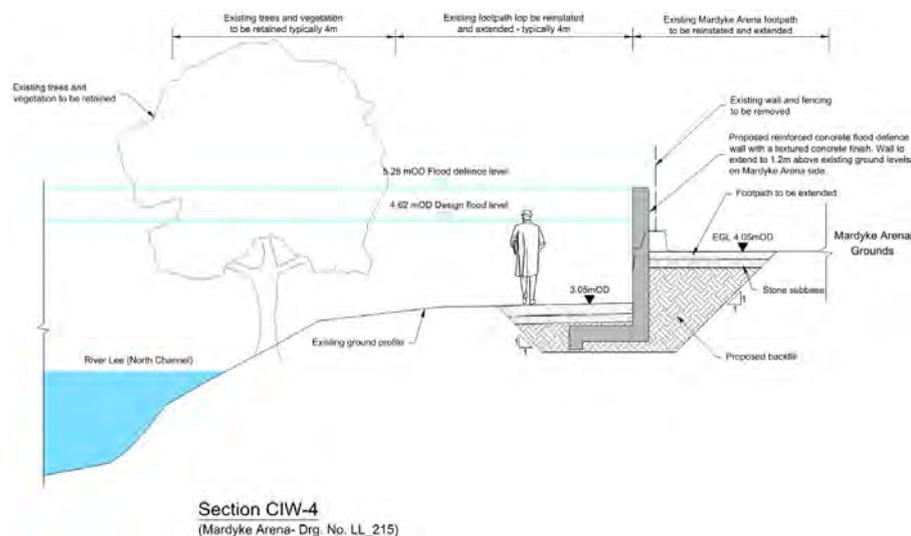
Any existing lighting and CCTV will be reinstated where they are impacted by the proposed works. In other locations where new pedestrian walkways are proposed, new lighting will be provided in accordance with the relevant design codes.

Street and path lighting will be incorporated, using LED fittings. The good colour rendering that this will provide, will significantly enhance perceptions in respect of the safety of the area. The design will be site specific and will be agreed with the local authority. Specific areas of concern highlighted in the submissions are discussed below.

6.6.2.1 Mardyke Riverside Walkway

There are concerns that the riverside walkway between Thomas Davis Bridge and Daly's Bridge could have increased potential for security issues / antisocial behaviour due to the increased height of the wall between the walkway and the Mardyke Arena. Views were expressed that the pathway currently benefits from a degree of "passive surveillance" from the Mardyke Arena, which would be removed by the proposed scheme as exhibited. This walkway is currently gated and locked at night, which will continue in the future. Figure 27 below shows a typical section through the exhibited solution at this location.

Figure 27: Section of Exhibited Defence Solution along Mardyke Arena



This issue was considered in detail by the Steering Group and it is now proposed to amend the scheme to raise the existing footpath on the wet side of the defence to ensure that passive surveillance will be maintained. Refer to Section 9.5 for further detail.

6.6.2.2 Dyke Parade Riverside Walkway

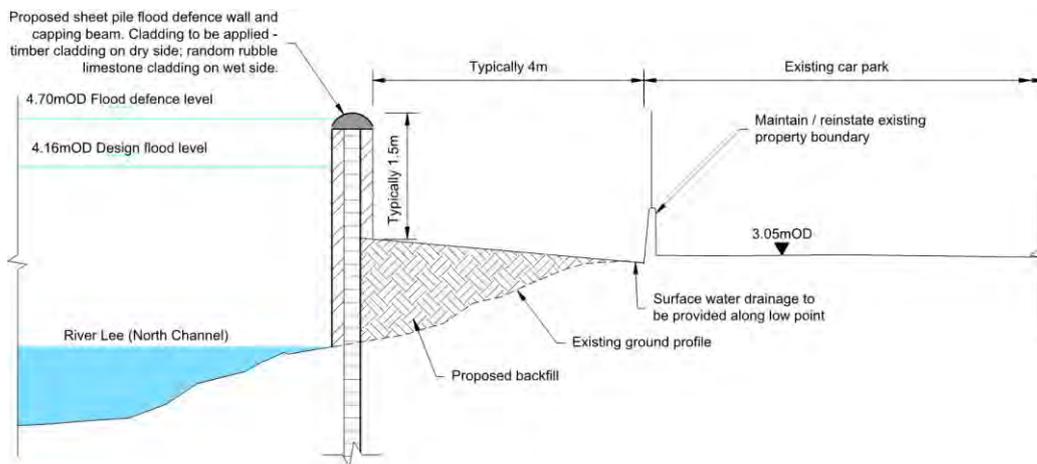
There are a number of locations across the scheme where flood defence walls are being provided in channel, on the river side of existing boundary walls, leading to some land being reclaimed from the foreshore.

In some of these areas, Cork City Council has an aspiration to utilise this reclaimed land to provide public walkways and boardwalks. However as they are not required for flood protection, their development does not fall within the remit of the project.

Therefore, the design of the scheme has considered the potential future use and has ensured that the design is compatible with it. Cork City Council will therefore retain the potential to develop the reclaimed land for a potential public walkway in the future, but this would be subject to consultation with adjacent property owners and separate granting of statutory consent.

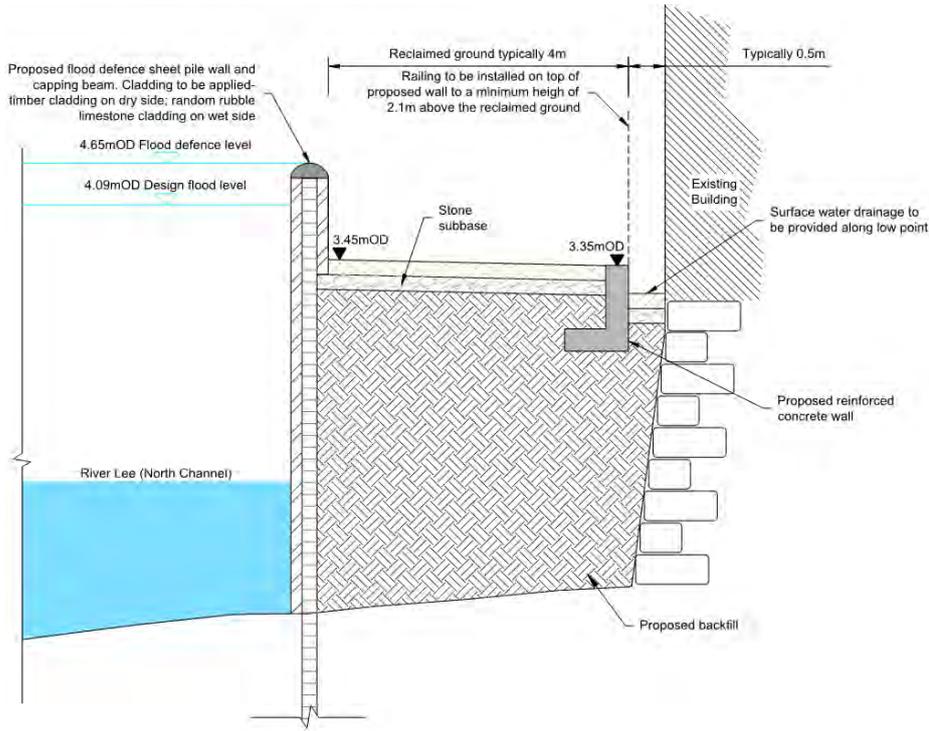
See Section 0 for information on how the public's connection with the river will be maintained with the proposed scheme in place.

Figure 28: Section of Proposed Defence at rear of Presentation Brothers School



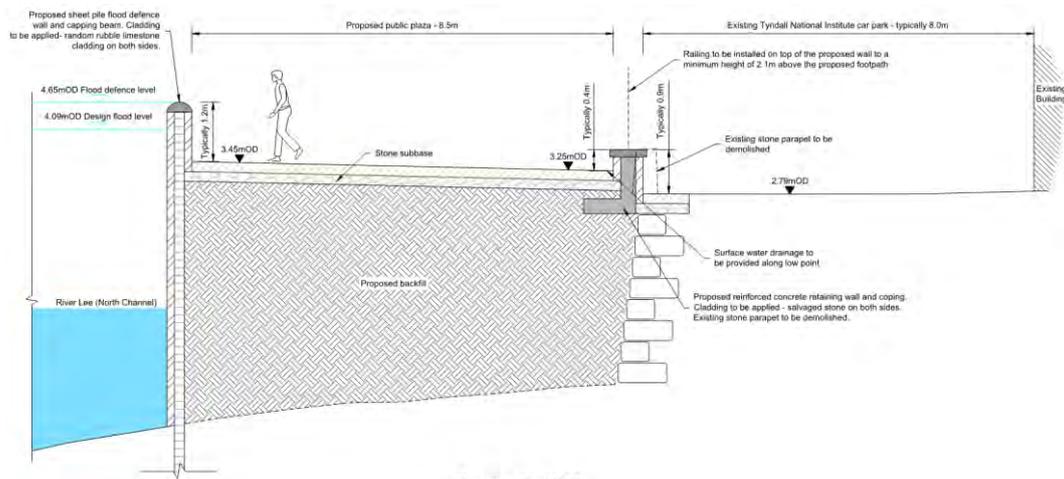
Section CIW-15
(PBS - Drg. No. LL_217)

Figure 29: Section of Proposed Defence at Tyndall



Section CIW-16
(Tyndall National Institute - Drg. No. LL_218)

Figure 30: Additional Section of Proposed Defence at Tyndall



Section CIW-17
(Tyndall National Institute - Drg. No. LL_218)

The following schematic plan identifies existing riverside walkways, new riverside walkways proposed under the scheme and potential future walkways to be developed by Cork City Council.

Figure 31: Schematic of Riverside Walkways



6.6.2.3 South Mall Boardwalk

Further to the feedback received during the public exhibition and from subsequent submissions, a review of the South Mall Boardwalk was undertaken, following which it has been decided to remove the boardwalk element from the scheme as this element isn't required for the flood defence function. Cork City Council retain an aspiration to develop a boardwalk at this location at a later date following the necessary further consultations and a separate statutory consent process.

6.6.2.4 Grenville Place Public Realm

The proposed public realm at Grenville Place will be designed by the project team's specialist landscape architect in conjunction with the City Architect. The public realm will be an open space that will be visible from adjacent properties, St Vincent's Bridge and the riverside walkway along the northern bank, see Figure 32 for a photomontage of the proposed design. Further detail will be provided by the landscape architect during the detailed design.

Figure 32: Photomontage of Grenville Place plaza from the Mercy Hospital as exhibited



6.7 Construction Disruption

6.7.1 Summary of Submissions

There have been a number of submissions in relation to the disruption that will be caused by the construction of the flood relief scheme. The main concerns include the:

- Duration of construction;
- Impact on the environment (specific mention of concrete);
- Noise levels;
- Impact on existing buildings/structures;
- Impact on local businesses and tourism; and
- Impact on traffic.

6.7.2 Response

Whilst there will be some disruption during construction, this will be minimised by careful phasing of the works and inclusion of contractual provisions in relation to working times, traffic management, noise and dust management, maintaining critical infrastructure etc. Liaison will continue to be undertaken with An Garda Síochána and the local authority to ensure that minimum disruption is caused.

Significant consultation has already taken place with various business organisations and property owners, and this will continue throughout the project. Access will be maintained to all properties during the constructions works.

In order to facilitate additional pedestrian and traffic movement in the period up to and immediately after Christmas each year, no works other than emergencies will be carried out in the city centre island and on all major arterial routes during this period. This will be in compliance with the well-established Cork City Council policy.

The construction timing and phasing will be co-ordinated with other works in the city such as development works and works associated with the City Centre Movement Strategy (CCMS), thus reducing the overall duration of disruption in areas.

The works along the quay walls will include installation of spare utility ducting, which will minimise the need for any future excavation associated with potential utility installation projects in the future.

The permanent benefit of the scheme in protecting existing businesses and attracting new business far outweighs any short term impacts.

6.7.2.1 Duration and Phasing of Construction

It should be noted that that the construction works will not be carried out at all locations in the city at the same time.

The proposed phasing of the works is outlined in detail in the Assessment of Phasing Options Report, March 2017 and is shown in Figure 33 below. The current construction programme is shown in Table 3.

Figure 33: Location Plan of Proposed Phasing of Work

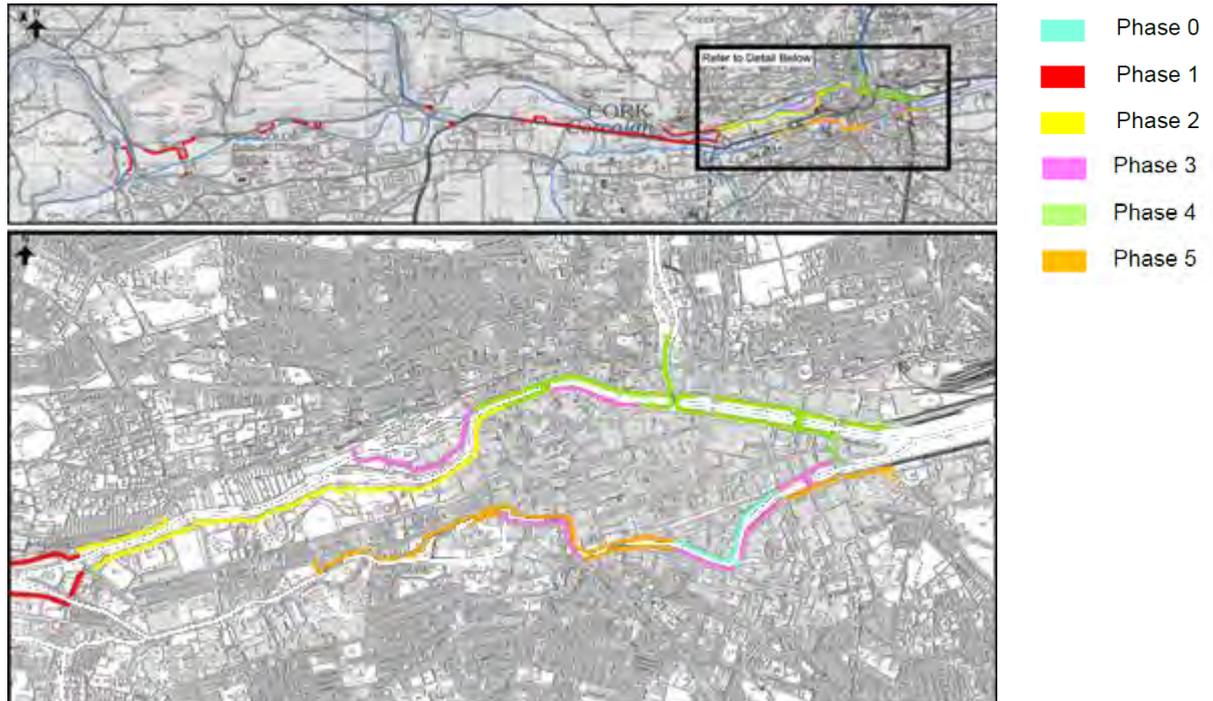


Table 3: Phasing Programme

Phase	Statutory Process	Description	Start	Finish
Phase 0	Planning & Development Act/Regs (Part 8)	Morrison's Island	July 2018	July 2019
Phase 1	ADA	West of City (to Wellington Bridge)	Mid 2019	End 2020
Phase 2	ADA	Wellington Bridge to St. Vincent's Bridge	Mid 2020	End 2021
Phase 3	ADA	Other Priority High Risk Tidal Locations	End 2021	Mid 2023
Phase 4	ADA	Remainder of North Channel	Mid 2023	End 2024
Phase 5	ADA	Remainder of South Channel	End 2024	End 2025

Further to requests from local stakeholder groups, the project team will again review the possibility of further rationalisation of the above phasing in order to provide maximum benefit to the city as soon as possible, while reducing the overall construction programme and minimising disruption. In particular there appears to be an opportunity to increase the overlap of construction works on Phase 1 and Phase 2. The steering group have reviewed this proposal and propose to proceed with implementation of this strategy in the next stage of the project.

6.7.2.2 Noise, Environmental and General Disruption

In addition to the Environmental Impact Statement, a Construction Environmental Management Plan (CEMP) will also be produced which will detail the measures to be put in place to minimise the impacts on the environment from the proposed works. The CEMP includes standard environmental protection measures, including operational procedures and contingency measures, to reduce the environmental impact of construction activities. Limits for vibration, noise, dust, etc. will be specified. Working hours for the contractor will be included in the contract specifications.

General disruption will be managed through the phasing plan to ensure that the works are planned so that a minimal area is affected at any one time. A specific liaison for the contractor/OPW/local authority will be nominated to liaise with those directly affected during the construction works and to deal with any concerns.

Temporary traffic measures will also be put into effect during the construction period, which is detailed further in Section 6.7.2.4.

6.7.2.3 Damage to Existing Buildings/Structures

Measures will be put in place to minimise the risk of damage to existing buildings/structures during construction. In areas where rock breaking or sheet piling is required in the vicinity of structures, a pre-condition survey will be undertaken before the works begin, which will include a photographic survey and crack monitoring. A post condition survey will be undertaken upon completion of the works and if it is found that the works have caused any damage it will be the responsibility of the Contractor to ensure it is rectified.

