Castleconnell Flood Relief Scheme – Options Report

Final Report

October 2024

OPW Oifig na nOibreacha Poiblí Office of Public Works

Tionscadal Éireann Project Ireland 2040

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Contract

This report relates to the Castleconnell Flood Relief Scheme commissioned by Limerick City and County Council, on behalf of the Office of Public Works. Leanne Leonard and Conor O'Neill of JBA Consulting and Willem Snyman of Egis carried out this work.

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Purpose

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Contents

List of Figures

List of Tables

Abbreviations

AA	Appropriate Assessment
AAD	Annual Average Damage
ACA	Architectural Conservation Area
AEP	Annual Exceedance Probability
BCR	Benefit Cost Ratio
CDP	County Development Plan
CEMP	Construction Environmental Management Plan
CFRAM	Catchment Flood Risk Assessment and Management
DoEHLG	Department of the Environment, Heritage and Local Government
EcIA	Ecological Impact Assessment
ECoW	Ecological Clerk of Works
EIA	Environmental Impact Assessment
EPA	Environmental Protection Agency
ESB	Electricity Supply Board
FEH	Flood Estimation Handbook
FHRC	Flood Hazard Research Centre
FRM	Flood Risk Management
FRS	Flood Relief Scheme
GDSDS	Greater Dublin Strategic Drainage Study
HEFS	High End Future Scenario
HMWB	Heavily Modified Water Body
IFI	Inland Fisheries Ireland
INA	Initial Needs Assessment
LCCC	Limerick City & County Council
MCA	Multi Criteria Analysis
MCM	Multi Coloured Manual
mOD	Metres above Ordnance Datum
MRFS	Mid Range Future Scenario
NBS	Nature Based Solutions
NIAH	National Inventory of Architectural Heritage
NIS	Natura Impact Statement
NPV	Net Present Value
OPW	Office of Public Works
OSI	Ordinance Survey Ireland
PCD	Public Consultation Day
PPD	Public Participation Day
PDV	Present Day Value
pNHA	proposed Natural Heritage Area
RMP	Record of Monuments and Places
RPS	Record of Protected Structures

RPZ	Root Protection Zone
SAC	Specific Area of Conservation
SG	Steering Group
SPA	Special Protection Area
SoP	Standard of Protection
SuDS	Sustainable Drainage Systems
WFD	Water Framework Directive

1 Introduction

1.1 Context

Castleconnell is located approximately 10km northeast of Limerick city. The study area for the scheme, shown in Figure 1-1, comprises the village centre with residential areas stretching outwards to the north and the south, and more rural lands to the east. The River Shannon flows in a southerly direction past the western edge of Castleconnell. The village centre is located approximately 1km off the old Limerick/Dublin national road.

The River Shannon is the dominant source of flood flows at Castleconnell and heavily influenced by Parteen Weir and Lough Derg. The Shannon River is the natural outlet of Lough Derg, with the ESB regulating the flows over Parteen Weir. Other fluvial sources influencing the area are the Kilmastulla River, Black River, Cedarwood Stream and Stradbally Stream.

Over time, as a result of the modified flow regime, the Shannon River downstream of Parteen Weir has significantly changed geomorphic characteristics with the manmade development of river features which have further developed into semi-permanent features and islands with heavy vegetation growth. The riverbed is also regularly intersected by inline rock weirs creating a stepped profile through the reach at Castleconnell. Castleconnell village and the surrounding area was badly flooded in the winter of 2009 following record rainfall over the large River Shannon catchment. Further flood events were experienced in 2015/2016 and 2020.

The Shannon Upper & Lower River basin (UoM 25/26) CFRAM Study Area included Castleconnell as an Area for Further Assessment (AFA) and concluded that a flood relief scheme would be viable and effective for the community. Accordingly, following a public competition, JBA Consulting/JB Barry (now Egis) were commissioned by Limerick City & County Council (LCCC) to provide engineering and environmental services for the Castleconnell Flood Relief Scheme (the Scheme). This scheme will be designed to provide protection to properties in the study area from the 1 in 100-year fluvial flood event (1% AEP event).

There are five stages in the project:

- Stage I: Scheme Development and Design;
- Stage II: Planning Process;
- Stage III: Detailed Design and Tender;
- Stage IV: Construction;
- Stage V: Project Close-Out (Handover to Client).

This Options Assessment Report is produced as part of Stage I of the project.

It follows on from work carried out to date and the report should be read in conjunction with the earlier Constraints Study, Hydrology Report and Hydraulics Report.

1.2 Project Objectives

The overarching objective of the project is:

"*…to assess, develop and design an appropriate viable, cost-effective and sustainable flood relief scheme which aims to minimise risk to human beings, the existing community, social amenity, environment and landscape character.*"

The scheme is to be developed primarily to protect the affected properties against fluvial flooding. In addition, consideration will be given to the potential impact of any flood relief scheme on groundwater and pluvial flood risk.

The target standard of protection (SOP) is the 1% AEP fluvial event.

1.3 Study Area

The study area is as outlined red in Figure 1-1.

The River Shannon is the largest river in Ireland, with a total catchment area covering approximately 15,700 km^2. The river rises in the Cuilcagh Mountains, at Shannon Pot, in Co. Cavan. The river flows in a southerly direction, discharging in the Shannon Estuary. Approximately 10,824km^2 of the Shannon catchment and associated flood flow is drained via Castleconnell village.

Flood flows at Castleconnell are heavily influenced by Parteen Weir and Lough Derg which is approximately 6.5km upstream of Castleconnell village.

There is a topographical fall in a southerly direction with road levels adjacent to Rivergrove B&B on the Lacka Road of c.24mOD falling to 22.7mOD on Chapel Hill fronting the public carpark (Refer Figure 1-2).