The work areas will be cordoned off and isolated from the public and will be set out where required at a sufficient distance from the buildings to minimise the risk of damage as far as is practicable. Any excavation works required will be supported by either battered back slopes, trench supports (such as trench boxes) or sheet piling which will be detailed in the temporary works design. In locations where buildings are abutting the river, the works will be carried out in stream which could require the following temporary works: silt barrages, damming the river locally around the river bank/ wall, suspending scaffolding from the wall, or constructing a temporary pontoon or causeway on the river side of the wall. The construction works will be preceded by geotechnical and archaeological investigations to further inform the design team i.e. ensuring that the correct method of excavation is being utilised.

Vibration limits will be set in the contract that will adhere to the limits set in the EIS. Vibration monitors will be set up adjacent to the closest building/structure to the works and will be monitored by the contractor to ensure the limits are not exceeded.

6.7.2.4 Traffic

It is recognised that the proposed scheme will have a short term impact on transport infrastructure in the area, most significantly during the construction phase. This impact is likely to occur where work areas are on or directly adjacent to roadways, particularly at bridges and in Cork City centre. This will have a temporary impact on traffic volumes in the immediate surrounds of the works areas due to the increase in additional traffic movements associated with the site investigation, construction of new infrastructure including walls, embankments, parapets etc. However, taking into account the large numbers of vehicles using the road network in Cork City and in the vicinity of the works areas, it is unlikely that traffic generated during the construction phase will have a significant impact on traffic flow in general. Further details of the predicted increase in traffic flows can be viewed in Section 12.7.1 of the EIS¹².

It is likely that temporary road closures and diversions will be required during the construction phase of the works at a number of locations. All road closures will be advertised in local papers beforehand as per standard practice. The most significant impacts in terms of traffic are expected within the city centre area.

Works to the west of the city are considered to have a much lesser potential impact on traffic, as the proposed works are generally located off of existing roads. Any impacts will be temporary in nature. For further information, see Section 12.7.2 of this EIS.

A wide range of mitigation measures will be implemented in order to minimise the significance of the potential impacts of the project on the wider transport network. Site-specific mitigation measures for works sites will be determined and agreed with all relevant stakeholders during the detailed design process. Although the scheme is divided into 5 principal phases, each individual phase is also likely to be sub-divided further into discrete 'blocks' for the purpose of construction. Each individual works element will require the preparation of a Construction Traffic Management Plan (CTMP), which will be subject to agreement with Cork City Council and An Garda Síochána prior to commencement of construction. The CTMP will set out specific working criteria for each individual works area and the appropriate measures to be implemented. Further information on the proposed CTMPs can be found in Section 12.8.1 of this EIS.

¹² Lower Lee (Cork City) Drainage Scheme Environmental Impact Statement, Chapter 10 Cultural Heritage, Page 10-1: http://www.lowerleefrs.ie/assets/lee_valley/docs/Main%20Report.pdf

The localised traffic disruptions as a result of other proposed works throughout the scheme will be mitigated through the use of industry standard traffic management measures.

The phasing of the proposed Lower Lee FRS is likely to affect the phasing of the City Centre Movement Strategy (CCMS).

It is recommended that extensive high level consultation is carried out with the Roads and Transportation Division of Cork City Council and that the phasing of the CCMS and Lower Lee FRS are cognisant of each other.

The traffic impacts are described in the Phasing Report, March 2017 and are summarised below.

Phase 0 Morrison's Island

Phase 0 at Morrison's Island is unlikely to significantly affect the flow of traffic, as the route is primarily used for access to parking spaces as opposed to a major traffic route.

The works will be undertaken in phases to ensure parking losses are minimised in the interim and access can be maintained via a combination of both quays and the adjacent sides streets leading on to South Mall and Parliament Street.

On Union Quay, between Copley Street and South Terrace there are two opposing lanes and no car parking. Direct defences and pointing/re-grouting works proposed here will likely necessitate the closure of the northbound traffic lane during the works. This traffic can divert via George's Quay, Parliament Bridge, the South Mall and Parnell Bridge.

Phases 1 and 2

Phase 1 will have a minimal effect on traffic as most of the construction works to the west of the city do not interact with roads. The impact on traffic within Phase 2 will be localised as much of the construction works are located away from the roadways.

Phase 3

Phase 3 consists of works along a number of quays at Cork Central Island. The areas of Coal Quay, Lavitt's Quay, Lee Distillery Branch, Lapp's Quay, George's Quay, Union Quay from Copley Street to Anglesea Street and Crosses Green to Crawford Hall contain sufficient area to accommodate works without diversions.

There are a number of areas which will require diversions where there are relatively narrow one way systems or there is insufficient area to accommodate the existing two way system, including

- The area around Forde's Funeral Home;
- The section from St. Finbarre's Bridge to Sharman Crawford Street;
- Between Copley Street and South Terrace; and

- The pinch point from Pat McDonnell Point to Grenville Place on Bachelor's Quay (West) – the lane layout here is likely to be revised under the City Centre Movement Strategy (CCMS).

Phase 4

Phase 4 consists of works along the North Channel of Cork Central Island on both the northern and southern banks of the channel.

Works along both banks at the same time will be avoided to allow for at least one of the quays to be unaffected by vehicular traffic disruption. Furthermore, works on subsequent/adjacent bridges at the same time will also be avoided.

The following areas can either accommodate the works in footpaths/verges or are expected to have minimal impact on traffic - Port of Cork, Anderson's Quay, St. Patrick's Quay (East)/Penrose Quay (West) and Penrose Quay (East).

Areas which may require diversions include:

- Works in the area of Christy Ring Bridge.
- In the area of St. Patrick's Quay (West).
- In the area of Knapp's Square.
- Farren's Quay as well as Shandon Pedestrian Bridge.
- Griffith Bridge.
- North Mall, in areas where there is no car parking and
- The area of Bachelor's Quay (East).

All works will have to be considered in conjunction with the phasing of the City Centre Movement Strategy (CCMS).

Phase 5

Phase 5 consists of works along numerous quays along the South Channel of Cork Central Island.

The following areas can either accommodate the works in footpaths/verges or are expected to have minimal impact on traffic – Albert Quay East, Terence McSweeney Quay, Sullivan's Quay, the Beamish and Crawford Site, back of the Hanover St properties, Western Road and at the back of the former Service Station site.

Areas which may require diversions or closing of one lane include:

- Clontarf Bridge
- In the area of Sullivan's Quay and
- In the area of French's Quay.

6.7.2.5 Flood Risk During Construction

The phasing report was produced to maximise the interim benefit of incrementally reducing flood risk in Cork City during the construction works. To achieve this from the outset, it has been recommended that the implementation of the Flood Forecasting System (FFS), the creation of the washlands and phase 1 direct defences be undertaken as soon as possible to provide some reduction in flood risk to Cork, prior to construction of the remaining physical elements.

The implementation of the FFS will provide a warning in advance of the flood event which will allow property owners and authorities to take measures to mitigate against the effects of a flood event. This will allow dam levels to be lowered at interim predefined spill rates which won't flood property (buildings), in preparation for/anticipation of the extreme event. The proposed washlands areas upstream of the city centre will be deliberately flooded in advance of a forecasted extreme event to facilitate pre-emptive lowering of water levels in Carrigadrohid and Inniscarra reservoirs. This will create additional storage/attenuation capacity and subsequently reduce the peak flow during the event. Both of the aforementioned systems will work in tandem with the physical elements of the flood relief scheme.

It is proposed to implement interim flood management rules at the dams during the construction period as soon as is feasible. During the construction phase, trigger values in the FFS will be set conservatively low to ensure that all large events are catered for by the system. This measure in conjunction with the creation of washlands and optimised dam procedures will allow for greater discharges (without causing the flooding of properties) in advance of a forecast event.

For the central island defences, the level of flood risk was assessed in order to prioritise works for the various sections of quays and embankments with the aim of prioritising defences to the most at risk areas. Morrison's Island is planned to be completed as an advanced contract and will therefore be in place to defend against the vast majority of the typical tidal flood events in Cork City, before the other phases begin.

Consideration will be given to purchasing a suitable quantity of temporary flood defences at the outset of construction. These temporary defences could be erected if necessary to block potential flood routes through sections of defence wall under construction. Figure 33 shows an example of a typical temporary barrier. These are typically to be erected by the contractor.

Figure 34: Typical Temporary Flood Barrier (Image: Courtesy of Geodesign AB)



6.8 Flood Risk Downstream of City Centre Island

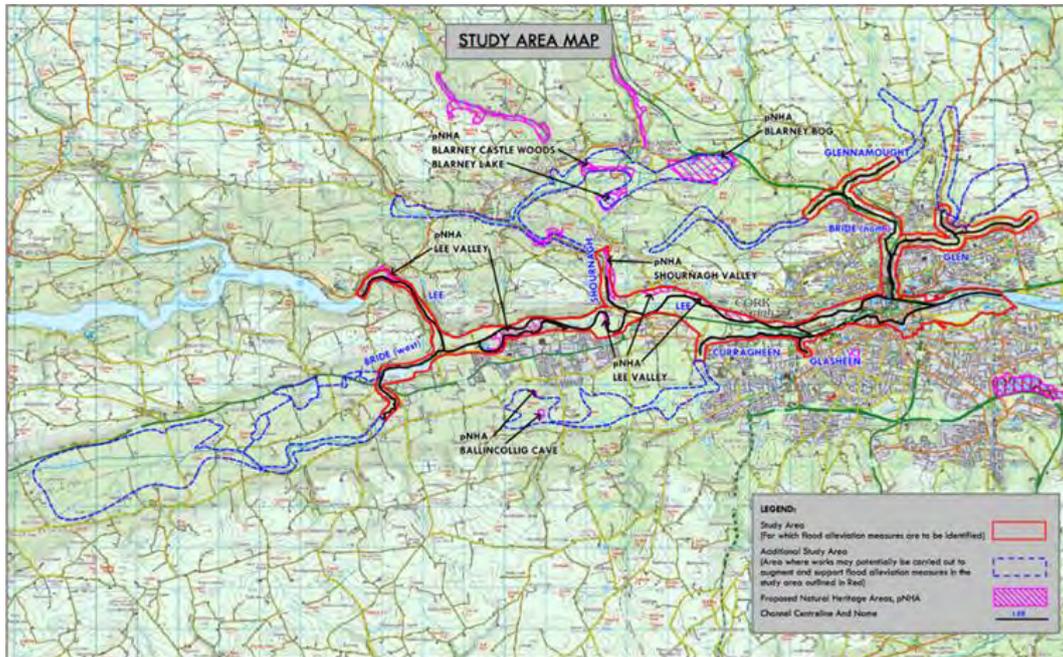
6.8.1 Summary of Submissions

A number of submissions have queried the extent of the scheme and the impact of the scheme further downstream in areas such as the Docklands, Tivoli, Blackrock, Mahon and Rochestown.

6.8.2 Response

The study area for the scheme is as shown in Figure 35 and covers from Inniscarra dam through predominantly greenfield areas west of the city through to the urbanised areas of Carrigrohane Road and Victoria Cross. From here it covers both the North and South Channels and extends from Custom House Quay to Tivoli on the left bank and Páirc Uí Chaoimh on the right bank. The study area coincides with the extent of the fluvial flooding of the River Lee.

Figure 35: Lower Lee Study Area Map



The part of the North Docklands within the study area does not contain any existing properties with floor levels below the design flood level.

The South Docklands were given due consideration during preparation of the proposed scheme. The following points were established:

- Albert Quay East to the South Deepwater Berth are currently active working quays under the ownership of Port of Cork.
- The South Docklands within the study area is already substantially defended to a high standard against predicted tidal flood risk by the existing Marina embankment and high ground levels south of the existing quays. The majority of the predicted tidal flood risk in the South Docklands enters via a local low point at Albert Quay East/Victoria Road. This route can be readily defended by a combination of limited road re-grading and defence walls. If these measures were implemented, the South Docklands would be isolated as a discrete flood cell. The above can clearly be seen with reference to the Lee CFRAMS predictive flood maps (see Figure 36 below). This was verified by hydraulic modelling undertaken as part of development of the exhibited scheme.

Figure 36: Extract from Lee CFRAMS Predictive Tidal Flood Map (No. M9/RA/EXT/CURS/001), showing existing defended area within the South Docklands (hatched)



- The crest level of the Marina embankment is generally above the predicted 1 in 200 year tidal flood level, including an appropriate freeboard. The high ground levels immediately south of the existing quays (Kennedy Quay to the ESB Marina Generating Station) are also generally above the 1 in 200 year tidal flood level, however they have insufficient freeboard to fully meet the design standard. If tidal flood defences were to be constructed to the full design standard along these quays:
 - They would be predominantly for the purpose of freeboard only,
 - They would have been over 1km in length,
 - They would severely impact the operational functionality of the existing working quays
 - They may ultimately have been redundant upon redevelopment of the South Docklands area (depending on the nature of the redevelopment which is yet to be determined)

Considering the above, the project Steering Group decided that the appropriate strategy was to limit new defences in this area to localised measures at Albert Quay East/Victoria Road. This would allow the existing properties at tidal flood risk within the South Docklands to benefit from an increased standard of protection, in addition to the level of protection provided by the existing tidal defences along the remainder of the South Docklands as discussed above.

It should be noted that the majority of recurrent flooding which occurs on roads within the South Docklands is related to issues with the existing surface water drainage system (i.e. pluvial flooding). Alleviation of pluvial flood risk is outside the scope of the scheme.

Note that all future, Development Plans, Local Area Plans and development proposals in this area will be required to manage flood risk to an acceptable standard, giving regard to OPW's statutory guidelines¹³, which are already in place within the Planning and Development System.

Downstream of the scheme study area in areas such as Tivoli, Blackrock, Mahon and Little Island etc., the flood risk is predominantly tidal, and therefore the proposed scheme will not worsen the existing situation in any way. Note that the Lee CFRAMS mapping suggests that the number of existing properties at risk in these areas during the design 1 in 200 year event is very low.

¹³ Office of Public Works (November 2009) The Planning System and Flood Risk Management – Guidelines for Planning Authorities

7 Response to Submissions – Site Specific Issues

A number of submissions received raised queries about site specific issues which included access on the Lee Road, Fitzgerald's Park, Grenville Place, North Mall, Sullivan's Quay and South Mall boardwalk.

This chapter addresses queries raised in relation to these areas to provide further information in relation to the proposed design.

7.1 Lee Road Access

7.1.1 Summary of Submissions

A number of submissions were received raising queries or concerns that no flood defence measures were included in the exhibition drawings for the north side of the River Lee, west of the UCC ERI Building on the Lee Road.

The overriding concerns in the submissions are associated with the risk of the Lee Road flooding with the consequence of access/egress being blocked off given the previous flood incidents that have occurred over the years in this area.

The main concerns included:

- Seeking assurances that appropriate infrastructure is included in the scheme to deal with surface and groundwater issues – noting effects from existing streams;
- Concerns associated with the increased flood risk to properties due to the provision of defences on the south side of river, given that there are no defences included in the exhibited plans for the north side of the river along this section of the Lee Road (and associated impacts e.g. property devaluation);
- Concerns similar to above but related to access in and out of properties along the Lee Road and Hollymount – noting access issues encountered in previous flood incidents; and
- Concerns regarding appropriate maintenance of the scheme after completion e.g. non-return valves etc.

7.1.2 Response

Typically, the first priority of OPW flood schemes when identifying areas that require flood defences is to ensure defences are provided for all directly affected dwellings within each flood cell for the design case scenarios. Additional defence measures e.g. to maintain road access during events, is then a second priority and usually assessed on a case by case basis depending on the likely frequency of access issues, importance of road, cost/benefit evaluation and other factors.

In the case of this section of Lee Road, only one property was identified as being at risk for flood events up to the design event. In such cases Individual Property Protection (IPP) is often the most cost beneficial solution and was considered appropriate in this case. IPP measures are not usually included as part of the statutory exhibition drawings but agreed in consultation with the individual property owner as part of the project design development. Hence the reason, this measure was not included in the exhibition drawings.

Whilst it had been recognised that access for the properties on Lee Road and within the Hollymount estate was an issue in the flood scenario, based on information available pre-exhibition it had been understood that alternative vehicle access/egress routes were available to the north via existing lane ways.

However, during exhibition consultation and subsequent investigations it was determined that even though there were potentially viable options for alternative access to the north, the condition of these routes and the private ownership of these routes meant that they were problematic. In addition, whilst a number of properties on the Lee Road border an alternative roadway to the north, the steep change in ground levels mean that it is not reasonably feasible to access these routes.

As a result of the issues raised, and further consideration of the impact of the proposed changes in dam discharges, the OPW now propose that the design in this area be amended to incorporate a flood defence to the Lee Road itself, thus ensuring that the road remains accessible for flood events up to the design standard. Please see Section 9.4 of this report for further detail of the revised design proposal in this area.

All appropriate infrastructure will be included in the scheme as part of the proposed works which will be finalised during the detailed design. Back of wall drainage will be provided behind all flood walls to intercept runoff from upstream and drain the lands appropriately through the line of the flood defence. Where required, non-return valves will be installed at the outfalls of the wall drainage to ensure that flood waters do not enter the drainage system during flood events. Where road re-grading is required, the existing infrastructure will be assessed to ensure it is in compliance with standards i.e. road geometry, drainage, safety restraints systems, etc.

Regular maintenance will be undertaken on all of the infrastructure installed as part of the scheme. The OPW are responsible for maintaining the flood defences walls as well as drainage and pumping stations, which will undergo regular inspections to ensure their structural integrity. A maintenance plan will be developed which will detail the regularity of the inspections over the life span of the infrastructure and when additional inspections are required i.e. after flood events.

7.2 Fitzgerald Park

7.2.1 Summary of Submissions

A number of submissions have raised concerns regarding the proposed works at Fitzgerald's Park.

The recurring theme in relation to FitzGerald's Park was that the connection between the park banks and the river should be maintained at all costs.

Further comments related to how this is one of the last remaining natural floodplains before the Lee enters the city, and how removing this floodplain was going to direct more water to the city centre.

Others concerns in relation to the park included:

- Loss of views and connection to the river;
- Loss of trees;
- View that the park should not be protected

7.2.2 Response

During the scheme design, a number of measures were considered in Fitzgerald's Park, taking into account the key infrastructure, including the playground, the mature trees, the museum/café and the bandstand plaza. The options considered ranged from fully defending the park and all its infrastructure, to not providing defences to the park and allowing it to flood during extreme flood events. The options were developed in conjunction with Cork City Council and a landscape architect which CCC engaged. A number of workshops were held where the technical and aesthetic merits of each option was discussed.

The following primary options were considered for Fitzgerald Park, as illustrated in Figure 37:

- Measure A: Direct defences along northern park boundary.
- Measure B: Direct defences through park following existing footpaths.
- Measure C: Direct defences to the north of Mardyke Walk.

Figure 37: Considered Fitzgerald's Park measures.



A number of variations of these options were also considered, adopting various alignments through the park.

The flood defence option that was exhibited was a variation of Measure A.

To ensure that the views and connection to the river are maintained, glass flood defence walls were to be provided along the proposed elevated footpaths in Fitzgerald's Park, as it is a particularly sensitive amenity area. The earthen embankments for the elevated footpaths will be grassed to preserve the amenity grassland area.

The location of the flood defence walls was developed to provide protection up to the flood defence level while minimizing the landscape and visual impact in Fitzgerald's Park which included minimising the impact on the existing mature trees. Only those trees required to be removed for the installation of the flood defences will be, with the overall aim to retain as many trees as possible. The majority of the Riparian treeline in Fitzgerald's Park will be retained while other treelines can be replanted or reinstated. Mitigation was considered at the design stage, to minimise tree and vegetation loss. Areas containing trees which are the subject of Tree Preservation Orders were avoided. Embankments and walls were moved back from treelines in several locations across the scheme including at Fitzgerald's Park in order to minimise adverse impacts, and paths were designed taking existing vegetation into consideration. Where mature trees are to be removed, these are to be replaced with similar semi mature trees.

While parks and pitches are generally considered suitable as potential floodplains, the use of Fitzgerald's Park as storage has negligible benefit as the potential storage is negligible in the context of the volume of the design flood for Cork. Hydraulic modelling was undertaken on the various potential alignments which confirmed that there is a negligible difference in water levels in the area, between the various alignments. Therefore, the loss of floodplain storage is not a significant factor in choosing a preferred option for Fitzgerald's Park.

Having reviewed the submission received, Cork City Council has acknowledged that whilst the exhibited scheme will result in a change to the Park, it considers that the exhibited scheme remains its preferred choice and that with careful detailing, it will provide an excellent amenity equivalent to the current experience.

Notwithstanding this however, it has been agreed that the Paul Hogarth Company, urban landscape architects commissioned for the project would again review all possible options and revert for discussion of their observations with CCC after their review.

Once a design is finalised for this area, it is proposed to make the finalised plans publically available for information prior to submission of the Scheme for Ministerial Confirmation.

7.3 Grenville Place

7.3.1 Summary of Submissions

A number of submissions have raised concerns regarding the proposed works at Grenville Place. The issues raised may largely be attributed to a lack of clarity in the exhibition documents at exhibition stage, together with the introduction of some incorrect information into the public domain by third parties. This was evidenced by the numerous exhibition submissions which objected to a “2 metre high wall proposed at Grenville Place”. This gives a clear indication that there is some misunderstanding amongst some of the public in terms of what is actually proposed in this area. The parapet wall at Grenville Place will be limited to a safe guarding height of 1.2m above ground level. The main concerns raised at the exhibition stage include:

- Concerns that the parapet wall heights are excessive and will completely block river views.
- View that there is a lack of detail provided regarding the use and finishes of the proposed public plaza area.
- Concerns regarding the building of a new wall in the river channel, particularly in relation to narrowing the channel, and the subsequent impact potential rising river levels may have on bridges along the North Channel.
- Concerns regarding road re-grading along the quay.

7.3.2 Response

7.3.2.1 Original Exhibited Solution

In response to the submission queries above, it is acknowledged that one of the primary factors that contributed to the widespread public perception that the parapet wall heights in this area were excessively high was the production of an erroneous photomontage image where the “Proposed” scenario image was produced based on a camera shot at the incorrect level.

The image therefore shows a proposed view taken at knee height instead of at eye line height. The incorrect image is shown in Figure 37.

A corrected photomontage was subsequently prepared and is shown in Figure 38. This correct image is taken at eye line level for the proposed scenario and illustrates that the relative parapet height is not dissimilar to at present and will ensure that river views will be retained.

In addition to the erroneous project photomontage, a variety of incorrect and misleading photographs and photomontages were put into the public domain and are considered likely to have influenced much of the concern in this area.

Figure 38: Original Exhibited Photomontage of Grenville Place



Figure 39: Revised Photomontage of Grenville Place depicting accurate parapet heights

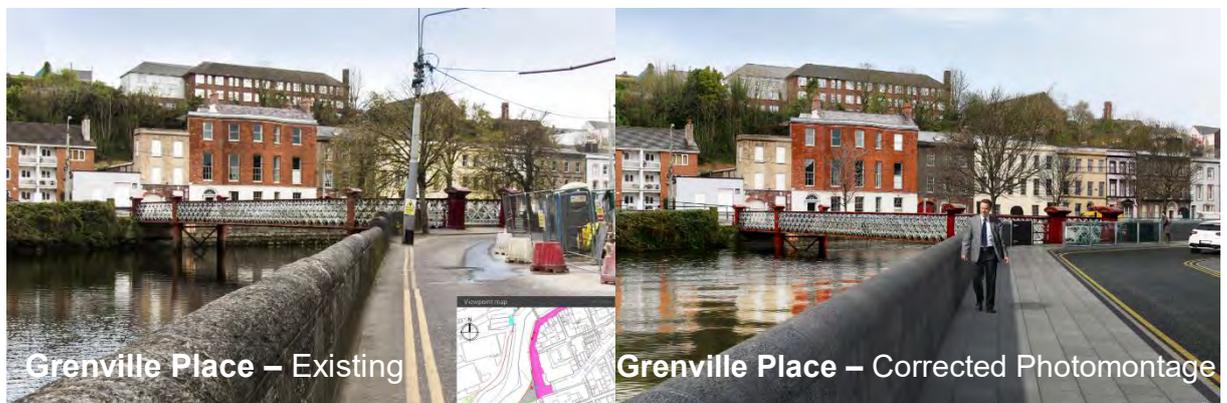


Figure 39 above more accurately reflects the proposed solution at this area. It is clear that parapet heights are kept to a maximum height of 1.2metres. This, coupled with the introduction of a footpath along the river edge will increase the ease at which pedestrians can view the river and thus increase the connection to the Lee in this historic location.

Similar to the above situation regarding parapet heights, a lack of clear photomontages contributed to the concerns raised at exhibition in relation to the proposed plaza area.

Figure 40 below was intended to give the public an impression of the proposed space created and its potential. It was deliberately left as a blank canvas as Cork City Council had yet to finalise the detail of this area, and it was hoped that the public might offer suggestions as to how this area might be treated. For the same reason, paving finishes etc. were left non-descript.

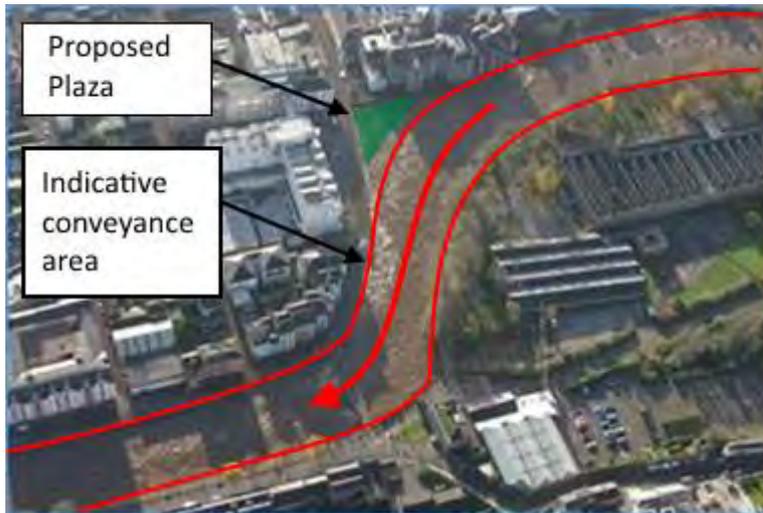
Figure 40: Exhibited Photomontage of Plaza Proposed at Grenville Place



It is intended that the detail in this area will be further developed during the detailed design stage, and it is intended that revised detailed photomontages will be provided to the public for information in advance of confirmation of the Scheme. In this regard, we would note that The Paul Hogarth Company have been engaged to develop an integrated urban landscape plan for this area.

Concerns were also raised in relation to potential increase in river levels due to the construction of the plaza. This is not the case, as the proposed wall alignment has been subject to detailed hydraulic modelling to ensure that it does not significantly reduce the conveyance capacity of the channel at this location. While the proposed wall will involve reclamation of part of the existing river channel, it has been determined that this area currently does not contribute significantly to conveyance capacity. This has been separately verified through observations of past flood events, which showed large zones of slow moving water and eddy currents within the area to be reclaimed. Figure 41 below indicates the approximate extent of the effective conveyance area within this reach.

Figure 41: Image showing conveyance route adjacent to Grenville Place and indicative extent of proposed plaza



The proposed solution along Grenville Place involves the raising of existing road levels in order to achieve the required flood defence level, whilst maintaining a maximum parapet height of 1.2m. Figure 42 illustrates the difference between the existing and proposed scenarios. Figure 43 provides a photomontage of the proposed compared against the existing.

Figure 42: Cross Section of Typical Solution at quays such as Grenville Place

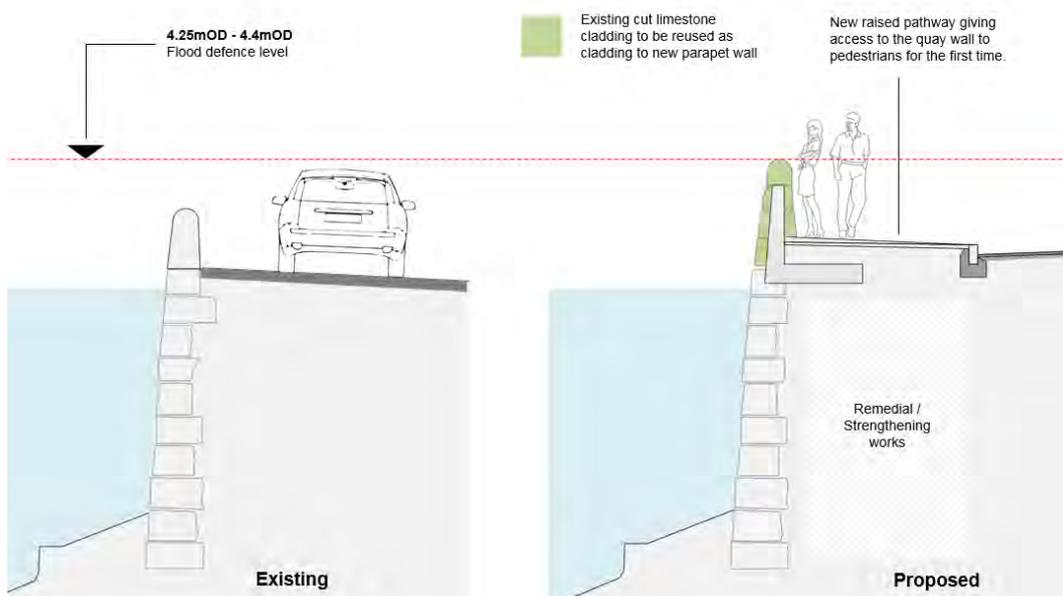


Figure 43: Photomontage of Proposed Solution along Grenville Place



There has been some commentary suggesting that the road re-grading here is a negative and simply hides the impact of the true change. However, OPW would point out that any area needs to be considered in the context of how it will function and be enjoyed as a whole. In the Grenville Place area, it was acknowledged that not re-grading the roadway and footpath would leave the wall height unacceptably high relative to the adjoining ground. It therefore is providing a significant investment to ensure that the potential of the adjoining area is maximised and that the entirety of the area works well together in a holistic way.

Despite some negative response to the proposal along Grenville place, the OPW and Cork City Council remain confident that the exhibited solution remains the best option for this location, increasing the length of riverside walkways in conjunction with the City Centre Movement Strategy, along with creating a large public realm plaza which will be developed further during the detailed design stage. Consequently, no alterations to the Exhibited solution are proposed, other than development of further detail in terms of finishes, soft and hard landscaping, street furniture, lighting etc.

7.4 North Mall

7.4.1 Summary of Submissions

A number of submissions have raised concerns about the exhibited solution at North Mall.

The main concerns include:

- Concerns in relation to whether the scheme results in increased flows and increased river levels in the North Channel post scheme versus at present. In particular, queries as to whether the North Mall currently is at flood risk and whether the scheme will increase the flood risk in this area.
- Concerns about the visual impact the exhibited solution will have on the river views and historical connection to North Mall and impact on historically significant railings and mature trees.
- Concerns in relation to risks associated with bank erosion in flood scenarios due to increased flow.

- Concerns in relation to several existing major sewerage discharges in this area and how the scheme will deal with this issue.
- Impact of the scheme on the bridges along North Channel.

7.4.2 Response

7.4.2.1 Original Exhibited Solution

The North Mall is currently at risk from both fluvial and tidal flooding and a combination of both as shown on Exhibition Drg. LL127, and extract from which is shown in Figure 44 below.

Figure 44: Extract from Exhibition Drawings showing North Mall area at risk of flooding and benefiting from the scheme.



The introduction of the proposed flood forecasting system, proposed washlands and revised dam operating rules will result in a decrease in the design flow reaching the city from circa 861m³/s to 555m³/s. The introduction of the flow control structure on the south channel will also provide flexibility in terms of managing the split of flow between the north and the south channel. Even if the flow control structure is fully closed and all of the flow is directed down the North Channel, the flow at North Mall will be significantly less in the post scheme scenario than at present.

To put this in context, the existing case 1 in 100year fluvial flood level at the western end of North Mall is 4.13mOD (excluding freeboard). In the post-scheme case, the 1 in 100 year fluvial flood level at the western end of North Mall is 3.69mOD (excluding freeboard). This is a reduction of over 400mm, which shows the benefit of the scheme.

While the design flood defence levels in this reach are driven by the fluvially dominated case, including an appropriate freeboard allowance, North Mall is also at risk of tidally-dominated flooding to a slightly lesser degree. In the tidally dominated case, pre-and post-scheme levels are similar for the same combinations of tidal boundaries and flow.

However, due to the effect of the proposed revised dam operational rules on the fluvial flood frequency curve, there will be an effect on tidal-fluvial joint probability in this area. This means that the likelihood of a high tide coinciding with a reasonably high fluvial flow (e.g. during advance dam discharges ahead of forecast fluvial flood) will be slightly increased. This will result in a modest increase in tidal flood levels for similar return periods compared with the existing situation at this location.

However, the critical fluvially-dominated flood levels at this location will still be reduced post scheme versus the current scenario, as a result of the revised dam operation rules.

North Mall did not flood in the major fluvial event of 2009 because the peak flow did not coincide with a high tide. However, North Mall would have suffered significant flooding if the timing had been different.

The lowest level on North Mall is at approximately 2.8mOD. During the majority of major tidal events in the last 20 years, (e.g. 2004, 2014, 2016 etc.), there has not been a significant rainfall event and therefore ESB were able to reduce discharges from the dam during the high tide period, thus significantly reducing the impact of the extreme tides. Again, within the design envelope, this won't always be possible. Therefore, it should be noted that whilst there are no recorded instances of past fluvial or tidal flooding at North Mall, defences are necessary to meet the design standard of the Scheme.

In developing the exhibited scheme design for North Mall, all relevant constraints were reviewed and discussed among the Steering Group, including:

- Health and safety issues,
- Existing mature trees,
- Heritage value of the existing quay wall and railing,
- Traffic, pedestrian and cyclist movements (including proposals for future changes as part of the City Centre Movement Strategy),
- Constructability,
- Costs, etc.