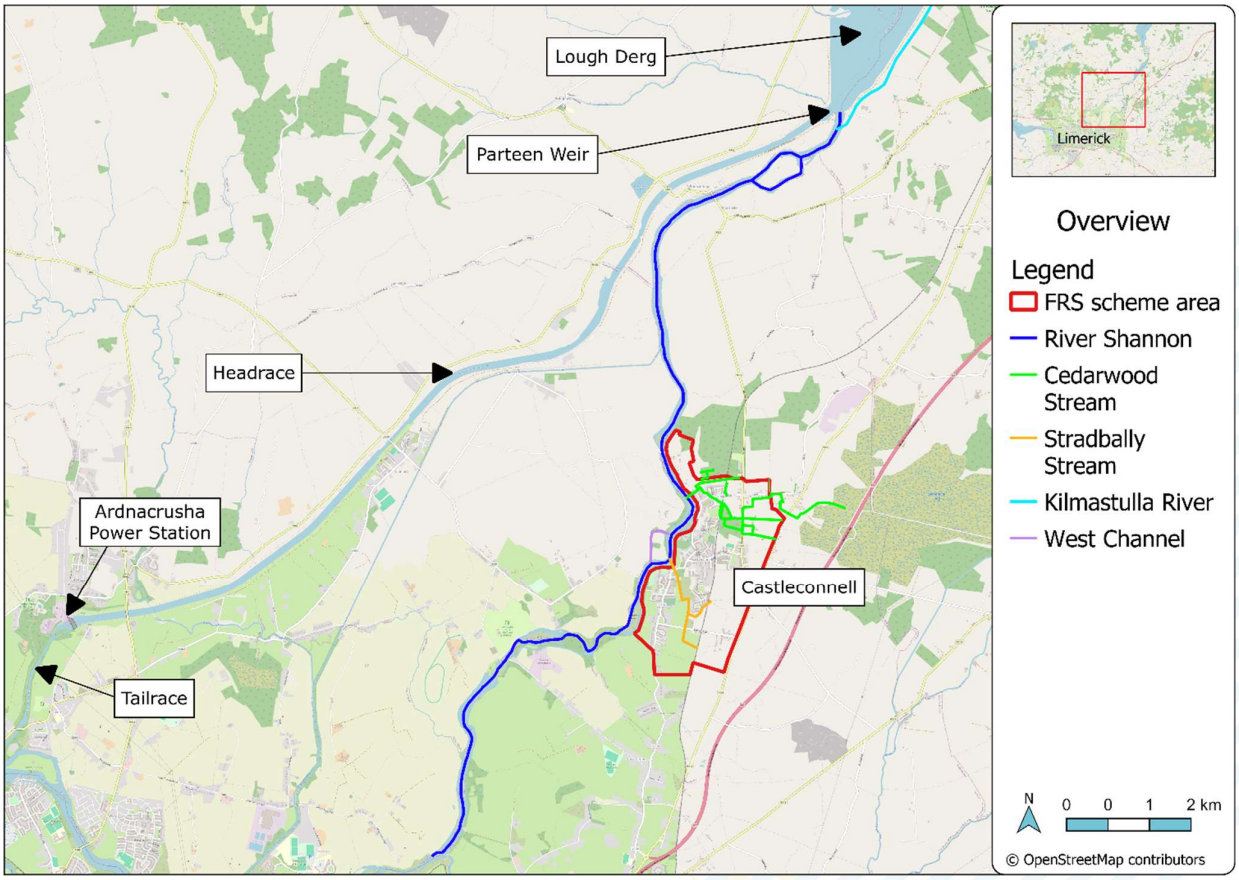


Figure 1-1: Castleconnell Study Area

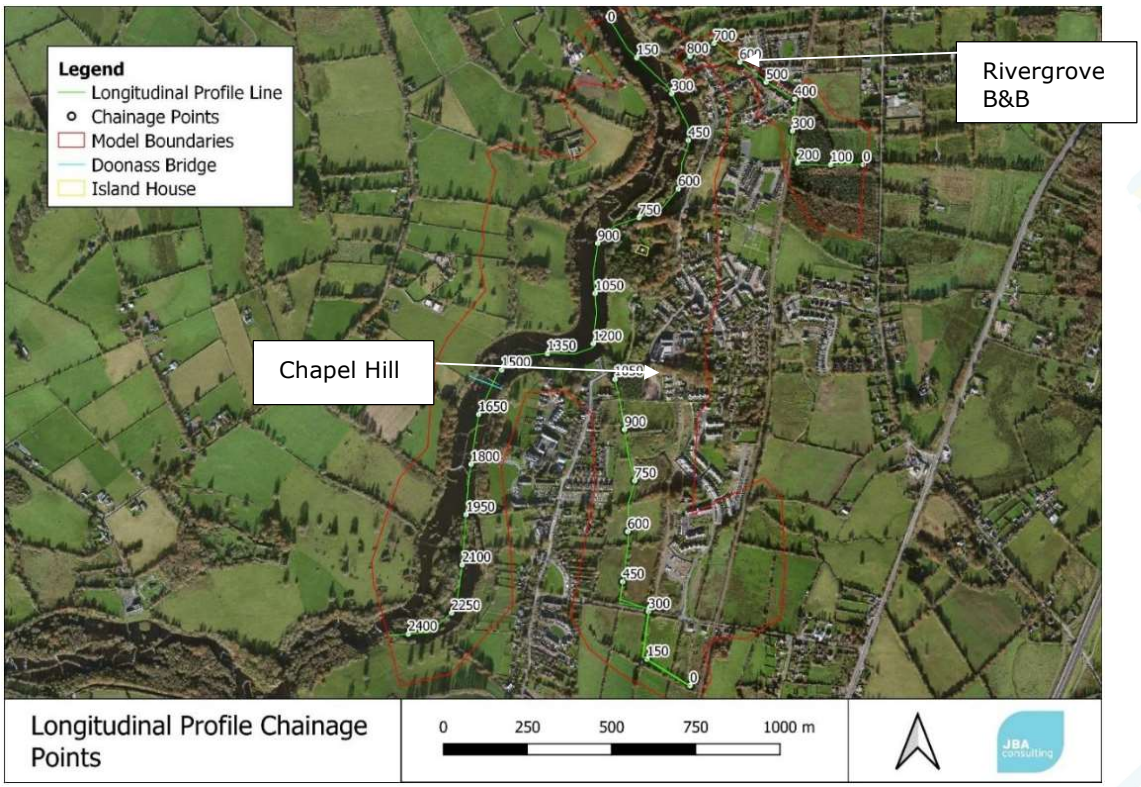


Figure 1-2: Longitudinal Profile Chainage Points

1.4 Scope of Report

The purpose of this report is to outline the development of possible flood relief options that could be implemented in Castleconnell and to describe the procedure for options assessment and selection of a preferred option.

The process is outlined as follows:

- An initial screening was carried out on alternative Flood Risk Management Approaches to set the strategic context for the different measures and options to manage flood risk. An extensive list of possible flood risk management measures, grouped by their approach to flood risk management and the spatial scale of benefits, are assessed against a predetermined set of criteria, to determine their viability;
- A technical assessment of potentially viable flood risk management measures was undertaken;
- Potential flood relief options for all locations around the site were developed using combinations of those flood risk management measures which were determined to be technically viable. Each flood relief option was assessed from an environmental, engineering, and economic perspective;
- The flood relief options were then subjected to a multi-criteria assessment consisting of technical, economic, social and environmental criteria;
- Three public consultation/participation events were held to consult the public on the options, including the emerging preferred option. The first consultation was held in June/July 2020 to gain information on past flooding and an insight into the aspects that are most important to the local residents. The second event was held in September 2022 to present and gain feedback on the emerging options. The final

event was held in September 2023 to present and gain feedback on the identified preferred option for Castleconnell;

- The preferred option was selected taking account of the following;
    - Multi Criteria Analysis;
    - Feedback from the Public and other stakeholders;
    - Cost benefit assessment;
    - Climate change adaptation plan
    - Consideration of wider LCCC objectives for the area;
    - Professional judgement of the project Design Team.

2 Stakeholder Input and Constraints

2.1 Constraints Study

The Constraints Study was the first step in determining the key environmental constraints and drivers which would inform the development of potential flood relief options and will ultimately inform the preparation of Environmental Assessment for the final Castleconnell Flood Relief Scheme. The purpose of the Constraints Study was to determine what constraints (physical, procedural, legal, environmental etc.) exist that could affect the design of the scheme, might delay the progress of the scheme and could influence the cost of the scheme.

While the Constraints Study is not a statutory document, the EPA's Draft Guidelines on the Preparation of Environmental Impact Assessments (2017) were used as a template for the study. The headings used in the Constraints Study, repeated here, are:

- Human Beings
- Material Assets
- Waterbodies
- Biodiversity
- Soils and Geology
- Landscape and Visual Amenity
- Cultural Heritage
- Air and Noise

A summary of the Constraints Study key findings is presented below in Sections 2.1.1 to 2.1.8. This information was used by the design team during the development of potentially viable measures and the development of potential options. A detailed assessment of the preferred options, building on the information gathered at the Constraints Study stage, is in Section 6 of this report.

2.1.1 Human Beings and Active Travel

Much of the land which surrounds the village centre and which has flooded in the past is zoned as open space and recreation or for agricultural use, however small areas zoned for residential use or used for access are also at risk of flooding, and will require consideration.

The Castleconnell Local Area Plan (2023-2028) highlights the importance of potential walkways and cycle routes throughout the village, and in particular on the riverside.

A children's playground is located beside the river at the southern end of the village and is of particular importance to Castleconnell.

2.1.2 Material Assets

Constraints to any material assets will be restricted to any coincidence with sewer, electricity, gas, or telephone networks. Parts of the FRS will likely be located along parts of these networks, and as such will require safety measures to be put in place during construction.

There is an Uisce Éireann foul pumping station and ESB substation situated across the road from the entrance to Island House. This asset is at risk of flooding and as such is a key constraint of the project, given the implications of the pumping station being out of operation for an extended period of time.

Clareville Water Treatment Plant (Uisce Éireann) is located approximately 1.5km downstream of Castleconnell village on the Limerick bank of the River Shannon.

There is an Uisce Éireann pumping station located on the Belmont Road across from the entrance to the Castlerock Estate.

There are existing surface water outfalls and a foul overflow to the river within the scheme area that will require non-return valves fitted as part of the scheme.

- Surface water outfall immediately south of Spa House (across from Charco's Pub);
- Surface water outfall c. 30m south of the entrance to Dunkineely House;

- Surface water outfall at the Scanlon Park junction;
- Overflow from the foul pumping station at the Scanlon Park junction;
- Surface water outfall at Meadowbrook Estate;
- Surface water outfall from the SuperValu car park to the Coolbane Woods Forestry;
- Surface water outfall to the Stradbally Stream adjacent to the Ferry car park.

There are existing overhead and underground electricity cables, underground gas sewer networks and underground Éir cables that will also require consideration, protection and/or diversion as part of the scheme.

2.1.3 Waterbodies

The key objectives of the WFD are set out in Article 4 of the Directive. It requires Member States to use their River Basin Management Plans (RBMPs) and Programmes of Measures (PoMs) to protect and, where necessary, restore water bodies in order to reach good status, and to prevent deterioration. Good status means both good chemical and good ecological status.

There are two WFD surface waterbodies in the scheme area; SHANNON (LOWER)_050 at the northern end of Castleconnell, and SHANNON (LOWER)_060 for the majority of the scheme extent south of that.

- SHANNON (LOWER)_050 is classified as Poor Status and is regarded as At Risk for the 2016-2021 WFD reporting period.
- SHANNON (LOWER)_060 is classified as Moderate Status and its Risk Status is Under Review.

It is noted that the Cedarwood Stream and the Stradbally Stream are not mapped as being part of any WFD waterbody, though they flow directly into the Shannon (Lower)_060. They therefore do not have a WFD status assigned, nor are they subject to any WFD monitoring. Nonetheless, the streams are being treated as if they are WFD waterbodies, i.e., they are being held to the same standard of assessment.

During construction, there is a risk of accidental release of contaminants into surface and groundwater, or the mobilisation of nutrients and suspended solids. This could have an adverse impact on water quality, negatively impacting on the WFD status of the waterbody and preventing the waterbody from achieving its WFD objectives. Such release of contaminants can also impact the habitats and species of the Lower River Shannon SAC. The WFD and the need to maintain water quality are therefore constraints.

Potential construction impacts on the water environment can often be mitigated or reduced by the implementation of mitigation measures. These will be outlined in the Natura Impact Statement (NIS), Environmental Impact Assessment Report (EIAR), and Construction Environmental Management Plan (CEMP) for the proposed scheme and will be put in place by the appointed contractor.

The level of the Old River Shannon in the study area is controlled by Parteen Weir, approximately 6km upstream. Under normal flow conditions, 10-11 cubic metres per second passes over Parteen Weir down the Old River Shannon, with the remaining flow regulated to Ardnacrusha power station. During flood events under standard operational conditions, 345 cubic metres per second is regulated to Ardnacrusha with the remaining flow into the Old River Shannon. Design flows for the scheme are discussed further in Section 3.2.

The WFD recognises that some waterbodies are altered in such a way as to prevent or hinder them from reaching Good ecological status. Lower Lough Derg, directly upstream of the Old River Shannon at Castleconnell, is defined as a Heavily Modified Waterbody (HMWB), due to Parteen Weir. While the two waterbodies in the scheme area are not defined as such, the Parteen Weir has dramatically reduced water levels in the area, with resulting changes to fish passage, hydromorphological regime, and sediment transport.

2.1.3.1 Interaction of the WFD and the Habitats Directive

Article 4.7 of the WFD and Article 6.4 of the Habitats Directive deal with 'new modifications changing the physical characteristics of a water body' and 'plans or projects not directly connected with or necessary for the management of a Natura 2000 site', respectively. Both articles allow for the possibility of using derogations or exemptions for the implementation of such projects, once certain requirements outlined under the relevant articles are met. It is important to note that 'if a measure or project fulfils the conditions of one directive, but not the other, then the authorities may not authorise it under either directive' (European Commission, 2011, pp. 27) and that the WFD does not allow for derogation under the Habitats Directive, and vice versa. Therefore, if an exemption under the WFD for meeting Good ecological status is sought, it will be necessary to also meet the requirements of Article 6.4 of the Habitats Directive in relation to the Lower River Shannon SAC. Several of the Qualifying Interests of the SAC rely directly on water flow and water quality, such as species of Lamprey, Freshwater Pearl Mussel, and Salmon.

2.1.3.2 Hydrogeology and Groundwater

Castleconnell groundwater body is at 'Good' Status and is 'Not at Risk' of not achieving its WFD objectives. Any pollution or contaminated groundwater which enters into the River Shannon could impact the habitats and species for which Lower River Shannon SAC is protected.

During construction, accidental spillage or release of pollution, or mobilisation of sediments, could result in contaminated water entering the groundwater body in the area. This could lead to a deterioration in water quality and prevent the groundwater body from achieving its WFD objectives.

Once operational, the scheme will likely reduce the potential for contamination of the groundwater body in Castleconnell by:

- Reducing the likelihood of contaminated floodwaters discharging to ground during flood events; and
- Improving parts of the surface water drainage system in Castleconnell and reducing the risk of discharge of contaminants to the watercourse due to the provision of mitigation measures (such as petrol interceptors where appropriate).

2.1.4 Biodiversity

There is potential for negative impacts on a number of protected species and habitats, particularly during construction or due to the design of the scheme requiring the removal of vegetation or habitat area. The Lower River Shannon SAC borders Castleconnell village (Figure 2-1); any works in or near the SAC have the potential to adversely impact the SAC or its qualifying interests. The SAC is protected under European Law. Consultation with the National Parks and Wildlife Service (NPWS) will likely be required to take place at various points during the scheme, in order to agree assessment techniques and mitigation measures if necessary.

The SAC boundary is adjacent to The Mall, the existing walls along it and Island House, it includes Cloon Island and the area of made ground, which is said to be excess material from construction of the adjacent foul pumping station, shown in Figure 2-2. Works such as removal of this material or replacement of the walls would therefore be taking place adjacent to the SAC and have the potential to cause damage to the qualifying interests of the site, due to the creation of dust and the potential for accidental spillage or release of pollutants. In particular, Annex I habitat riparian woodlands and hydrophilous tall-herb are present on islands in the Old River Shannon and on the riverbanks adjacent to the Mall Road and at the downstream end of Cloon Stream. The presence of the SAC and protected habitats are constraints for the design, construction and operation phases.

2.1.4.1 Invasive species

Invasive plants such as Giant Hogweed, Himalayan Balsam and Buddleia are present at various locations in Castleconnell. These were identified during the preparation of the Constraints Report. There is currently an invasive treatment programme in place by a local community group to manage invasive species. This programme should be reviewed on an ongoing basis and if the current programme ceases, it is recommended that a similar treatment programme is put in place by Limerick City & County Council.