During the scheme design stage, several alternative options were investigated for this area, including:

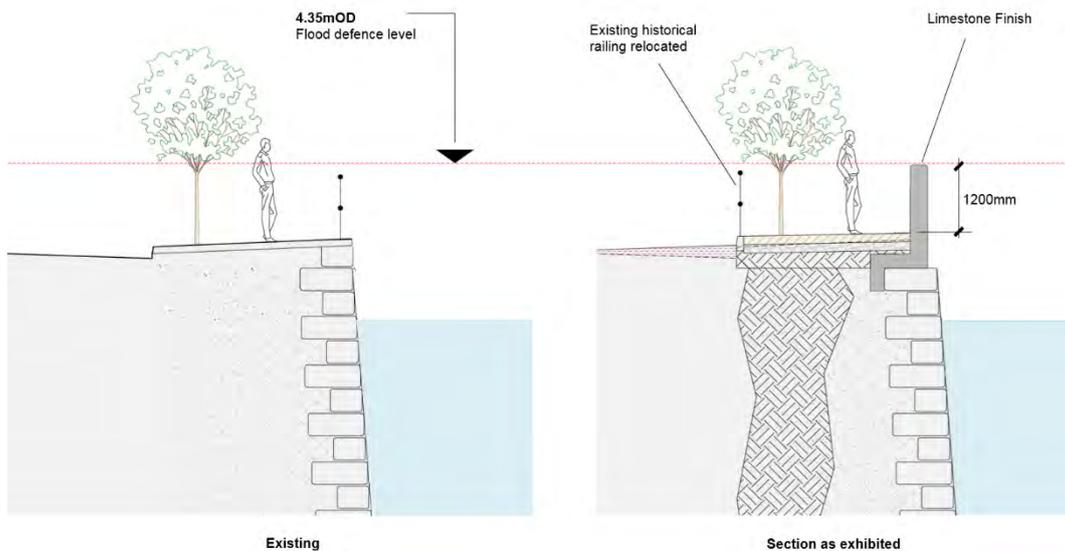
- Road re-grading;
- Setting back a defence wall and keeping the existing railing in place;
- As above albeit with sections of glass defence incorporated; and
- Demountable flood defences.

It was decided by the Steering Group that the solution which achieved the best balance of the above constraints was to set back the existing railing and construct a defence along the line of the existing quay wall.

This was seen to have the benefit of providing a flood defence along the quay while retaining the historic railing in the immediate vicinity of its original location. It was envisaged that some historic information boards could be introduced along the length to describe the history of the railing.

The originally exhibited solution proposed replacement of the existing historic quay-side railing with a 1.2m parapet wall is shown in Figure 18 below.

Figure 45: Existing & Exhibited Section along North Mall



The solution as shown in Figure 45 & Figure 46 would limit the height of the parapet wall to no higher than normal minimum guarding height (1.2m). The proposed parapet wall was exhibited as a fair faced finished concrete. However, it was recognised that the actual finish would need further consideration, particularly in light of comments received from the public and other key stakeholders.

Figure 46: North Mall Exhibited Photomontages



Notwithstanding the above, given the significant amount of submissions received in this area, the Steering Group has now decided that the design in this area should again be reviewed in consultation with the recently commissioned urban landscape and conservation architects (The Paul Hogarth Company and Coey Architects).

Following this review, an alternative solution is being developed which is described below in Section 9.7.

The potential issue of water ingress via the existing bridge decks is well recognised. As part of the proposed scheme, it is proposed to construct low height flood defence parapet walls on Griffith Bridge and Christy Ring Bridge. This will result in the bridge decks being subject to some limited uplift water pressure during the design event. This will be assessed during the detailed design stage, and if necessary, appropriate mitigation measures will be specified.

Non return valves (NRV's) will be fitted on all drainage outfalls into the river to protect against rising river levels backing-up through the drainage system.

Bank erosion is a consideration in all areas of the scheme and will be assessed as part of the detailed design stage. If necessary, appropriate mitigation measures will be specified.

7.5 Sullivan's Quay

7.5.1 Summary of Submissions

Numerous submissions have raised concerns in relation to the exhibited solution for Sullivan's Quay.

The key issues raised include:

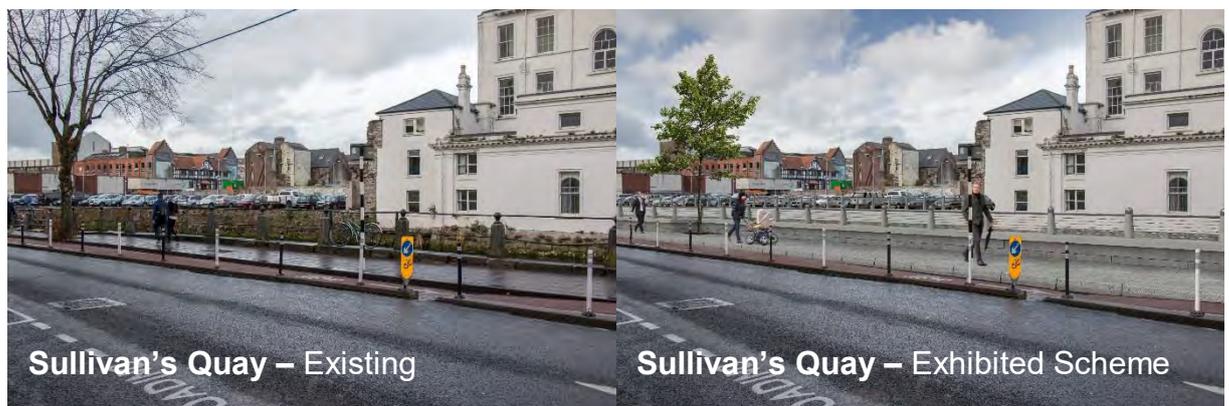
- Similar to North Mall, there were concerns about the visual impact of the exhibited solution in relation to the proposed wall/railing. Concerns regarding the impact on existing river views and requests to retain the historically significant existing railings, limestone flagstones and mature trees.
- Requests to consider creating additional public space along the quay by incorporating a widened footpath into the defence solution with additional seating and/or an 'urban green area'.
- Queries as to whether the redevelopment of buildings along this quay provide an opportunity to develop the area sympathetically and in parallel with the needs of a flood relief scheme.

7.5.2 Response

7.5.2.1 Original Exhibited Solution

The originally exhibited solution along this stretch proposed replacing of the existing quay-side railing with a 300 - 600mm parapet wall with new railing on top, finished with cut limestone cladding to match the quay wall and parapet/quay walls on the opposite bank as shown in Figure 47 below. It was proposed to retain and relocate the existing historical railing to another suitable location in the vicinity.

Figure 47: Sullivan's Quay Existing vs. Exhibited



During the pre-exhibition design process, several alternative options were investigated for this stretch, including amongst others:

- Setting back the defence alignment and retaining the existing historical railing. This also involved creating a widened footpath and improved public realm on the river side of the quay.
- Road re-grading to minimise overall required defence height above ground levels.
- Demountable flood defences along quay and
- As above albeit with sections of glass defence incorporated.

Ultimately, following a review of the advantages and disadvantages, the various constraints, in particular the Health and Safety issues associated with the open existing historic railings (but also trees, traffic, parking, constructability, costs, etc.), and in consultation with the Steering Group, it was agreed to progress based on the option as shown in Figure 47.

The solution would limit the height of the parapet wall to no higher than 600mm (or half height), finished with reclaimed limestone cladding on the exterior side and complete with new proposed railing on top to achieve the 1.2m guard height.

Creating additional public realm space in this area by extending the footpath width was also examined but this solution resulted in a loss of street parking, the creation of pinch points along the quay and had a negative impact on mature trees, consequently it was not favoured over the exhibited solution.

Notwithstanding the above, given the significant amount of submissions received in this area, the Steering Group have decided that this area be again reviewed in consultation with the recently commissioned urban landscape and conservation architects.

Following this review, an alternative solution is being developed which is described below in Section 9.8.

7.6 Rear of South Mall Properties

7.6.1 Summary of Submissions

A number of submissions raised queries in relation to the proposed defence incorporating an extended boardwalk at rear of South Mall properties. Some of the submissions were in favour of the solution, noting it would enhance the area, whilst others raised concerns or objections to the proposal.

Some of the main issues raised included:

- Requests that if the boardwalk were to be implemented it would incorporate:
 - Access from either side (Parliament bridge and Grand Parade).
 - Ability to be closed at night and
 - Further consultation with existing properties regarding the design of access, lighting and security/privacy elements.
- Queries as to whether the proposal would narrow the channel to the effect that it would impact flooding levels upstream.
- Concern that the proposed extended boardwalk would not be in keeping with the character in the area – some noting that the existing boardwalk is considered out of character too and should be removed.
- Concern in relation to interference with Parliament Bridge and
- Concern in relation to potential loss of natural light, privacy, river access and security, and potential anti-social behaviour implications that may be created for existing properties – and associated devaluation of properties.

7.6.2 Response

The solution incorporating the extended boardwalk had originally been determined as a possible solution to simultaneously address the flood defence requirements as well as taking the opportunity to improve the public realm and implement Cork City Council's long term aspiration (in conjunction with proposed improvements as part of the Morrison Island scheme) to create a continuous riverside walk from the Grand Parade Boardwalk through to the Lapp's Quay Boardwalk.

Consultations were carried out with the relevant adjacent property owners ahead of the exhibition to explain possible options.

During the course of these consultations it had been recognised that some of the property owners had concerns or objections to the concept of a future extended boardwalk and it was outlined that whilst a version of it may be exhibited the detailed progression of such a boardwalk would require further consultation and agreement with landowners prior to developing the detail.

The exhibited solution is shown in Figure 48 and Figure 49 below.

In relation to some of the concerns raised during consultations and submissions, the following should be noted:

- As described above, the exhibited solution proposed indicative details for many aspects – including property screening, access points, finishes, lighting preferences, security measures etc. – on the premise that these would be agreed with landowners and other stakeholders during the detail design;
- As the proposed defence scheme incorporates a significant flow reduction on the south channel, flood levels at this location are largely a function of tide level rather than flow and so the proposed wall alignment has a negligible impact on upstream flood levels; and
- Flood defence measures are necessary to protect the properties in this stretch – the proposal was chosen on the basis it achieved the required flood defence whilst achieving best aesthetic and improved public realm. The proposal was chosen so as to match the existing character of the area – boardwalk and railings to match the existing and limestone cladding to match the adjacent and opposite quay walls. The tie-in detail to Parliament Bridge would require careful design to minimise visual impact or disruption to the historic bridge.

Figure 48: Exhibited Solution for rear of South Mall Properties

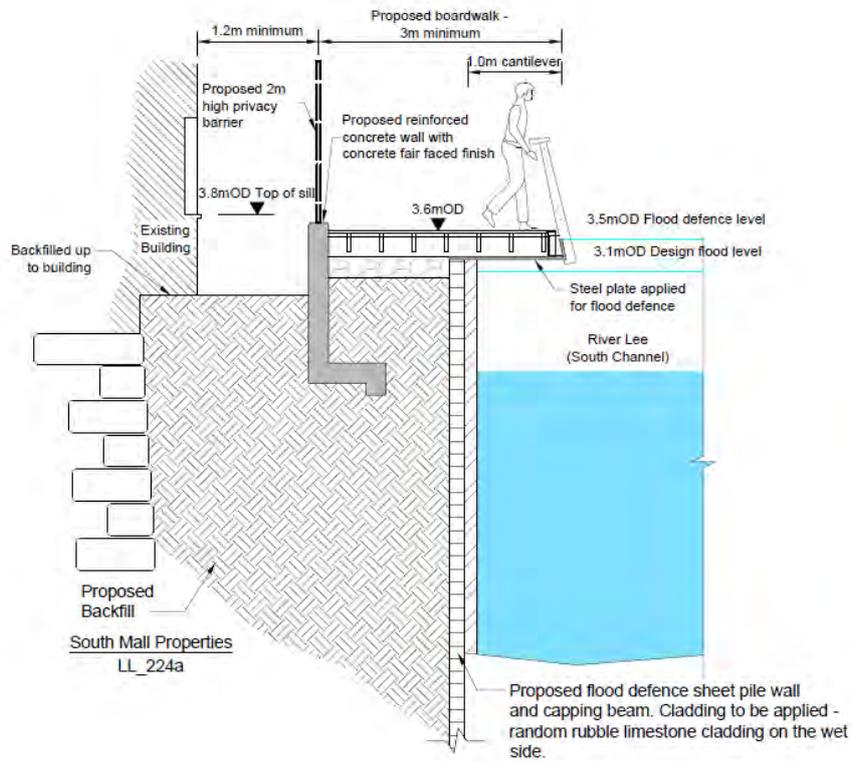


Figure 49: Photomontage of Exhibited Solution for rear of South Mall Properties



Further to the feedback received during the public exhibition and from subsequent submissions, a review of the South Mall Boardwalk was undertaken, following which it has been decided to remove the boardwalk element from the scheme as this element isn't required for the flood defence function. Cork City Council retain an aspiration to develop a boardwalk at this location at a later date following the necessary further consultations and a separate statutory consent process.

Details of the revised solution are provided below in Section 9.9.

8 Response to Submissions on Project Delivery and Governance

8.1 Introduction

A number of submissions have queried the governance and delivery of the project. The main concerns include:

- Concerns about the overall governance of the project including the role of the Government, OPW and local authorities and the appropriateness of the use of the Arterial Drainage Act to deliver the Cork Scheme (and suggestions that the titling of the exhibited scheme as a ‘drainage’ scheme is misleading).
- Concerns about the adequacy/appropriateness of the Project Brief and how and by whom it was formulated.
- Concerns about the adequacy/completeness of the multidisciplinary design approach and teams and requests for an International Peer Review and Expertise.
- Concerns about the adequacy of public engagement/consultation.
- Concerns in relation to the funding commitment to the project and
- Queries and concerns in relation to the issue of flood insurance.

These issues are discussed in the following sections.

8.2 Overall Project Governance

8.2.1 Summary of Submissions

A number of submissions have raised concerns about the overall governance of the project, including the role of the Government, OPW and local authorities and the appropriateness of the use of the Arterial Drainage Act to deliver an integrated flood scheme for Cork (including suggestions that the title of the exhibited scheme as a ‘drainage’ scheme was misleading).

8.2.2 Response

8.2.2.1 Government/OPW Role

The OPW is the state body through which Government exercises its statutory responsibilities in respect of river drainage and flood relief as arise under the Arterial Drainage Acts, 1945 and 1995, and the European Communities (Assessment and Management of Flood Risks) Regulations 2010.

The Lower Lee Flood Relief Scheme is a key deliverable of the National Flood Risk Management programme. The OPW are advancing this scheme as part of its mandate as the lead agency for flood risk management in Ireland.

OPW Flood Defence Schemes are generally carried out under the Arterial Drainage Act 1945 and the Arterial Drainage Amendment Act 1995. The 1995 amendment was enacted specifically to facilitate the delivery of major localised flood relief schemes (as opposed to a near catchment wide land drainage scheme which was the primary remit of the original 1945 Act.)

The OPW either works in association with the relevant Local Authorities or funds Local Authorities directly to undertake flood defence works. With regard to the Lower Lee FRS, the OPW is working in association with Cork City and County Councils as the local authorities and the ESB as one of the main stakeholders and operators of the hydroelectric dams on the system.

The local authorities have an express function under the Arterial Drainage Act:

“5 — (2) Every council of a county to which a copy of a drainage scheme is sent by the Commissioners in pursuance of this section—

.....

(b) shall examine and consider the drainage scheme of which such copy is a copy, and

(c) may, at any time within three months¹⁴ after the date of the publication in the Iris Oifigiúil in pursuance of the next preceding sub-section of this section of the notice relating to such scheme, send to the Commissioners all such observations in regard to such scheme as such council shall think proper.

(3) The duty imposed on the council of a county by paragraph (b) of sub-section (2) of this section and the power conferred on the council of a county by paragraph (c) of the said sub-section (2) shall each be a reserved function.”

In the case of the Lower Lee Scheme, the elected members of both local authorities have passed their respective submissions under the Arterial Drainage Act, in favour of the scheme as exhibited with only minor requests for local variations to be considered.

Having taken on board the submissions received from the local authorities, statutory consultees and the public, the scheme is currently being amended as deemed appropriate to address concerns raised where reasonably possible.

The scheme will subsequently be submitted to the Minister for Public Expenditure and Reform for statutory confirmation under the Arterial Drainage Act.

¹⁴ Note conditional amendment by Section 5 (b) 1995 Act 5.—Where a drainage scheme prepared under section 4 of the Principal Act includes a statement that the scheme has been prepared for the purpose of preventing or substantially reducing localised flooding section 5 of that Act shall have effect, in relation to that scheme, as if the reference in subsection (2) (c) thereof to three months were a reference to one month.

When and if, ministerial confirmation is given, this imposes an obligation on the OPW to deliver the Scheme.

8.2.2.2 Governance Structure.

The overall governance of the project is driven by the Steering Group comprising the key decision makers and stakeholder representatives.