Works taking place in areas containing invasive species will need biosecurity measures put in place, while there could be seasonal restrictions to works while invasive species eradication takes place. Treatment measures may also be required as part of the construction contract.

2.1.4.2 Fisheries

The Shannon at this point supports salmonid species such as Salmon, Brown Trout and lamprey, and other protected aquatic species. Maintenance of fish passage and good water quality are constraints.

Any instream works or culvert works may require consultation with Inland Fisheries Ireland (IFI) and will be subject to seasonal constraints, i.e., may be carried out from July to September inclusive.

2.1.4.3 Birds

Castleconnell has a rich and diverse bird life, including a heronry adjacent to Maher's Pub car park and the Cloon Stream. The scheme should aim to avoid the loss of trees with heron nests if possible. Where works are required to these trees or the adjacent areas, these will be subject to seasonal constraints i.e., must be carried outside of the nesting season.

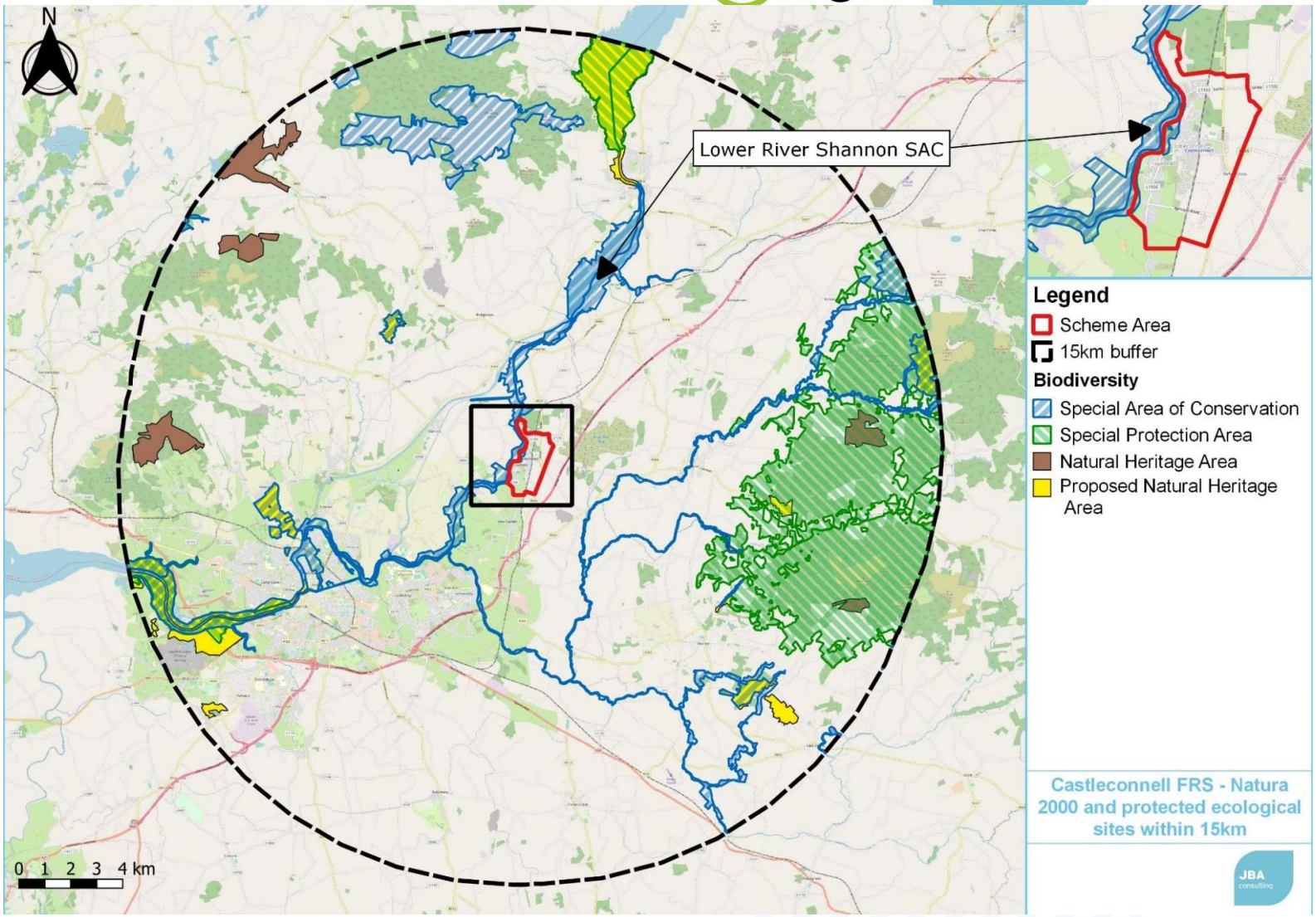


Figure 2-1: Natura 2000 sites, NHAs, and pNHAs within 15km of the scheme area

2.1.4.4 Appropriate Assessment

The EU Habitats Directive requires an Appropriate Assessment to be carried out where a plan or project is likely to have a significant adverse effect on a Natura 2000 site. The Natura 2000 network of European sites in Ireland comprises Special Areas of Conservation (SACs) and Special Protection Areas (SPAs).

An AA Screening Report has been prepared for the preferred option as well as a Natura Impact Statement (NIS).

2.1.5 Soils and Geology

There is a raised area of land directly north of the Island House causeway, which partially blocks one of the culverts. This mound comprises made ground which is said to be excess material that was placed here during construction of the adjacent foul pumping station. As such, it could be a potential source of contaminated soil. If the soil is to be removed as part of any FRS works, it will require classification and removal to an appropriate licenced facility.

2.1.6 Landscape and Visual Amenity

There are no designated views or landscapes in the study area. Views of the Old River Shannon and surrounding vegetation are important locally, and are particularly prominent from The Mall (Figure 2-2) and Chapel Hill. Removal of select vegetation (Figure 2-3) or the construction of flood walls (Figure 2-4) could result in a loss of visual amenity. Some residences face towards proposed walls or embankments, and so could potentially experience constrained views.

Figure 2-2: View of the Old River Shannon from The Mall

Figure 2-3: Trees along Coolbane Wood which contribute to the character of the area

Figure 2-4: Low stone walls on The Mall contribute to the landscape and cultural heritage of Castleconnell.

2.1.7 Cultural Heritage

There are 12 nr. recorded archaeological sites in the village (RMP/SMR sites), as well as an Architectural Conservation Area, 47 nr. assets on the Record of Protected Structures (RPS) and 51 nr. assets on the National Inventory of Architectural Heritage (NIAH). Of particular importance are Castleconnell Castle, with its associated zone of archaeological potential, and Island House and its lands. A number of houses in the northern end of the study area are protected. Due to their protected status, any proposed works at these properties sought consultation with a conservation architect to ensure that the proposals do not negatively impact the structures. Although the Castle and the church of a former Mendicant Augustinian Friary will not themselves be impacted by the proposed works, all options will comprise works within the Zone of Notification of one or both of these structures.

The existing stone walls throughout the village form much of the character of the ACA and as such should be replaced on a like-for-like basis in order to maintain the character of the ACA. The stone kerbstones alongside the Mall Road are part of the original footpath, which was constructed above historic flood levels. These should be reinstated following any alterations to footpaths.

All proposed works, particularly those to the above-mentioned features, included extensive consultation with the Limerick City & County Council Heritage Officer, the National Monuments Service of the Department of Housing, Local Government and Heritage and two specialist conservation and cultural heritage consultants. Measures and considerations arising from this consultation are discussed in further detail in Chapter 6 of this report and in the Environmental Impact Assessment Report (EIAR).