The key Steering Group members include the following organisations:

- Office of Public Works (the client);
- Cork City Council;
- Cork County Council;
- ESB;
- The Engineering Team of Arup in association with JBA Consulting; and
- The Environmental Team of Ryan Hanley and McCarthy Keville O’Sullivan.

The Steering Group has coordinated closely and met on a regular (generally monthly) basis throughout all of the key project phases since the inception of the project. This regular coordination has led to greater collaboration and efficiency in the decision making process through the project.

In addition to the Steering Group meetings, a number of workshops were held throughout the scheme development and assessment stages. These typically consisted of larger groups including representatives from each of the various directorates in the local authorities. These workshops ensured that all aspects of the scheme were carefully considered, e.g. conservation and heritage, parks, environment, planning, architecture etc.

8.3 Project Brief and Scope

8.3.1 Summary of Submissions

A number of submissions raised concerns about the adequacy/appropriateness of the Project Brief and how and by whom it was formulated.

8.3.2 Response

8.3.2.1 Project Brief

The Lower Lee Flood Relief Scheme project follows on from a previous CFRAMS pilot project entitled the Lee CFRAMS. The Lee CFRAMS was undertaken primarily between 2006 and 2012. Cork City and County Council were partners with OPW in delivering the Lee CFRAMS.

In conjunction with OPW, both local authorities were actively involved in numerous public consultations forming part of the Lee CFRAMS including public consultation on the (Catchment Flood Risk Management Plan) CFRMP which identified that direct defences in Cork would form a key part of the solution.

Following on from this, the Briefs for the Lower Lee Scheme were developed by OPW with input from Cork City and County Councils and informed by the public feedback received on the CFRMP. The development of the Project Briefs were also informed by the ESB, as owners and operators of the hydroelectric dams which were also to form a key part of the solution.

Separate Briefs were prepared for the engineering lead design team and for an environmental assessment team.

A decision was made to commission a separate environmental team to ensure that the scheme impacts could be independently identified and assessed.

Both commissions were publically tendered, fully in accordance with both EU and national Procurement rules.

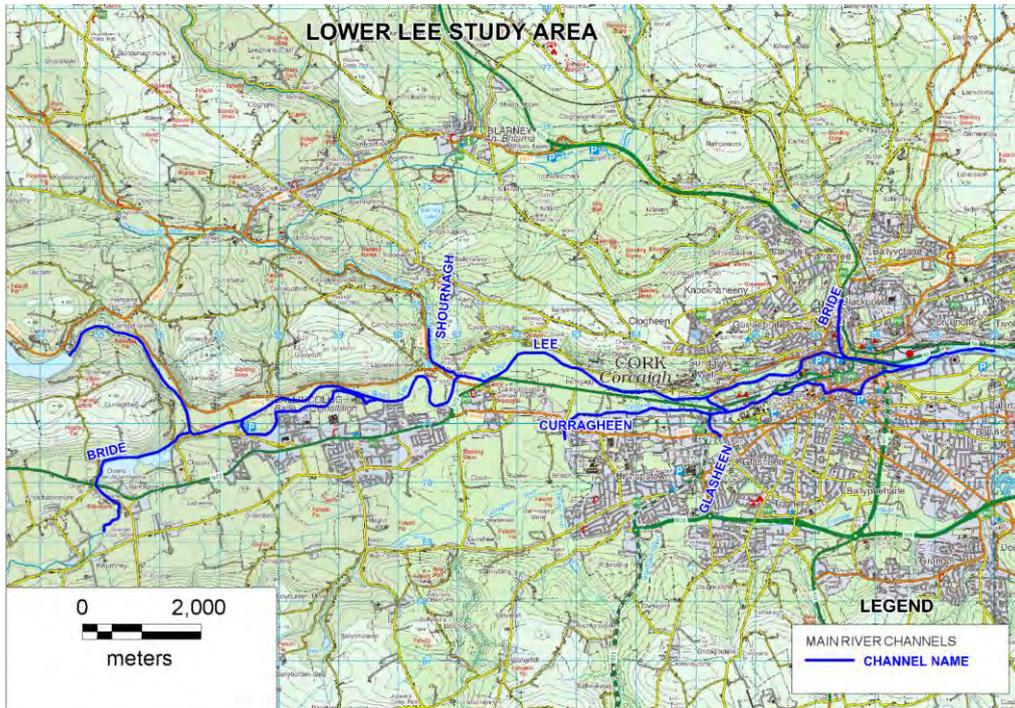
The Project Briefs provided background on the project and details of the work already undertaken in the Lee CFRAMS and its findings.

The stated key objectives of the Engineering Project Brief included the following:

- Design a flood forecasting system for Cork City and the lower reaches of the River Lee (downstream of Inniscarra) to facilitate decision-making on dam discharges and, if necessary, the erection of temporary / demountable defences downstream and in Cork City.
- Assess and develop a viable, cost-effective and sustainable Scheme, to permit greater discharges from the Inniscarra Dam without causing flooding of properties, and to provide protection along the Lower Lee and through Cork City against residual fluvial flooding and flooding from high tides and surge levels, etc. having regard to the preferred option from the Lee CFRAM Study.
- Bring the preferred Scheme to formal Public Exhibition through the Arterial Drainage Acts. Ascertain the public's view of the proposals. Consideration of observations received and the making of possible amendments to the Scheme. Prepare the Scheme for Confirmation by the Minister for Finance.
- Undertake the procurement of a works contractor to construct the Scheme and supervise the contract and construction works.

The Study area is shown in Figure 50 and was defined as *'All areas potentially prone to flooding from the River Lee downstream of the dam from the Inniscarra Reservoir to the discharge of the River Lee into Cork Harbour adjacent to Pairc Uí Chaoimh. Tributaries prone to flooding due to a backwater effect from the River Lee shall also be included.'*

Figure 50: Study Area



The key components of the Brief for the environmental consultants included undertaking a Constraints Study, environmentally assessing the potentially viable options, and preparing an EIS for the preferred flood scheme.

The environmental consultants were required to have expertise in all key areas requiring assessment as part of the EIS preparation. This included for example expertise in ecology, cultural heritage, landscape and visual etc.

8.4 Adequacy of the Design Team and Design Approach

8.4.1 Summary of Submissions

A number of submissions have raised concerns as to the appropriateness of the design approach and the make-up of the steering group and design team.

Due to the scale of disciplines required for a project of this complexity, concerns have been raised regarding the qualifications and relevant experience of consultants involved in the project. There have also been a number of requests for an international peer review to be undertaken.

8.4.2 Response

8.4.2.1 Previous CFRAM Study

Prior to the appointment of consultants for the Lower Lee FRS, the Office of Public Works and its partners, Cork City Council and Cork County Council, had undertaken a catchment-based flood risk assessment and management study of the Lee Catchment (River Lee, its tributaries and Cork Harbour) – the Lee Catchment Flood Risk Assessment and Management (CFRAM) Study.

The Lee CFRAM was undertaken and published in January 2014 by an international team lead by Halcrow Group with support from Marcon Computation International Ltd, J B Barry & Partners and Brady Shipman Martin. Halcrow were a recognised international leader in the area of flood risk management.

The Lee CFRAMS assessment took place over approximately 5 years and was prepared to meet the requirements of the then National Flood Policy. It also to a large extent met the requirements of the EU Floods Directive which was enacted during the course of the study. It identified a programme of prioritised studies, actions and works (both structural and non-structural) to manage flood risk in the Lee Catchment both now and into the future. In addition, as the primary pilot project for the national CFRAM Programme, the outputs and recommendations of the Lee CFRAM Study informed the process and methodologies for undertaking the current programme of CFRAM Studies throughout Ireland.

The possible flood risk management options highlighted in the Lee CFRAM Study were reviewed and considered as part of the Lower Lee FRS and provided a detailed starting point.

8.4.2.2 Lower Lee FRS - Core Engineering Design Team

The design team for the Lower Lee FRS is comprised of a multidisciplinary team, which have provided their expertise during the development of the project and the proposed design.

Following the public tender competition, Arup in association with JBA Consulting were commissioned by the OPW in 2013 as the engineering consultants for the project.

Arup is an international consultancy that provides integrated, holistic and sustainable solutions to help developers, local authorities, government agencies and infrastructure operators to understand and manage flood risk. Arup has drafted national guidance for CIRIA (Construction Industry Research and Information Association) in the UK, worked closely with the UK Environment Agency for many years and supported flood management authorities such as the Regional Water Management Boards in Poland.

While managing the risks of flooding is the main priority on flood relief schemes, Arup also works to enhance both the built and natural environment for people and wildlife which is evident on the Connswater Community Greenway and East Belfast Flood Alleviation Scheme in Northern Ireland that will reduce flooding risk for 1,700 homes and businesses, while increasing the biodiversity and natural aesthetics of the waterway. Arup have acted as lead engineering consultants for a number of other similar schemes in Ireland and the UK which have been completed successfully. These include the Mallow flood relief scheme and the Dodder flood relief scheme.

JBA Consulting is a leading environmental, engineering and risk management consultancy and is at the forefront of Flood Risk Management in Ireland. JBA brings experience of completing Flood Mapping Studies, Flood Risk and Management Strategies (FRAMs), Strategic Flood Risk Assessments (SFRAs), Catchment Flood Risk and Asset Management Plans (CFRAMs), Flood Risk Assessments (FRAs) and detailed understanding of land use planning to each and every project. JBA Consulting, was in fact established in Ireland in 2007 on the foot of writing the development planning guidelines “The Planning System and Flood Risk Management” for DoEHLG and OPW.

8.4.2.3 Lower Lee FRS - Environmental Team

Following a public tender competition, Ryan Hanley Consulting Engineers and McCarthy Keville O'Sullivan were commissioned to assess the environmental aspects of the project. Both have significant experience in flood relief schemes.

In addition to the core team, a number of other specialist subconsultants have also been engaged in the project to supplement and add further expertise.

The following fields have been considered and the associated experts involved in the scheme include experts in:

- Air Quality
- Archaeology & Cultural Heritage
- Ecology
- Engineering – Civil, Structural, Transport, Geotechnical, Maritime, etc.
- Human Beings
- Landscape
- Material Assets
- Socio-economic
- Soils & Geology
- Water

8.4.2.4 Input from Steering Group

The work of the design team has been undertaken in close collaboration with the OPW, Cork City and County Councils, the ESB who all sit on the project steering group.

The Steering Group has coordinated closely and met on a regular (generally monthly) basis throughout all of the key project phases since the inception of the project. This regular coordination has led to greater collaboration and efficiency in the decision making process through the project.

Cork City Council was fundamental to the decision making process for crucial aspects of the project such as finishes, alignments, compatibility with public realm improvements and general approaches to the solutions. The three key areas of focus were the city centre quays, the amenity areas of Lee Fields and Fitzgerald Park and the east west public “Greenway” through the city.

In terms of the city quays, the City Architect and Heritage/Planning departments liaised closely with the design team to agree preferred railing and finish details for each area, taking into account the particular setting, heritage and amenity value of each area. This ensures that the flood defence element are integrated in a holistic way into the setting and add value to the city.

Multiple detailed workshops were held between Cork City Council and the Steering Group to agree preferred approaches – for example the required finishes on each quay, road re-grading and other critical decisions that affect the look and feel of the city centre.

In terms of the Lee Fields and Fitzgerald’s Park, the City Council also engaged the services of a specialist landscape consultant in order to help shape the preferred design solutions through the western areas. It was recognised that these areas form some of the most sensitive and important areas of the city and it was critical to arrive at the correct solution. The design team liaised with the City Council and its landscape architect to incorporate significant aspects of the overall long term landscape and amenity strategy as part of the proposed scheme.

8.4.2.5 Input from Key Stakeholders

Outside of the core design team, statutory consultees have been liaised with during the development of the flood relief scheme as detailed in the Environmental Impact Statement. The consultees are the organisations responsible for their respective fields in Ireland, some examples of which include: government departments such as National Monuments Service, National Park and Wildlife Service and the Department of Jobs, Enterprise and Innovation; Fáilte Ireland who are the National Tourism Development Authority; An Taisce who work to preserve and protect Ireland's natural and built heritage; statutory bodies such as The Heritage Council; and local interest societies such as the Cork Historical and Archaeological Society. All statutory consultees are invited to provide feedback in their respective capacities on the proposals during the design process which are incorporated into the design and provide another source of expertise for the scheme.

8.4.2.6 Additional Specialists for Detailed Design Element

Following the exhibition stage, the level of detailed work increases significantly as the finer detail of the scheme is development. To assist with this work, an urban landscape/public realm architect and a conservation architect have been engaged to supplement the team with particular focus on the integration of the flood defence elements into the existing historic city and public realm spaces.

Following a tender competition, the Paul Hogarth Company in association with Alastair Coey Architects have been appointed, and have now commenced their work.

8.4.2.7 Project Design Chronology and Approach.

Assessment and management of flood risk in the Lee catchment commenced in 2006 through the Lee CFRAMS. Whilst this preceded the 2007 Floods Directive, the approach adopted was entirely consistent with the principles of the Floods Directive which seeks to address flood risk at a catchment rather than a local scale. For this reason, the Lee CFRAMS examined potential solutions at a number of scales from catchment wide solutions such as a catchment flood forecasting system, harbour wide solutions to tidal flooding such as a tidal barrier, to local solutions in each discrete urban area at risk.

The recommended Lee CFRAMS solutions for Cork City consists of solutions at varying scales for example, the catchment wide flood forecasting system, revised use of the ESB dams for the entire Lower Lee area to the direct defences in the city itself.

Notwithstanding that the Brief for the Lower Lee FRS was to build upon the findings of the Lee CFRAMS, the design again examined the findings of the Lee CFRAMS, undertook an entirely fresh hydrological analysis for the entire catchment and undertook fresh hydraulic modelling. It subsequently reassessed the long list of potential solutions, again at a number of scales in accordance with the Floods Directive.

The exhibited solution was developed with input from a vast range of diverse specialists within the engineering design and environmental teams, as well as OPW, all of the various directorates of Cork City Council, Cork County Council, the ESB and other key stakeholders such as Port of Cork, Cork Chamber of Commerce and many others. It is evident that an array of multidisciplinary skills have informed the selection and design of the scheme now proposed.

The Scheme exhibited in 2016 was the culmination of over 10 years of study on the Lee, in conjunction with the many stakeholders and following numerous public consultation processes and events over that time.

It is evident from the above that the approach adopted is entirely in compliance with legislative requirements such as the Floods Directive and the Arterial Drainage Act, based on international best practice, in close collaboration with the many key stakeholders, landowners and the public, and having carefully considered the wider impacts and benefits in terms of the economy, the environment and society.

Further to the comments received in the submissions from the public exhibition, a number of further studies have been undertaken and reports prepared to provide further information and assurances to the public that this solution is the most appropriate and cost effective scheme for Cork.

8.4.2.8 International Peer Review

As already noted above, the precursor to this project, the Lee CFRAMS was undertaken by a consortium led Halcrow, a recognised international leader in the area of flood relief. Its work was supervised by OPW, the lead agency for flood relief in Ireland, itself having a wealth of expertise in this area. Both local authorities were also actively involved in the project. The Lee CFRAMS identified a direct defence scheme in Cork as the optimum solution for Cork.

The Lower Lee FRS is being undertaken by Arup, one of the largest international consultancy firms in the world, in conjunction with JBA Consulting, who also have significant international experience.

All aspects of the design undergo detailed internal reviews by the design team before being presented to the steering group for review and approval. All aspects of the design are in accordance with best practice and current guidelines. In addition, at key stages of the project, Arup have held project reviews where the design was assessed by senior international experts in the area of flood risk management, who are independent of the project team. This ensures that international as well as national expertise is brought to bear.

An international peer review has been carried out, of the implementation of Flood Risk Management Policy as led in Ireland by OPW. This review was carried out by a Risk Review team appointed by the Dutch government. A key finding of the review was as follows – “The review team concludes that Irish FRM complies with international best practice. The international benchmark shows that Irish Flood Risk Management follows international best practices.” A copy of the review is available to view at the following website address <https://www.opw.ie/en/media/drr-team-peer-review-report.pdf>

A number of submissions have suggested that the proposed scheme no longer represents best practice and that the Dutch model of making ‘room for the river’ should be adopted. However, we would note that like in Ireland, the Dutch develop the best solution for each given location. Direct defences continue to form a major part of the majority of Dutch schemes. All options have been considered for Cork and the proposed scheme represents the best solution.

Following over 10 years of study by OPW, Cork City and County Council, and a number of international consultants (expert in the delivery of flood relief schemes), all studies have arrived at essentially the same conclusion with regard to the optimum solution for Cork. In this time, Cork has suffered from a major fluvial flood event in 2009 and significant tidal events, particularly in 2014 and 2016.

The undertaking of a peer review is a lengthy and time consuming process which would further delay the progression and development of the project and would result in properties remaining at risk from flood events due to the lack of vital infrastructure.

Therefore, OPW do not see any merit in undertaking a further international peer review as it is highly unlikely to result in any change to the proposed solutions and would only serve to further delay the delivery of this vital infrastructure.