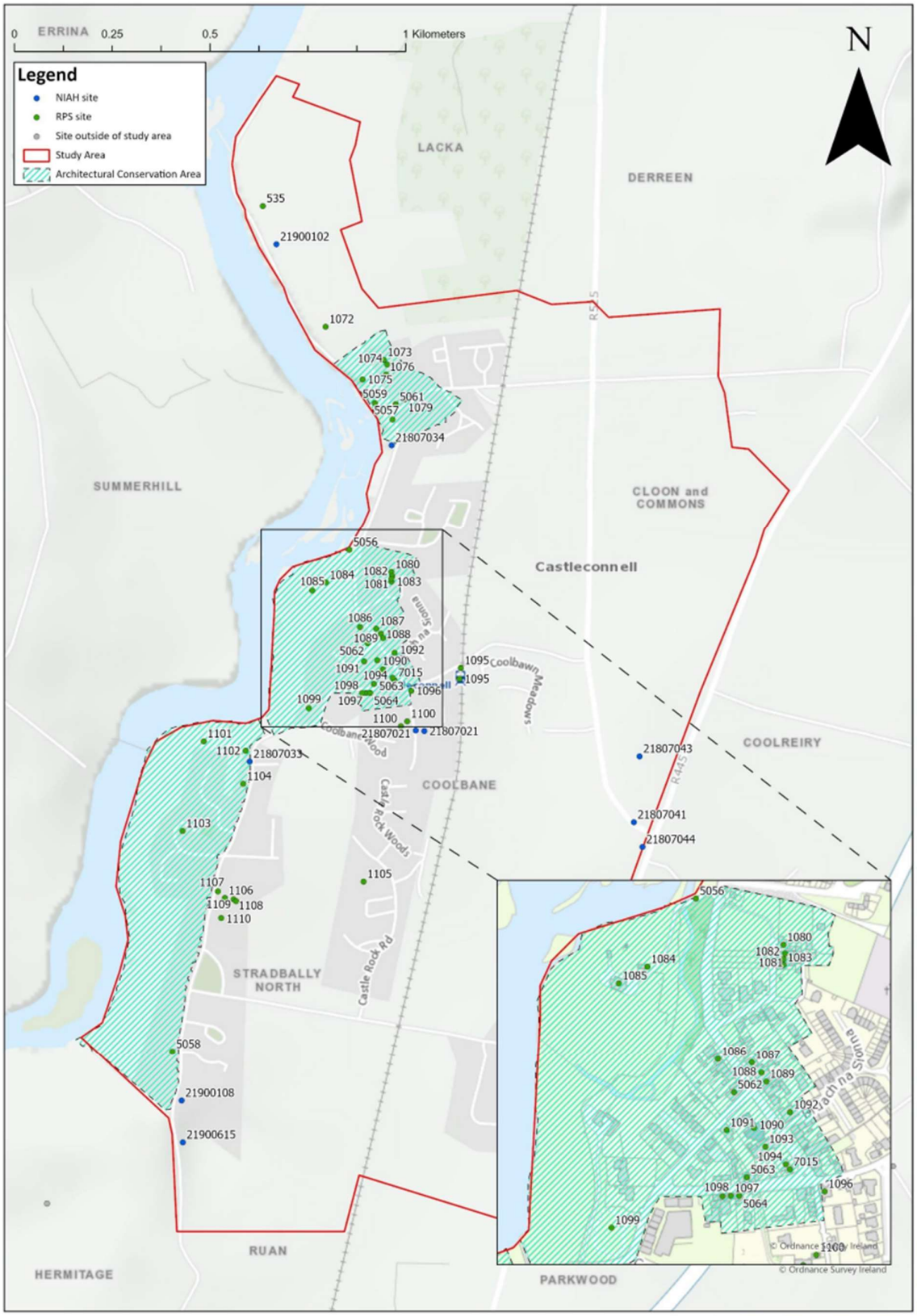


Figure 2-5: ACA, RPS sites and NIAH sites in study area

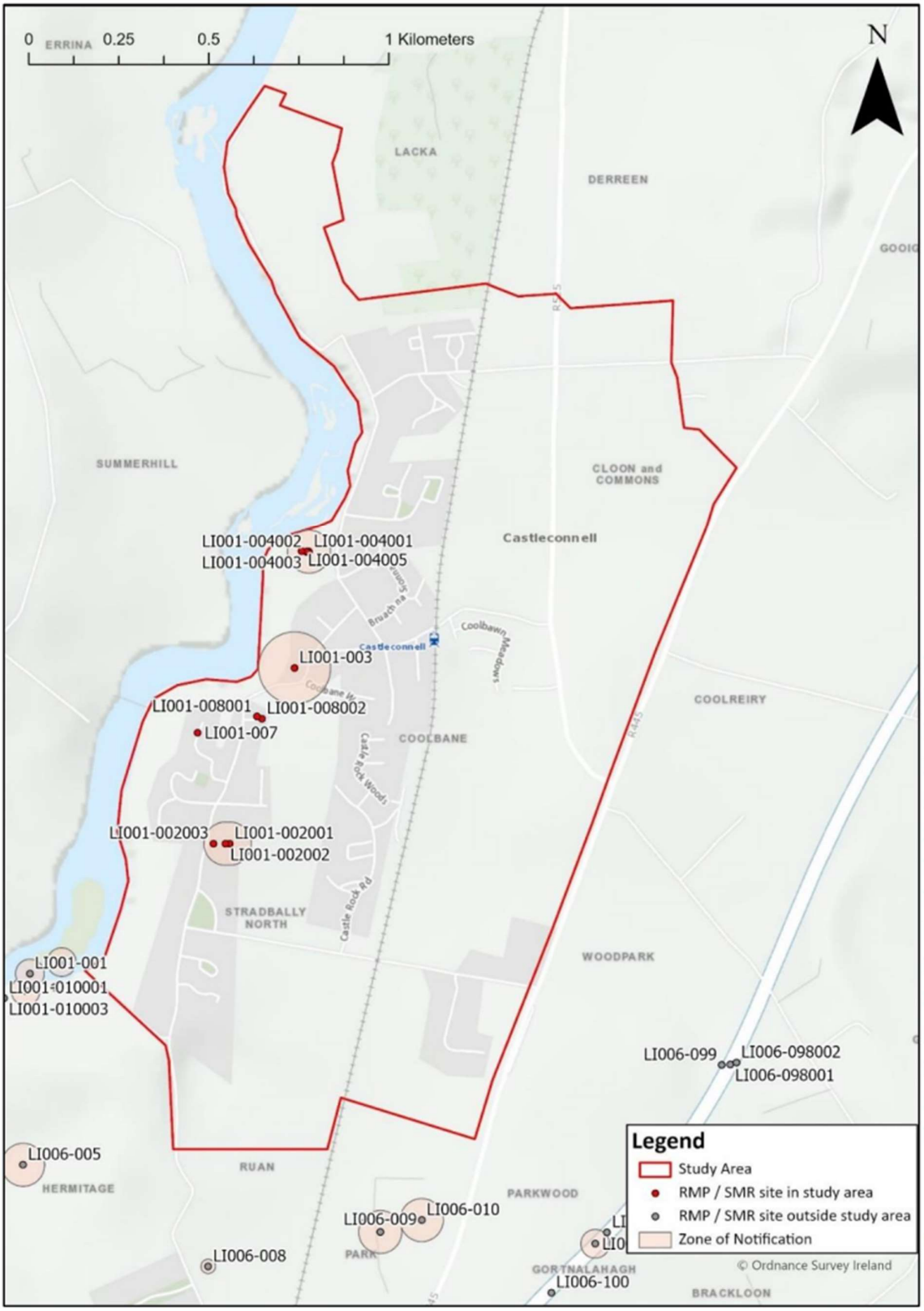


Figure 2-6: RMP sites in study area

2.1.8 Air and Noise

Impacts relating to air and noise would be temporary in nature, during the construction phase and during operation and maintenance post construction of the scheme resulting from the temporary presence of construction plant and machinery and vehicle movements and the usage of pumps to manage surface water during flood events. Though some pumps will be permanent installations, their use will be intermittent as and when required during flood events. Mitigation measures could be implemented during construction to limit any impacts. This is discussed in further detail in the Environmental Impact Assessment Report (EIAR).