8.5 Public Engagement/Consultation

8.5.1 Summary of Submissions

A number of submissions were of the opinion that there was inadequate public consultation during the process. The main concerns/queries include:

- The frequency of exhibitions.
- Timing of exhibition – criticism that it was during the holiday period.
- Advertising of the exhibition – not a large enough audience reached.
- Residents with river views (as opposed to owning land affected) should also have received formal notices.
- Online access to documents not sufficient and difficult to access.
- Ineffective exhibition process, consultations and general public engagement.
- Single option presented (completed and decided) with no information on researched alternative options and
- Requests to engage with the local community.

8.5.2 Response

The OPW take a proactive approach to public consultation. It aims to reach as wide an audience as possible and provide them with the opportunity to have their views heard. In response to concerns related to public engagement, the following outlines the extensive consultation process undertaken in relation to a flood relief scheme for Cork since 2006. This includes consultation that was undertaken as part of the Lee Catchment Flood Risk Assessment and Management Study (CFRAMS) project and all the consultation that was undertaken on the Lower Lee FRS project. It will also outline how information has been communicated to various consultees, through the various mediums and forums.

8.5.2.1 Previous project – Lee CFRAMS

The OPW commissioned Halcrow to undertake the Lee Catchment Flood Risk Assessment and Management Study between 2006 and 2014. This project was undertaken to determine the preferred flood risk management options for the Lee catchment.

This project included public consultation to ensure that the public was aware of the study and had sufficient opportunity to express their views and comment on the draft outputs. A series of public information and consultation days were held at key locations around the catchment at the start of the study in December 2006 and in May 2009 when the draft flood maps and preliminary flood risk management options were presented. A total of 11 events were held (seven in 2006 and four in 2009).

The final stage of the consultation process was the publication of and consultation on the draft Catchment Flood Risk Management Plan (CFRMP) and accompanying Strategic Environmental Assessment (SEA) Environmental Report (ER)¹⁵, which were issued for consultation on 1 February 2010. A total of 28 submissions were received during the consultation period from local residents, businesses, government bodies and agencies. Following a review of comments received, and detailed analysis of the November 2009 flood event, the draft CFRMP was amended, finalised and published, together with a post-adoption SEA Statement, documenting how the comments received were addressed. All of the Lee CFRAMS information was contemporaneously available through the project website and continues to be available on the OPW website: <http://www.opw.ie/en/leecframs/>

8.5.2.2 Current Project – Lower Lee Flood Relief Scheme

The Lower Lee Flood Relief Scheme started in May 2013. This project built upon the work undertaken as part of the CFRAMS. Further detail is outlined below on the public information days, statutory exhibition process, engagement with landowners and statutory consultees.

8.5.2.2.1 Public Information Days

The public information days are not a legal requirement in the delivery of flood relief schemes. However these were held to meet OPW's objective of promoting consultation with the public. The purpose of the first public information day was to seek initial views from the public and other interested parties in relation to the key issues that the study should address, and to highlight points of local importance to inform the design of potential flood alleviation measures. The purpose of the second public information day was to gather views of the public about the emerging preferred scheme option in advance of the formal exhibition stage.

¹⁵ SEA Environmental Report:

<http://www.opw.ie/en/media/Lee%20CFRAMS%20SEA%20Environmental%20Report.pdf>

It should be noted that the scheme exhibited at the second PID in July 2014, is essentially the same scheme brought forward to the statutory exhibition stage, although changes were made to reflect views expressed by the public in the consultation event, such as reducing the height of walls and promoting better connectivity with the river. Section 2 details the dates and attendance of the public information days that have taken place.

Table 4: Public information days

Description of Event	Date	Attendance
Constraints stage (Public Information Day)	17 July 2013	44 (lower than expected, exceptionally good weather may have been a factor)
Emerging Preferred Option (Public Information Day)	29 July 2014	181

Brochures and questionnaires were available at the public information days. Stamped addressed envelopes were provided to those who wished to return the questionnaire by post. Information in addition to the questionnaires was also accepted on the day and later by post.

The public information days were regularly advertised in the local printed press and on local radio stations in the week preceding the event.

The events were also well publicised through postings on the websites and social media channels of Cork City Council, Cork County Council and the Office of Public Works, and also via a text alert system operated by the private CorkFloodWatch website.

The public information days provided information on the alternatives considered as part of the scheme design and screening that was carried out.

8.5.2.2.2 Statutory Exhibition and Open Days

The statutory public exhibition was held at four venues across the scheme which was extended from the normal four week duration to account for the Christmas holiday period. While it is unfortunate that the public exhibition was held over a holiday period, the stage of the project determined that the exhibition be undertaken in order to progress the design from the feedback received during the consultation. The extended duration allowed for the same period of time for the public to attend the exhibition as it would if it was not undertaken over a holiday period.

See Section 2.1 for information on the statutory public exhibition and open days.

Formal notification by post of the statutory exhibition and the open days was sent to property owners with land affected by the proposed works as per the statutory requirement. Adjacent property owners or residents with river views did not receive formal notification however the dates were publicised on the project website, local newspapers, radio and local authority social media channels.

8.5.2.2.3 Response to Observations/Submissions

The public were invited to submit their observations on the scheme. Further detailed information on the submissions received can be found in Section 3.

Based on the observations received, further detailed information regarding alternative options has been made available and are included as appendices in this report.

All those who made a formal submission at exhibition stage, will receive an individual response to their observations in due course. Where considered appropriate, amendments will be made to the scheme during the design development.

8.5.2.3 Other Consultations

Throughout the scheme design stage of the project, several consultation meetings were held between members of the project team and various interest groups, including the Cork Business Association, Cork Chamber of Commerce, the Cork City Public Participation Network, the Save Cork City group and other key stakeholders, such as UCC, Meitheal Mara, Search and Rescue teams, Port of Cork.

A number of workshops were held with the Cork City Council directorates – including representatives from traffic and transport, heritage, public lighting, architecture and planning.

There has also been extensive individual landowner consultation – approximately 120 individual landowners were consulted. Where landowners have had concerns, further follow-on meetings were held and this will continue throughout the scheme.

Numerous presentations have been given to the public, key stakeholders and government representatives.

Table 5 provides a list of presentations given as part of this scheme.

Table 5: Lower Lee (Cork City) Flood Relief Scheme Presentations

Description of Event	Date	Audience
Lower Lee (Cork City) Flood Relief Scheme (including Blackpool) Flood Risk Management Conference 2014	February 2014	Attendees at conference organised by Cobh and Harbour Chamber
Lower Lee (Cork City) Flood Relief Scheme (including Blackpool and Ballyvolane) Emerging Preferred Option Presentation to Public Representatives	July 2014	Public Representatives
Lower Lee (Cork City) Drainage Scheme Statutory Exhibition Presentation to Elected Representatives	December 2016	Elected Representatives
Lower Lee (Cork City) Drainage Scheme Exhibition Design	December 2016	OPW

Description of Event	Date	Audience
Lower Lee (Cork City) Drainage Scheme Presentation to Oireachtas Members	February 2017	Oireachtas Members
Lower Lee (Cork City) Drainage Scheme Presentation to Lord Mayor	10 March 2017	Public Meeting
Lower Lee (Cork City) Drainage Scheme Presentation to Cork County Council	20 March 2017	Presentation to Cork County Council
Lower Lee (Cork City) Drainage Scheme Presentation to Cork Chamber of Commerce and Cork Business Association	March 2017	Presentation to Cork Chamber of Commerce and Cork Business Association
Lower Lee (Cork City) Drainage Scheme Presentation to UCC Engineering Department	March 2017	UCC Engineering Department
Lower Lee (Cork City) Drainage Scheme Presentation to Cork City Public Participation Network	6 April 2017	Cork City Public Participation Network
Lower Lee (Cork City) Drainage Scheme Presentation to IBEC	18 May 2017	IBEC
Lower Lee (Cork City) Drainage Scheme Presentation to Minister of State, Kevin 'Boxer' Moran T.D.	25 July 2017	Minister of State, Kevin 'Boxer' Moran T.D.
Lower Lee (Cork City) Drainage Scheme Presentation to ICOMOS	13 September 2017	ICOMOS

8.5.2.4 Further Consultation

Public consultation will continue as the design develops. This includes individual landowner consultations.

8.5.2.5 Project Information Accessibility

A dedicated website to make details of the Lower Lee (Cork City) Flood Relief Scheme went live at the time of the first PID. The website address (www.lowerleefrs.ie) was widely publicised at the PID, and attendees were informed that all information on display at the public exhibition, including brochures, posters, questionnaires, etc. would be available for download from the website.

It is intended to keep the website live for the duration of the scheme, including throughout construction, and for it to become a destination for interested members of the public to get project information and news and where project documentation can be made available for download.

The Scheme schedules, drawings and plans were made available for inspection by the general public for the exhibition period as described above.

An interactive display was available at the Exhibition for the public to use. This was an interactive pdf which allowed the user to navigate through the scheme details. The desktop screen opened with a map of the full scheme extents, which allowed the user to click on the area of interest.

Once they were zoomed in to their selected area they could click on the labelled photomontages and sections and these would be displayed. This was mentioned by members of the public as being a very useful tool.

8.5.2.6 Name of Scheme

A number of submissions have raised concerns that the name of the scheme as per the Exhibition, the Lower Lee (Cork City) Drainage Scheme, is inappropriate for a project for flood relief.

The statutory name of the scheme is a function of the legislative delivery of the project which is being carried out under the Arterial Drainage Act.

In all of the other communications with the public and stakeholders, including the previous PIDs, the website and the various reports, Hydrology, Hydraulics, Options Report, EIS etc., the Scheme title was either the Lower Lee (Cork City) Flood Relief Scheme or the Lower Lee (Cork City) Drainage Scheme with the subtitle Flood Relief Scheme.

8.6 Funding Sources

8.6.1 Summary of Submissions

A number of submissions have requested more information on the funding arrangement for this project. Queries include sources of funding, consideration of alternative funding sources and the basis of budget for the scheme.

8.6.2 Response

8.6.2.1 Funding Sources

The design and construction of this scheme will be funded primarily by the State through the OPW, which is, a publically funded body that is responsible for flood risk management in Ireland. Provision has been made for the implementation of the Scheme in OPW's Multi Annual budgets over the period to 2025.

In discrete areas, e.g. Morrison's Island, supplementary funding is being provided by Cork City Council for public realm enhancements to take advantage of the synergies with the flood defence works, and thus avoid the need for future disruption in these areas.

For Schemes delivered under the Arterial Drainage Act, the OPW have a statutory obligation to maintain such schemes. The maintenance work is generally undertaken by the relevant local authority as agents of OPW, through a Service Level Agreement, where central funds are provided to the local authority to appropriately discharge this obligation.

8.6.2.2 Scheme Budget

All public projects funded by the tax payer have to take cognisance of the relative costs and benefits of a scheme to ensure that the project is cost beneficial and offers value for money.

In order to assess this, an economic assessment of the options was undertaken as part of the options assessment and included a Cost benefit Analysis. See Section 13 and 18 in the Options Report for further details.

In addition to the incremental reduction in flood risk and impacts during construction, the project is proposed to be phased to ensure that the works align with available State funding budgets and that the contract values are of a scale that allows sufficient competition amongst suitable civil engineering contractors.

The budget is based on the estimated cost of the project work elements plus appropriate additional amounts to provide for such things as fees, compensation, and maintenance over the life of the scheme and contingencies.

8.7 Insurance

8.7.1 Summary of Submissions

A number of submissions have requested more information on whether flood insurance will be available to all households following completion of the scheme.

8.7.2 Response

The scheme has been designed to a Standard of Protection (SOP) that is an internationally recognised standard and is the standard adopted nationally on the majority of OPW schemes. It is also the standard generally being requested by the Insurance Industry. This SOP is:

- 1% Annual Exceedance Probability (AEP) Fluvial (1% chance of occurrence in any given year or often known as a 1 in 100 year event)
- 0.5% AEP Tidal (often known as a 1 in 200 year event)
- Most Onerous Combination of tidal and fluvial events with AEP equivalent to the above.

Flood gates and demountable barriers have been kept to a minimum in the scheme insofar as possible due to the increased operational / maintenance burden and residual risk associated with such barriers compared with passive defences.

To assist insurance companies assess the risk and take into account the protection provided by completed OPW flood defence schemes, the OPW has a Memorandum of Understanding with Insurance Ireland, the representative body of the insurance industry.

This Memorandum sets out principles of how the two organisations work together to ensure that appropriate and relevant information on these completed schemes is provided to insurers to facilitate, to the greatest extent possible, the availability to the public of insurance against the risk of flooding. Insurance Ireland members have committed to take into account all information provided by OPW when assessing exposure to flood risk within these protected areas.

However, the decision on whether to offer insurance, the levels of premiums charged and the policy terms applied are matters for individual insurers. Insurance companies make commercial decisions on the provision of insurance cover based on their assessment of the risks they would be accepting on a case-by-case basis.

9 Recommended Changes to the Scheme to be Considered

Following review of the feedback and submissions received during the public exhibition period, a number of changes are now proposed to the scheme. The changes are proposed, having taking on board suggestions made by the public and affected property owners, where deemed appropriate.

This chapter sets out the primary changes proposed to the scheme as a result of the Exhibition Process.

9.1 Localised Amendments to Wall Finishes

Throughout the exhibition and design process, many decisions and revisions regarding wall finishes occurred in an attempt to ensure the completed works would be visually appealing and in keeping with the city's heritage in tandem with its future aspirations.

Throughout the scheme, limestone cladding was predominantly utilised in areas to match surrounding quay wall finishes. In certain other locations, a fair faced concrete finish was proposed. In these locations, the use of a form liner to create a limestone block effect could be implemented to better blend the proposed solution to the existing conditions.

The Paul Hogarth Company in conjunction with Alastair Coey Architects have now been commissioned to provide architectural input into the detailed design of the scheme and in conjunction with Cork City Council's Architects' Department, will again consider all of the proposed finishes. Once this exercise is complete, it is envisaged that drawings and photomontages of the proposed finishes will be made available to the public for information in advance of submission of the proposed scheme for Ministerial Confirmation.

9.2 Promoting River Engagement

A common theme throughout all submissions was that the people of Cork see the Lee as the heartbeat of the city. It is intrinsic to Corkonian life and any promotion of the river would be seen as a major benefit and step in the right direction for the city. Twenty Seven submissions were made by local boating clubs and civilians in relation to promoting river use. Potential improvements ranged from adding mooring rings for boats to creating new access slipways into the river. As a result of these observations, it is proposed to retain a number of access points which were shown to be extinguished in the Exhibition Drawings together with the addition of additional moorings etc. Refer to Figure 24 and Figure 25.

The proposed reconstruction of Albert Quay (west) will also enhance public engagement with the river at this location.

Furthermore, as the scheme is creating/enhancing many riverside walking areas in the city, there is scope to create a “Slí na Sláinte” route along some of the upgraded quays in an attempt to promote and raise awareness of the updated quays.

9.3 Additional Soft Landscaping

The recently engaged urban landscape architects will prepare a scheme wide landscape plan for the scheme.

Soft landscape proposals are informed by detailed site appraisal and by Ecology and Tree Surveys. This has facilitated an understanding of the value of the existing landscape and its associated habitats.

A key principal of the proposals has been to minimise the loss of existing trees/vegetation/habitats. Where loss was agreed to unavoidable, appropriate mitigation has been carefully considered.

Soft landscape proposals fall broadly into two types, those for the more ‘rural/parkland’ areas to the west of the City; and those which are associated with the ‘urban areas’ of streets/quays within the central area.

9.3.1 Rural/Parkland

Proposals minimise the impact on existing trees/vegetation. On the south side of the River Lee, careful alignment of the flood bunds/walls and associated paths minimises the impact on existing vegetation. Within this context, there is significant benefit that can be delivered through a programme of Landscape Management & Maintenance associated with the existing vegetation, particularly along the riparian edge. This will include thinning, removal of invasive species and removal of ivy in the trees.

The profiling of earthworks will be carefully considered, to ensure that they are visually appropriate – natural in their form where that is suitable and ‘sculpted’ as appropriate, but never looking like an ‘engineered imposition’. This is important for the character of the landscape. It is also important in relation to creating environments where planting will thrive and habitats prosper.

Proposals will be developed through close consultation with the Ecologists to optimise the bio-diversity benefits for the area. This will include a predomination of native species. Opportunities for use of wildflower grassland will further add to the ecological value, as well as the visual amenity.

Within the parkland areas, opportunities will be taken to introduce large specimen trees, which will provide immediate visual impact and structure, whether as a line/avenue or as an individual element within the landscape.

9.3.2 Urban Areas

The majority of soft landscape proposals in the urban areas is associated with street tree planting. Using best-practice principles, trees will only be proposed where growing conditions (pit size, etc) can allow the tree to establish and thrive. The street trees will be planted as large semi-mature specimens, using species appropriate to the environment and in line with Council guidelines.

Localised amenity planting will provide structure to spaces and introduce colour and texture into the hard urban environments. Species and sizes will be chosen relative to the visual requirements, the need for immediate impact, resilience and maintenance. These will all be in line with Council guidelines.

9.4 Lee Road

During pre- and post- exhibition assessments and consultations with residents of the Lee Road, it was established that flooding occurs on a regular basis and maintaining a constant safe passage along this road in times of flooding should form part of the scheme. The proposed design displayed at the public exhibition proposed to utilise alternative access routes to the north during flood events. However, during consultation and subsequent investigations it was determined that there were no viable options for providing alternative emergency access to all properties within the area.

Consequently, the OPW made the decision during the exhibition period that flood defence measures should be provided along this stretch of Lee Road to ensure access is maintained during all flood design events (and simultaneously address the flood risk for the property at risk within this area).

Whilst the proposed solution is being developed as part of the detailed design and consultations with the adjacent and benefitting landowners are still ongoing it will generally comprise sections of road re-grading at both the western and eastern ends of the Lee Road in combination with a defence wall along the south side of the road.

As per the indicative sketches below the proposed solution will comprise:

- A flood defence wall along the river side of the road from the Lee Road Clinic on the west through to Phoenix Kayak Club on the east. The wall will be typically between 1.5 and 1.7m in relative height above the road level and is proposed to be clad in limestone rubble cladding to match the existing wall finishes in the area.
- At the western end, the road will be ramped up to flood defence level (increase in approximately 1.5m of height) over a distance in line with typical road grade requirements. The ramp will be placed so as to ensure the Clinic remains inside the defended area.
- At the eastern end, the road re-grading is similarly proposed. The proposal is to keep the crest of the re-grading at the entry to the kayak club (continuing a flood defence wall along the northern boundary to tie in with higher road elevations to the east) to ensure no cut off of the kayak club river access.

The details of the tie in with the kayak club are being developed in consultation with the relevant parties.

- An unavoidable impact of the proposed solution will be the loss of many of the existing trees along the river side of the road. This is being coordinated with the environmental experts on the design team to ensure these impacts are minimised. This impact will be less in the area bounded by the wetlands toward the west where existing trees in the wetlands will still maintain the screening effect.
- Pedestrian and vehicle access points to the existing wetlands area will be reinstated (albeit possibly in alternative location) in the proposed solution.
- As noted in Section 7 – only one property in this reach was identified as being at risk to flood events (allowing for the impact of the proposed defences along Lee Fields south of the channel). The proposed solution will ensure that this property is defended to the full design event and hence no properties will be risk to flood events.

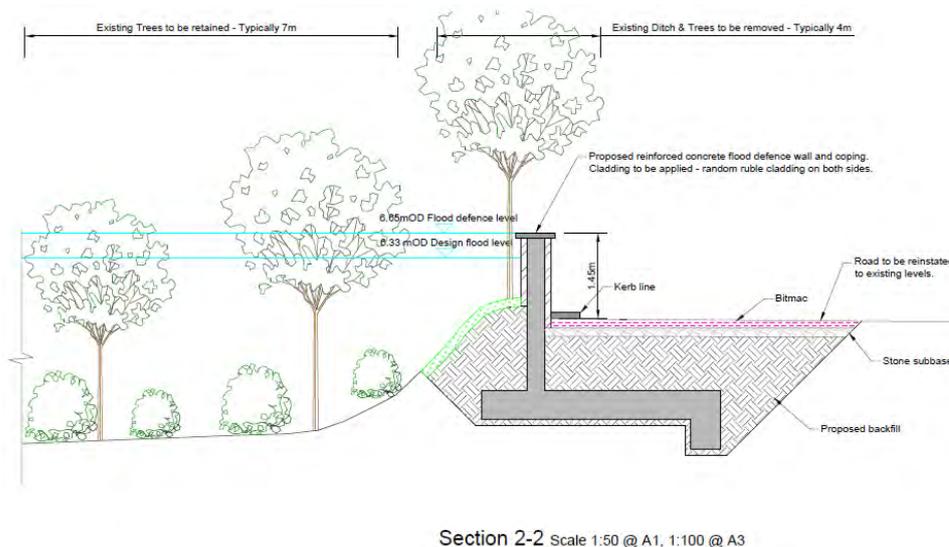
As part of the assessment for this area several alternative defence options were considered (e.g. including potentially raising the entire length of road for the section or installing sheet pile or embankment defence solutions). Ultimately alternative options such as these were determined as less preferred for various reasons including:

- Due to the height of defence required raising the road would require a retaining structure to the same height of the proposed defence wall on the south side of the road. This would result in increased disruption and impact together with significantly greater cost.
- A sheet pile defence was discounted on the basis of increased disruption, environmental impact and cost.
- An embankment defence option had been considered for the section bounding the wetlands area – however was discounted on the basis of complexities of the existing geology, lower topography (and hence increased height required) and increased environmental impacts.

Refer to Figure 51 below for an updated Benefitting Areas drawing (where areas shaded in green indicate area defended against River Lee events up to the 1% AEP Fluvial / 0.5% AEP Tidal).

Refer to Figure 52 to Figure 54 and for plan and section sketches of the proposed additional Lee Road defences.

Figure 54: Section Sketch of Proposed additional Lee Road defences



9.5 Mardyke Riverside Walkway

Further to feedback received in relation to security concerns, it is now proposed to raise the footpath on the wet side of this defence wall to ensure that passive supervision from the south is maintained.

Figure 55 and Figure 56 below show the amended solution at this location. The decision to raise the footpath along the river to the north of the Mardyke arena will help to retain an open aspect to the walkway and help it benefit from a degree of passive surveillance.

While a low retaining wall and railing is shown on the northern edge of the proposed footpath (refer to Figure 56), in locations where more generous areas of riverbank are available, a graded earth edge will be provided instead. This would allow a more open and accessible relationship with the river and remove the need for protective railing (particularly important at the beach area and ramp towards the western end of the walkway).

Where the wall and railing treatment is unavoidable, planting at the toe of the wall will be considered to help minimise the combined (and increased) influence of wall faces on views from Sunday's Well.

Some vegetation removal will be unavoidable and formative works such as crown lifting may also be required due to the raising of ground levels and any construction access requirements. Tree retention and protection will be guided by appropriate arboricultural assessment. The management and removal of ivy from trees (subject to ecological considerations) will also be considered in conjunction with arboricultural work to improve the visual relationship with the river.

This detail will be developed further during the detailed design stage in conjunction with the project landscape architect, The Paul Hogarth Company.

Figure 55: Plan Sketch of Defence at Mardyke Riverside Walkway

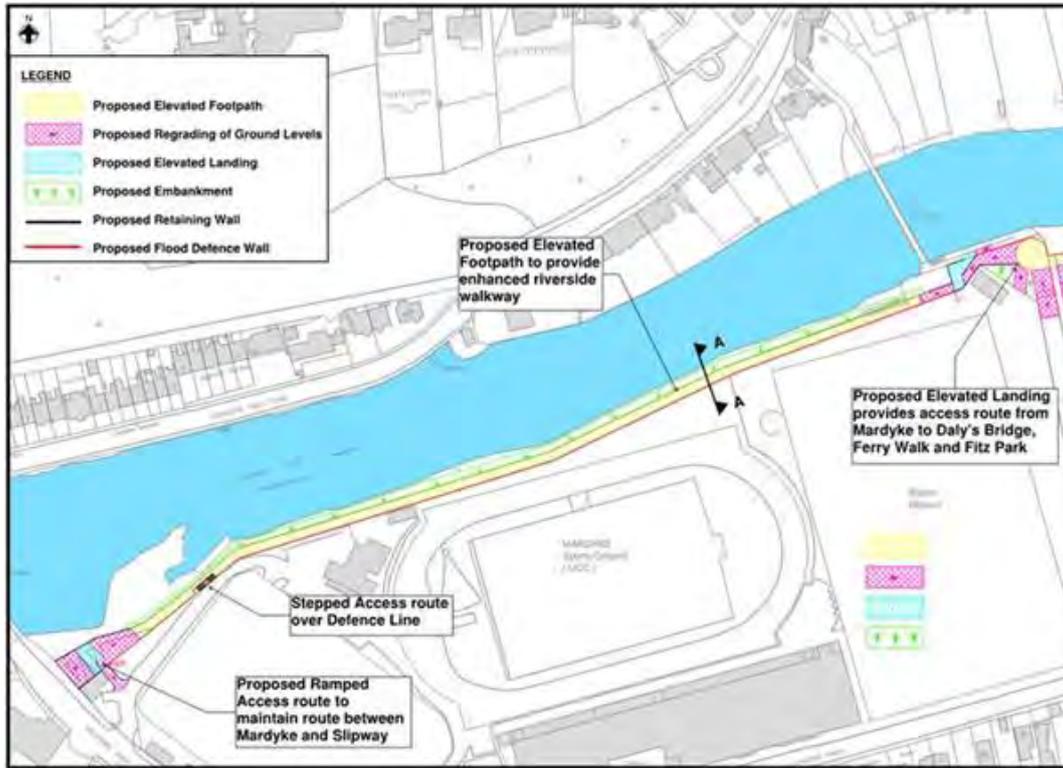
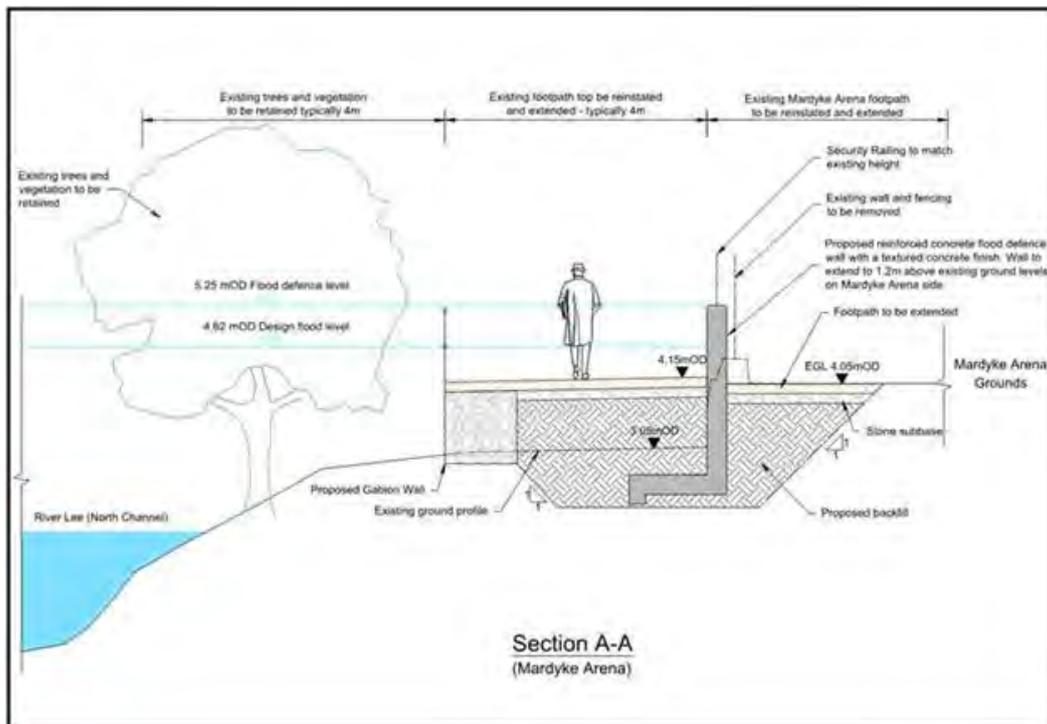


Figure 56: Section Sketch of Amended Defence at Mardyke Riverside Walkway



9.6 FitzGerald's Park

Following feedback received at Exhibition Stage, the proposals for the Park are being considered again by the project team's urban landscape architects in consultation with CCC. The solution here will integrate flood protection into the Park, whilst at the same time creating areas for the Park which deliver increased value and pleasure. In particular, the Rose Garden has potential to be improved, along with the rockery and pavilion.

9.7 North Mall

9.7.1 Revised Alternative Proposal

In light of the submissions received in relation to North Mall, the Design Team have again reviewed this area in close consultation with the Steering Group and have proposed an alternative solution which is considered to allow the existing historical railings and the close connection to the river to be maintained.

Key factors in this design change was the desire to retain the existing mature trees and line of vision between the quay and the river along its full length.

Following the public consultation process, the revised solution now proposed is shown below in Figure 57 and comprises:

- Demountable flood defences set back along the existing kerb line.
- Re-graded road levels at either end to ensure that in the unlikely event of a failure of the demountable defences, flooding would be confined to the limited local area of North Mall.
- The solution as exhibited at the western end tie in to Vincent's Bridge.

It should be noted that the details, finishes and look-and-feel of the solution will be finalised during the detailed design with input from the Design Team, Landscape and Conservation Architect and Cork City Council.

Figure 57: Plan of Alternative Solution.

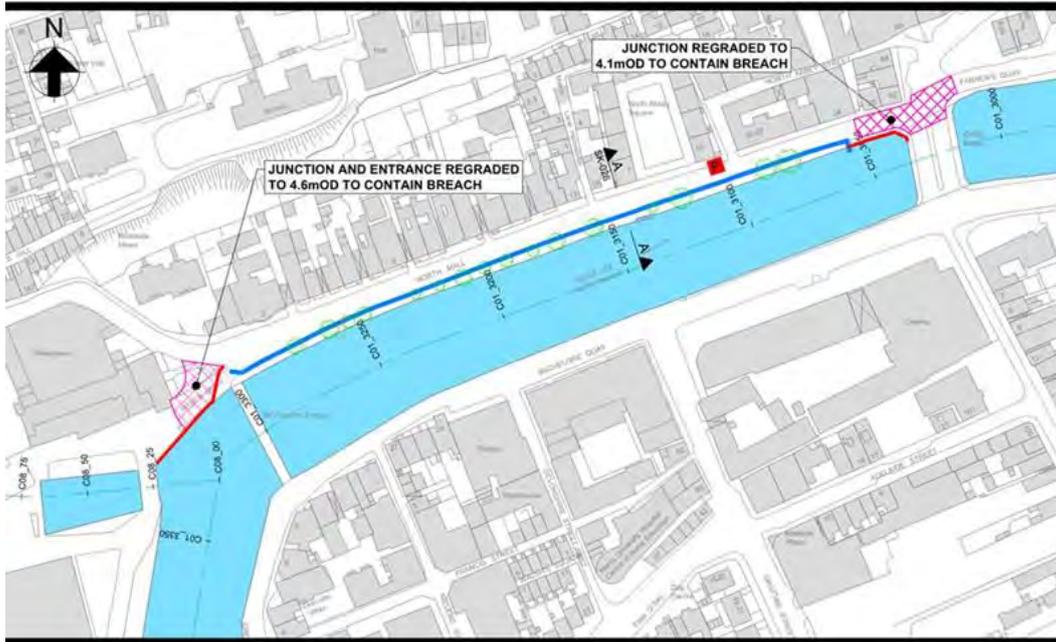
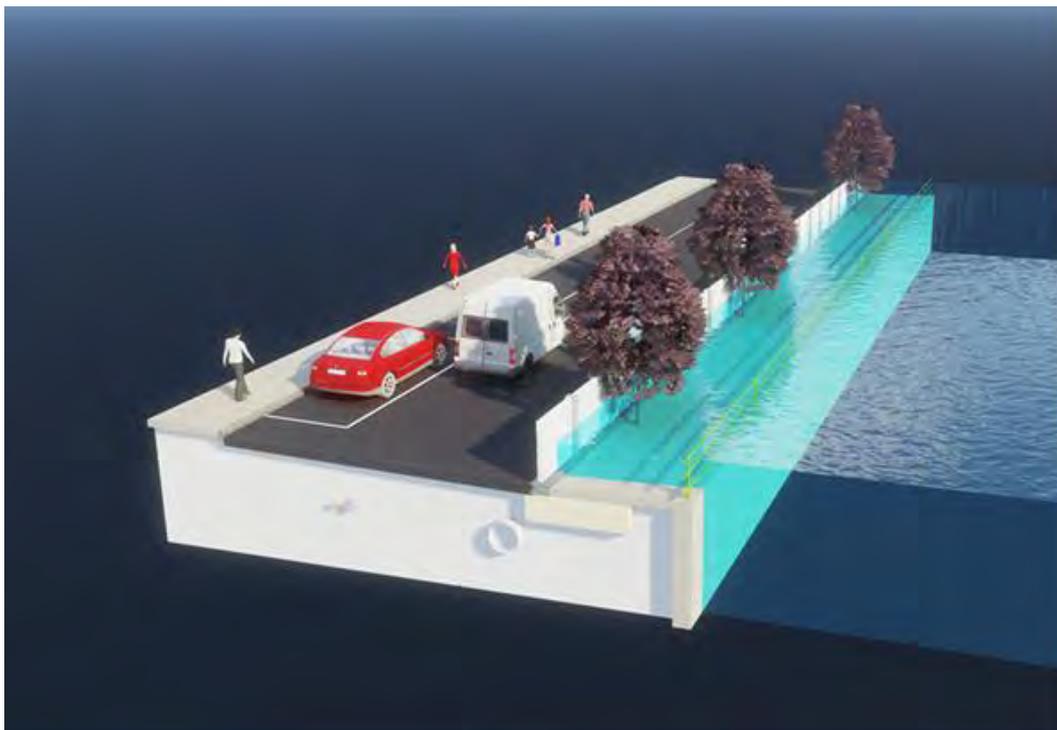


Figure 58: 3D Section of Proposed Alternative Solution in flood scenario



Demountable solutions have generally been avoided where possible on the scheme, due to the higher capital cost, higher maintenance cost and the resources required to erect the demountable barriers during a flood, compared with a passive flood defence wall. However, given the stakeholder feedback which strongly emphasised the heritage significance and unique setting in this area, the Steering Group felt that it would be appropriate to depart from the above approach at this location.