2.2 Design Constraints

In so as far as is practicable, flood defence proposals have considered the preliminary constraints identified in the preparation of the 'Constraints Study for Flood Relief Scheme at Castleconnell', through Public Consultation Questionnaires and through public engagement. A summary of the main design constraints are as follows:

- The flood defence solution shall ensure access to the River Shannon for fishing and boating.
- Timing constraints will apply to any in-channel work or works that may affect the surrounding wildlife (e.g. birds).
- A minimum safe-guarding height of 1.2m is to be provided on all walls. In some cases this will result in the wall being substantially higher than the finished defence level would otherwise require.
- Works should remain outside of the SAC where possible and should not impact the identified Annex I alluvial woodland.
- To maintain the heritage of the various features within the village, a number of measures will be implemented where possible.
    - Where the existing old stone walls will be removed, the finish of the replacement flood wall should replicate the visual appearance of the existing walls as much as possible by re-using the stone from the existing walls to clad the new flood walls. Where this is not possible, a similar locally sourced stone should be used.
    - Potential significant and permanent impacts on heritage have been weighted heavily in the assessment of the options. This is discussed further in Chapter 6 and Chapter 9 of this report and is evident in the assessment of Option 1, which proposes to replace the causeway into Island House, which is listed on the RPS.
    - Heritage and Archaeological consultants and officers have been consulted throughout the development of options to ensure that the impact on heritage is minimal and that any proposals integrate appropriately with their surroundings. For example, defence alignments and incorporation of glass panels into flood walls were strategic decisions to minimise impacts on light and views of the river.
- Disruption to residents is a major design constraint that requires considerable consultation with the affected stakeholders. Extensive liaison took place with these stakeholders, working closely with them to mitigate the impacts on them.

2.3 Consultation

Proactive consultation was a key requirement of the project. The purpose of the consultation was to obtain feedback on the proposals from all relevant affected stakeholders and landowners who might be impacted by the Scheme. Feedback throughout the project has been valued, informative, carefully considered, and where appropriate it has influenced decisions in developing

all options before identifying a preferred option. The goal was to ensure the public's opinion was taken into consideration when developing the scheme and that local residents were informed of the influence they had, and how the Design Team responded to their comments and concerns.

Detailed consultation planning for the project has been developed stage-by-stage, and is updated when necessary.

2.3.1 Public Consultation

Throughout Stage 1, the Design Team sought to take the opportunity to interact with the stakeholders that would be directly or indirectly affected by the FRS and to listen to the views of those living or working in areas near the scheme. Initial consultation was through individual site meetings, with more formal public consultation and participation events for the wider public at key milestone points. The goal of such consultation was to elicit these views from locals and to build a relationship with members of the local community. The consultation events were open to any and all interested parties, including political stakeholders.

Public Participation Day No. 1

Given the COVID-19 pandemic during Stage 1 of the commission, it was not possible to have a formal Public Participation Day (PPD) within the village in June/July 2020, as previously planned. Instead, the methods of consultation included:

- A newsletter Brochure and questionnaire drop to 110 nr. properties and businesses within the study area that were at risk of flooding or impacted by envisaged construction works;
- Information flyers within various local businesses directing the public to the questionnaire on the LCCC website;
- Digital issue of the questionnaire to various action groups;
- Emails.

The purpose of the PPD was to seek initial views from the public and other interested parties in relation to the key issues that the study should address, the options to manage the flood risk in Castleconnell, to highlight points of local importance that might influence or constrain the design and to collate information on any past flood events in the scheme area. The feedback provided via the completed questionnaires was very useful in the development of the FRS. There was a great deal of genuine interest in the works and in particular the timeline of the construction. For the most part, attendees agreed that a solution was needed and although many expressed their concern in terms of protecting local roads in addition to houses and businesses, they understood that it was more important to provide flood protection in a timely manner.

Members of the public were asked to identify the area of particular interest to them. The Mall scored highest, with the whole river and the whole village following in joint second place. This strongly influenced the development of measures and options to include an option that provides protection to the Mall Road. Views varied with regard to instream works where some respondents were of the opinion that instream works are required to improve conveyance whereas other respondents were conscious that any instream works may affect users of the river such as kayakers and canoers. A detailed assessment of potential instream works was undertaken to determine the potential effectiveness of reducing flood levels ahead of assessing any potential knock-on effect on factors affecting users of the river (e.g. velocities, flows and flow paths etc.). Many respondents highlighted the importance of both heritage and protection of wildlife habitats

Where further opportunities or constraints were highlighted by attendees, these have been detailed in the 'Design Constraints' sections of this report under the relevant Area headings.

Public Participation Day No. 2

A second PPD was held on 21st September 2022 at the Castle Oaks House Hotel to present the emerging technically viable measures and options to the public and other interested parties and to give them the opportunity to share their views and opinions on them. Posters displayed in the

room showed the key constraints and the three emerging options from these, presentations on the night explained the progress to date and the detail of the options with a Q&A session after each presentation. The Design Team were also available for questions throughout the event. A briefing was given to councillors ahead of opening to the public. Questionnaires were distributed to each attendee to share their views on the options presented. All materials presented at the event were subsequently uploaded to the Limerick City & County Council public collaboration and consultation portal, the MyPoint website.

The feedback from the event and the questionnaires was positive with most responders indicating that they were generally supportive of the proposals and highlighting their preferred option. There was once again a strong reaction in favour of protecting local roads and a strong desire to retain the cultural heritage and landscape characteristic of the existing stone walls in any new flood walls. As described in Chapter 6, re-using the stone from the existing stone walls, where possible, has been incorporated into all three options.

A lengthy discussion took place on the day regarding the operation of Lough Derg and Parteen Weir, which is a concern for many locals. While these concerns were addressed on the night, the Design Team undertook further liaison with ESB to convey these concerns and to ensure that the assumptions made within the hydraulic model were still valid and reasonable. The Hydraulics Report and this report were then updated to ensure that the assumptions and limitations surrounding flows over Parteen Weir are clearly presented.

The questionnaire asked respondents to identify which option they would select as their preferred option. Option 2 was chosen by most respondents with 73% of the vote.

Public Participation Day No. 3

The third PPD took place on 6th September 2023, also at the Castle Oaks House Hotel. The purpose of this event was to present the preferred option and the finer details associated with it. A recorded video presentation was displayed four times throughout the afternoon, which gave an overview of the project, an insight into the development and identification of the preferred option and a detailed description of each of the proposed measures. The Design Team were available for questions throughout the event. Posters showing the modelled flood extents, results of ecological surveys and a suite of preliminary design drawings were displayed. A briefing was given to councillors ahead of opening to the public. Questionnaires were distributed to each attendee to share their views on the options presented. All materials presented at the event were subsequently uploaded to the project website, www.castleconnellfrs.ie. The feedback from the event was positive with most responders indicating that they were generally supportive of the proposals and keen for construction to begin as soon as possible.

Some attendees queried whether the development to the south would increase flood levels in the Stradbally floodplain. It was explained that the development lies outside of the flood plain so will not have an impact. A further site meeting was held with a representative of one housing development with sketches illustrating flood levels in comparison to the lowest floor level.