It is felt that the revised solution as shown in Figure 58 and Figure 59 appropriately addresses stakeholder concerns, while balancing all of the constraints outlined in Section 7.4.

9.8 Sullivan's Quay

9.8.1 Revised Alternative Solution

In light of the submissions received for this area, the Design Team has again reviewed this area and, in close consultation with Cork City Council, has proposed an alternative solution which ensures the existing historical railings and the quays close connection to the river is maintained. As was made clear by stakeholder comments during the public consultation, Sullivan's Quay is a highly sensitive area. In order to maintain the historic railings, a solution involving demountable defences is now proposed as shown in Figure 59, Figure 60 and Figure 61 below.

The solution now proposed comprises of:

- Demountable flood defences set back along the road. An alignment is proposed so as to prevent impact to existing railings, quay walls and mature trees and so as to minimise parking loss whilst maintaining minimum widths for one way traffic in all scenarios. The design of this demountable defence may incorporate storage of certain elements of the system on-site, e.g. pull-up vertical posts. This detail will be developed further during the detailed design stage.
- Some minor re-grading to road levels in two locations to ensure that in the unlikely event of a local failure of the demountable defences, any flooding is confined to a limited area.
- The solution retains the historic railings and limestone flagstones insitu.

Figure 59: Plan of Alternative Solution for Sullivan's Quay

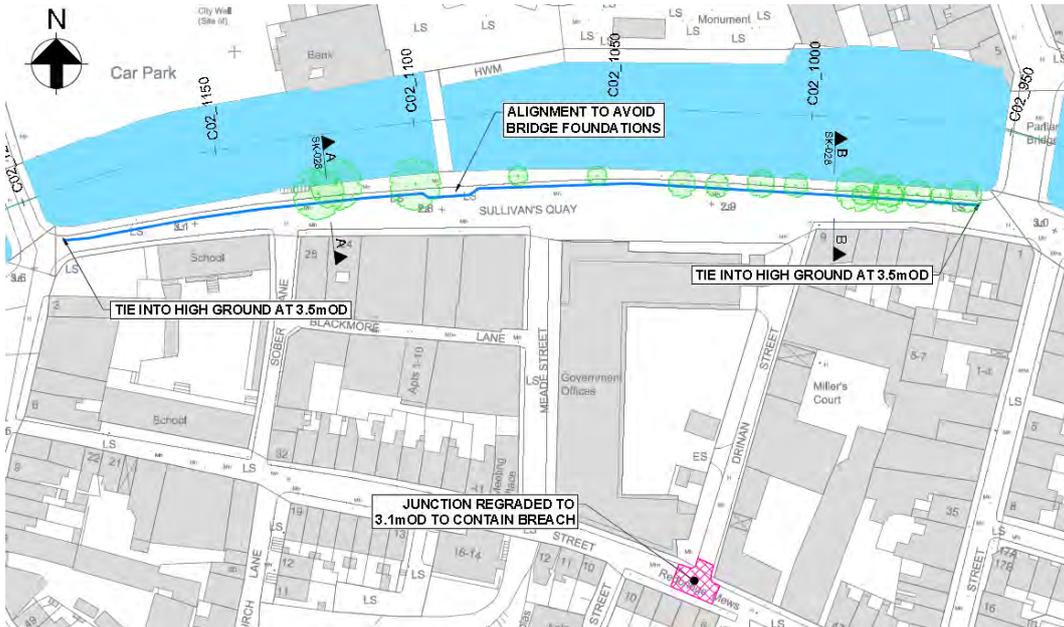


Figure 60: Photomontage of Alternative Solution for Sullivan's Quay west of Nano Nagle Bridge (note demountable barrier to be located along line of concrete median barrier shown)

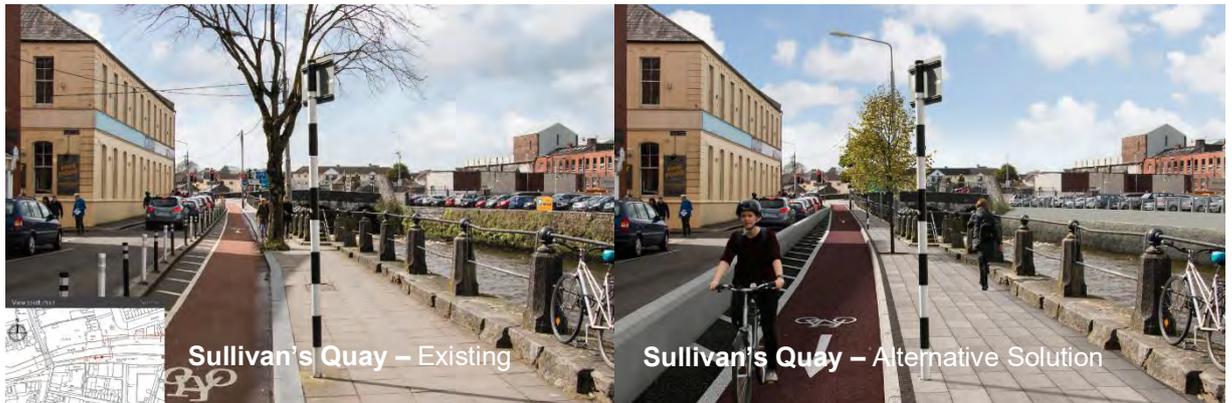
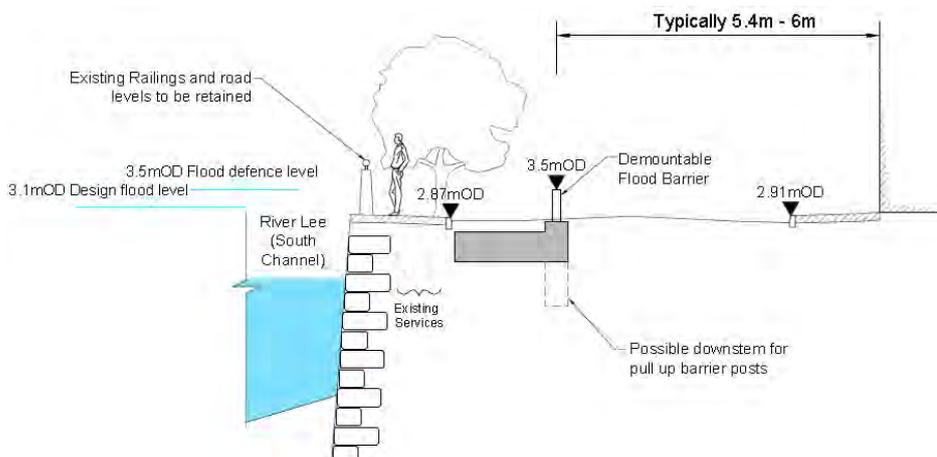


Figure 61: Typical Section of Alternative Solution along Sullivan's Quay (east of Nano Nagle Bridge)



It should be noted that the details, finishes and look-and-feel of the solution will be finalised during the detailed design stage with input from the project landscape architect, conservation architect and Cork City Council.

9.9 Rear of South Mall Properties

Further to exhibition submissions and subsequent review, it has been decided to remove the boardwalk element from the scheme, given that this element is not essential to the function of the flood defence scheme.

The proposed alternative solution will now incorporate a stone-clad sheet pile wall solution along the same alignment as shown at the exhibition stage. The solution will achieve the defence requirements while still being adaptable should Cork City Council decide to proceed with development of a boardwalk in the future, subject to the relevant statutory consent.

Provisions for maintenance access and appropriate security measures will be developed and agreed with Cork City Council. Lighting and privacy issues will be agreed with Cork City Council and the relevant landowners as part of the detail design, with input from the Landscape Architect (The Paul Hogarth Company).

Refer to Figure 62 and Figure 63 below for details of the alternative proposal.

The following should be noted in relation to the alternative proposal:

- Fundamentally the solution ensures the required flood defence level is achieved throughout.
- All finishes and details will be confirmed as part of the detail design with input from the project landscape architect, the project conservation architect and Cork City Council. It is envisaged that the walls will be finished with limestone cladding and coping to match the adjacent quay walls and bridge.
- It is proposed to backfill the reclaimed ground behind the defence to the level of lowest existing property yard. The backfill is proposed to be a landscaped finish to Cork City Council requirements. It is proposed to ramp up ground levels at the western end of the reclaimed ground to facilitate maintenance access from Grand Parade.
- The tie in to the existing boardwalk at the west will facilitate substantial reinstatement of the existing railing while still achieving the flood defence function.

Figure 62: Plan of Proposed Defence Alignment along South Mall Properties

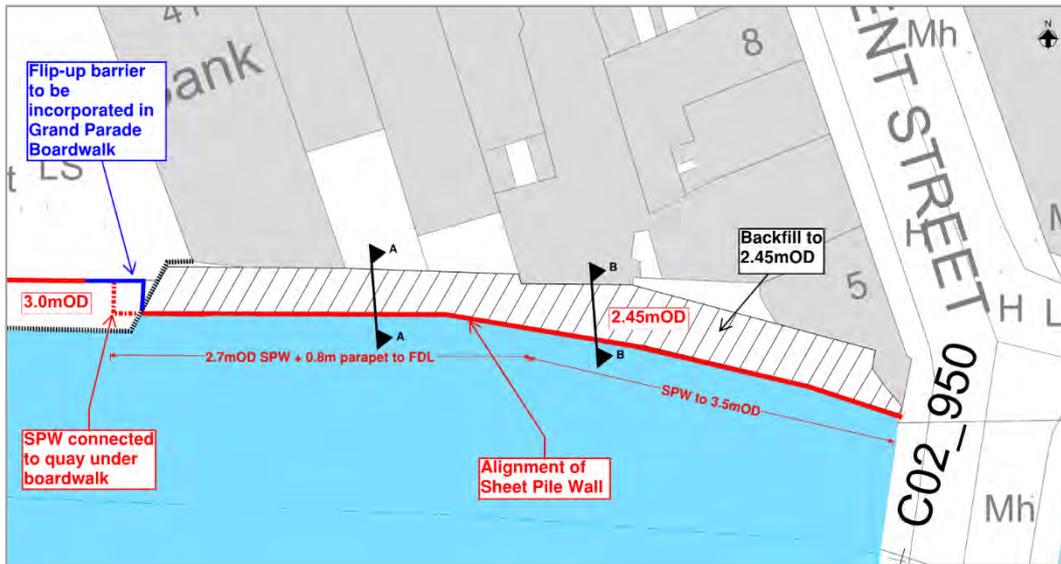
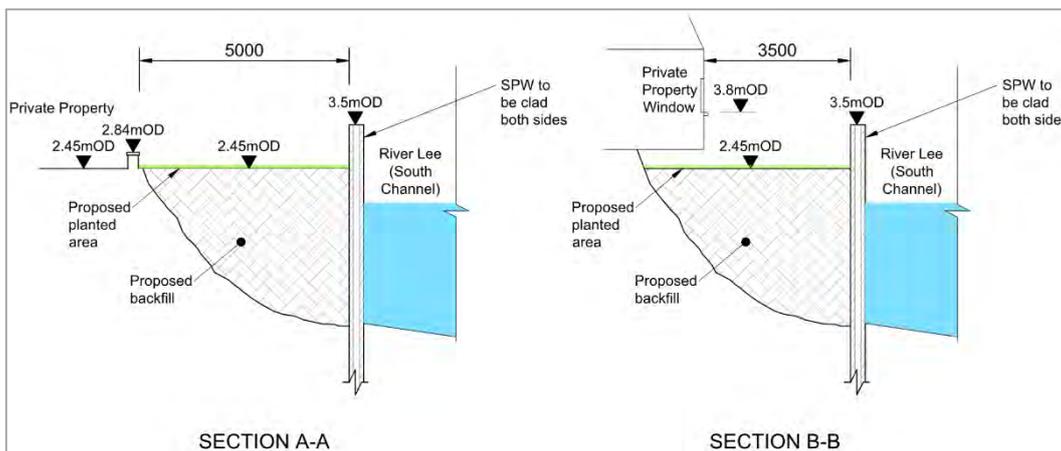


Figure 63: Sections of Proposed Defence Alignment along South Mall Properties



9.10 Patrick's Quay West

The exhibition drawings inadvertently called up the existing historic railing at the western end of Patrick's Quay to be replaced.

This was in error. It is proposed to retain this railing insitu. See Figure 64 below. There will need to be some minor re-grading of the footpath and roadway at the eastern extent of the railing but this will not affect the railing itself.

East of the historic section of railing, the existing modern railing is to be replaced as outlined in the Exhibition Drawings.

Figure 64: Existing Historic Railing at Patrick's Quay – To be retained



9.11 Other Changes to Scheme

Following a review of the submissions, other minor changes in various areas are under consideration and will be incorporated into the detailed design, as outlined in Table 6 below.

Table 6: List of changes to flood defence walls following review of submissions

Location	Exhibited design	Updated design
South side of St.Vincent's Bridge, along kerb edge	Clad RC wall	Wall to be replaced with glass panels to mitigate visual impact
North abutment of Shandon Bridge	Clad RC wall	Wall to be replaced with demountable defences so that in normal open operating mode there is no negative effect on pedestrian movement
Lavitt's Quay, Pope's Quay	Clad RC wall where gaps exist currently	Inclusion of intermittent glass panels (where gaps currently exist) within the new walls to maintain visual link to river
Lapps Quay	Glass barriers with only three small gaps for demountables	Increased length of demountable defences to maintain existing usage of area
Union Quay, George's Quay	Clad RC wall	Inclusion of intermittent glass panels within the new walls to maintain visual link to river
South Mall/Grand Parade Boardwalk Quay	RC wall incorporating seating	Increased amount of demountable defences

10 Conclusion

Given the long history of flooding in Cork City, and having carried out a Catchment Flood Risk Assessment and Management (CFRAM) Study for the Lee Catchment, the Office of Public Works (OPW) recognises the high levels of existing flood risk in and around Cork City. The Draft Lee Catchment Flood Risk Management Plan was published in February 2010, and identified a preferred option for the alleviation of flood risk in Cork City and along the Lower Lee.

Following a subsequent detailed study, the OPW now proposes to proceed with a preferred scheme, which consists of the following key elements:

- Flood Forecasting System and Early Warning Service;
- Revised operating procedures at the existing Lee dams;
- Designated washlands upstream of Cork City;
- Direct defences; and
- Flow reduction in the South Channel of the River Lee.

The proposed scheme was brought to Statutory Exhibition stage through the Arterial Drainage Act (as amended) in late 2016/early 2017. Details of the scheme were available for inspection to members of the public between the 12 December 2016 and the 20 January 2017 at four locations around Cork City. The Scheme has also been available to view online on the project website www.lowerleefrs.ie. Submissions were invited up to the 7 April 2017. Full details of the exhibition are provided in Section 2 of this report.

This report along with the appended technical reports will form part of the information required under Section 7(3)(b) of the Arterial Drainage Act. This report address the queries that were raised in submissions and throughout the exhibition process. Submissions by individual landowners in relation to the proposed defences within their landholding will be responded to separately on a one to one basis.

The proposed scheme received a high volume of submissions during the public consultation period, many of which questioned the technical basis for the scheme proposals and requested further consideration of potential alternative solutions. In order to fully address these submissions, several technical reports have been prepared and are included as appendices to this report, namely:

- Review of Options for Potential Tidal Barrier
- Review of Options for Raising Existing Dams
- Groundwater/Hydrogeology Report
- Review of Options for River Diversion
- Natural Flood Management in the River Lee Catchment

All of the submissions received during the public consultation process have been considered in detail and as a result, there are a number of recommended changes to the scheme. These changes are summarised in Section 9, and will be reflected in the updated Scheme Documentation to be submitted for Ministerial Consent.

Appendix A

Tidal Barrier Report

A1 Tidal Barrier Report

Please refer to:

www.lowerleefrs.ie/assets/lee_valley/docs/LLFRS_SupplementaryReportonOptionofTidalBarrier.pdf

Appendix B

Dam Raising Report

B1 Dam Raising Report

Please refer to:

www.lowerleefrs.ie/assets/lee_valley/docs/LLFRS_SupplementaryReportonOptionofRaisingExistingDams.pdf

Appendix C

Groundwater Report

C1 Groundwater Report

Please refer to:

www.lowerleefrs.ie/assets/lee_valley/docs/LLFRS_SupplementaryReportonGroundwater.pdf

Appendix D

River Diversions Report

D1 River Diversions Report

Please refer to:

www.lowerleefrs.ie/assets/lee_valley/docs/LLFRS_SupplementaryReportonOptionofRiverDiversions.pdf

Appendix E

Natural Flood Management Measures Report

E1 Natural Flood Management Measures Report

Please refer to:

www.lowerleefrs.ie/assets/lee_valley/docs/LLFRS_SupplementaryReportonOptionofNaturalFloodManagement.pdf