Similarly to PPD No.2, some residents reiterated the importance of maintaining the heritage of the village, particularly in relation to the stone walls.

All materials presented at the public participation day were subsequently uploaded to the project website, along with the materials from the previous PPDs, for the public to view in their own time.

2.3.2 Evaluation of Consultation Process

A summary report was prepared following each public participation day to evaluate the format of the event, the feedback received and to assess any lessons that could be learned. Following PPD No. 2, which was dominated by the presentations and Q&A sessions, it was agreed that an alternative format should be considered for PPD No. 3 to maximise the availability of the Design Team to discuss any concerns with the attendees. The presentation was pre-recorded and played at hourly intervals throughout the event. This allowed the presentation to take place twice as often as at the previous event while allowing those who were not interested in the presentation

to discuss their concerns with the Design Team. There was mixed feedback to this format, with some attendees in favour of the pre-recorded presentation and some attendees that would have preferred an in-person presentation. It was agreed that for any future events, if the presentation is pre-recorded, it should be displayed in a separate area to minimise background noise and disturbance from conversations in the background.

The advantage of the pre-recorded presentation allowed it to be uploaded to the project website following the event for those who could not attend.

A register of lessons learned is under development and a meeting will be held between the Design Team to assess which elements of each stage were successful and which elements could be improved on for future similar schemes.

2.3.3 Ongoing Consultation

Comprehensive communication and engagement plans have been developed and adopted by the Design team, including an information link on the LCCC website, direct emails, newsletters, local media, and public consultation among other approaches as listed in Table 2-1 below. A project website (www.castleconnellfrs.ie) was set up at the beginning of 2023 and contains all materials presented at all PPDs, the published Hydrology Report and Hydraulics Report, general project updates and background information. All published project material will be made available as they are published, as well as key project updates and timelines.

A Scoping Report for the EIAR has been shared with Statutory Bodies, non-statutory bodies, and interested stakeholders for feedback. Their views will be considered in the preparation of the EIAR.

Meetings with affected stakeholders, such as landowners and residents, has been ongoing since the outset of the project. As proposals were updated, the affected landowners were notified and consulted, typically through in-person meetings or Teams meetings as appropriate. Where residents have had specific requests, the proposals have been updated to incorporate these requests where possible.

Table 2-1: Castleconnell FRS Communication and Consultation Approaches

Communication Activity	Purpose
Project website (www.castleconnellfrs.ie)	To promote and provide information to stakeholders about the project. The website will provide updates. To provide a source of information that stakeholders and members of the public can download and review. To provide a means of consultation and allow stakeholders to ask questions or submit information.
Direct email (castleconnellfrs@jbaconsulting.ie)	Where stakeholders have supplied their contact details, project updates and invitations to consultation events have been shared via email. Contact details for key Design Team members from JBA and JB Barry (now Egis) were provided in the first newsletter and the subsequent public consultation packages. A scheme email address (castleconnellfrs@jbaconsulting.ie) was set up to allow members of the public to contact the team directly. This was shared on the website along with a 'Contact Us' form. Some local residents have been in regular contact following this. Names and addresses are held securely in compliance with the Data Protection Act 1998.
LCCC website	Links to newsletters and consultation documentation were made available on the LCCC website prior to set-up of the project website.
Local Media TV, radio, newspapers, magazine or publications	Public Participation Events were advertised in local and national newspapers. They were also published online newspaper websites and on social media.
Public Consultation Days / workshops - held at a community venue.	The first initial in person formal public participation event was not carried out due to safety concerns and restrictions during the COVID-19 pandemic. Instead, information brochures and questionnaires were distributed via a mail drop and online, in June/July 2020.The second public participation event to present the emerging options was held in person in the Castle Oaks Hotel on 21st September 2022. A third public participation event was held on 6th September 2023 to present the selected preferred option ahead of the planning submission, and close out of Stage 1.
Community groups and forums	Community groups provide opportunities to reach a wider community. The Design Team issued invitations to local community groups for public participation events.
Face to face meetings and site visits	Site meetings have taken place between JBA and a number of key stakeholders including LCCC officers, residents and local groups. Site visits can provide an opportunity for a less formal conversation with local residents, who have shared important information regarding previous flood events and suggestions for inclusion in the FRS. Extensive discussions have been held with the residents directly affected by the proposed defences.

2.3.4 Meeting with community groups and businesses

As the project has progressed and the impacts on specific parts of the scheme have become clear, relevant user-groups / businesses have been consulted with. This has generally taken the form of short, informal meetings held either in Castleconnell, at the local JBA offices, or at a venue appropriate to the group. Meetings were also held over the phone or Microsoft Teams where appropriate. These meetings provided the opportunity to discuss the requirement for flood protection and present the possible options (where more than one existed) and elicit feedback. This feedback has directly informed the selection of measures and development of the preferred option. Groups who provided feedback in this way included:

- Castleconnell River Association (formerly Castleconnell Fisheries Association)
- ESB
- National Parks & Wildlife Services
- Gas Networks Ireland
- Irish Rail
- Residents directly affected by the proposed defences

3 Baseline Flood Hazard, Exposure, Vulnerability and Risk

3.1 Introduction

Before considering what scheme is needed for an area, an understanding of the current flood risk is needed. By examining the present flood risk and the flood mechanisms in an area a more focussed approach to the development of measures and options targeting the key causes of flooding can be made. This section discusses the baseline flood mechanisms in Castleconnell and their impacts to provide context to the logic of the measures tested.

3.2 Baseline Design Event

Flow estimates for this HEP 25_3886_1 are strongly influenced by the assumptions relating to the operation of turbines and spillway at Ardnacrusha.

During flood events under "standard operational conditions", we have assumed four turbines are in operation and 345m³/s is regulated to the turbines. The headrace flow assumption of 345m3/s is based upon previous estimates in the Shannon CFRAM studies as informed by the ESB. The operational conditions of the power station were discussed in a meeting held between JBA, ESB, OPW and LCCC on 22/04/20. In this meeting the ESB advised that in high flow conditions, 345m³/s can be delivered down the head race to the power station, but a number of factors should be taken into account and this is not a fixed quantity and could be lower. With this assumed head race flow a "504" Event was established for the Old River Shannon at the HEP downstream of Parteen Weir (HEP ref 25_3886_1), with a 1% AEP peak flow of 504 m3/s. This flow is similar in scale to that experienced in the 2009 flood event.

For the purpose of the design of the Castleconnell FRS, an allowance has been made for operational conditions at Ardnacrusha that could, within reasonable contemplation, occur. In the event of one turbine being out of operation for maintenance or as a result of a mechanical failure, ¾ of the 345m³/s (258 m3/s) has been assumed to continue down the head race and the rest, ¼ (87m³/s) would pass over Parteen Weir into the Old River Shannon. In a planned situation, a spillway can be opened at Ardnacrusha and the flows along the canal maintained. However, as the spillway is not automatic, in an unplanned situation it cannot pass the full flow immediately. Therefore, a reduced flow down the head race must be considered in the design of the scheme. This scenario was discussed with ESB and based on their past operational experience the Design Team adopted a suite of operational conditions to define the potential uncertainties within the design flow. Extended turbine maintenance has been necessary during previous flood seasons, in February/March 2020 for example, where one turbine was out of commission during the 2022 winter season. This supports why the Design Team has had to consider the headrace inflow quantum carefully in selecting the design flow in the Old River Shannon.

These limitations in operational conditions outlined above will result in greater discharge passing over the weir at Parteen into the River Shannon resulting in a 1% AEP peak flow of 591 m3/s. This is adopted as the Baseline Design Event for the River Shannon at the HEP downstream of Parteen Weir (HEP ref 25_3886_1).

This approach has been adopted to ensure that appropriate contingency is accommodated in the design of the flood relief scheme to afford a high level of flood protection to Castleconnell Village and the scheme area, allowing for limitations in operational conditions at the power station.

These determine the peak flow estimates for the Old Shannon downstream of Parteen Weir and have been tested in the hydraulic model. These scenarios are referred to by the amount of flow regulated in the headrace to the Ardnacrusha power station. Table 5-1 and Table 5-3 present the design event flows for each of the operating and climate scenarios.

To give context to this, the 2009 event experienced in Castleconnell was approximately the 1% AEP peak (504m3/s) which occurred during "standard operational conditions" at Ardnacrusha.

The extent of the predicted 1% AEP fluvial flood extent is shown in Figure 3-2.

3.2.1 Flood cells and flood mechanism

The Mall Road naturally splits the village, and proposed scheme, into 'Northern properties' and 'Southern properties' affected by flooding. The proposed flood defences are split into flood cells, as shown in Figure 3-1.

During a flood event in Castleconnell as flows begin to increase, low lying properties including Mall House, The Grange, Rockville and Meadowbrook Estate are the first to be affected as well as the playground car park, the entrance road to Island House, the wooded area to the west of Coolbane Woods and the culvert crossing on the Belmont Road. As flows increase and flood waters rise, these levels build up, affecting the properties to the north of the Mall Road and Maher's Pub, safe access to Island House is no longer available, the Meadowbrook Estate becomes inundated and the Stradbally Stream backs up filling the floodplain between Coolbane Woods and the Belmont Road. Flow paths into the village are via access openings in existing walls, select driveways and through surface water outfalls. This impacts the Uisce Éireann's pumping stations, one at the Scanlon Park junction and the second on the Belmont Road, rendering them out of action for the duration of the flooding. Raised levels on the Stradbally Stream and in the wooded area to the west of Coolbane Woods results in flooding of the SuperValu car park and issues within Coolbane Woods due to backing up of flows through outfalls to adjacent field drains within the floodplain. Flows along the Cedarwood Stream, for approximately 300m downstream of the railway line, are sensitive to vegetation growth, constrictions, and culverts. These can result in overtopping of the bank at the rear of some northern properties in the design flood event. Overtopping of the banks upstream of the railway embankment occurs due to restrictions in the capacities of the crossing beneath the railway embankment. This results in flooding of the forestry lands only.

The flooding experienced in Castleconnell in 2009 was unprecedented for the village. Following this event, Limerick City & County Council (LCCC) established a response plan for future flood events in the area. This response plan was put in place for two further flood events, experienced in 2015 and in 2020, which prevented significant flooding of houses. This response plan included:

- A Crisis Management Team convening a number of times over the event to monitor the situation and plan an appropriate response. Media releases to update the public on the status of the flooding and public interest messages.
- LCCC Engineers constantly reviewing the situation on site and reporting back to the Crisis Management Team.
- Sandbags were filled and put in place at key locations throughout the village, to form temporary flood defences. Such locations include the road to World's End, properties to the north of the Mall Road, the Mall Road, Maher's Pub car park, Meadowbrook and SuperValu. In addition, sandbags are made available to all properties in the village.
- Placement of high-capacity pumps, operating on a 24-hour basis during the peak of the event. Pumps are typically put in place at Rivergrove B&B, Mall House, The Mall Road, Island House and Meadowbrook Estate.
- Traffic Management at roads affected by flooding.
- Remedial works and cleaning-up works following the flood event.

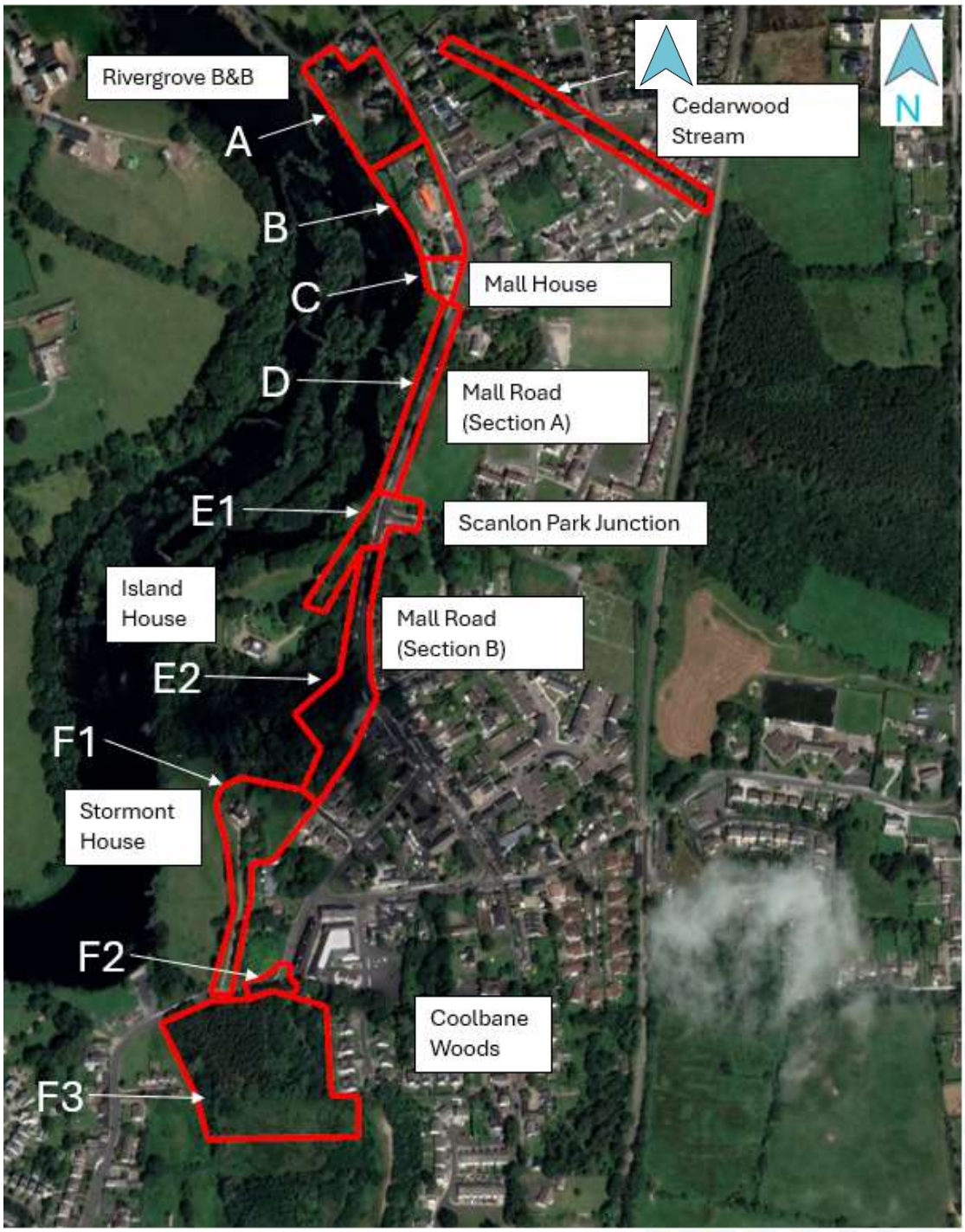


Figure 3-1: Flood Cells

3.2.2 Design flood level and extent

The 1% AEP flood level at Castleconnell varies throughout the village and generally follows the fall in hydraulic gradient from north to south, or in a downstream direction. The flood level varies from 24.48mOD at Rivergrove B&B to the north, to 23.40mOD at Coolbane Woods to the south. The extent of the predicted current 1% AEP undefended fluvial flood event is shown in Figure 3-2.

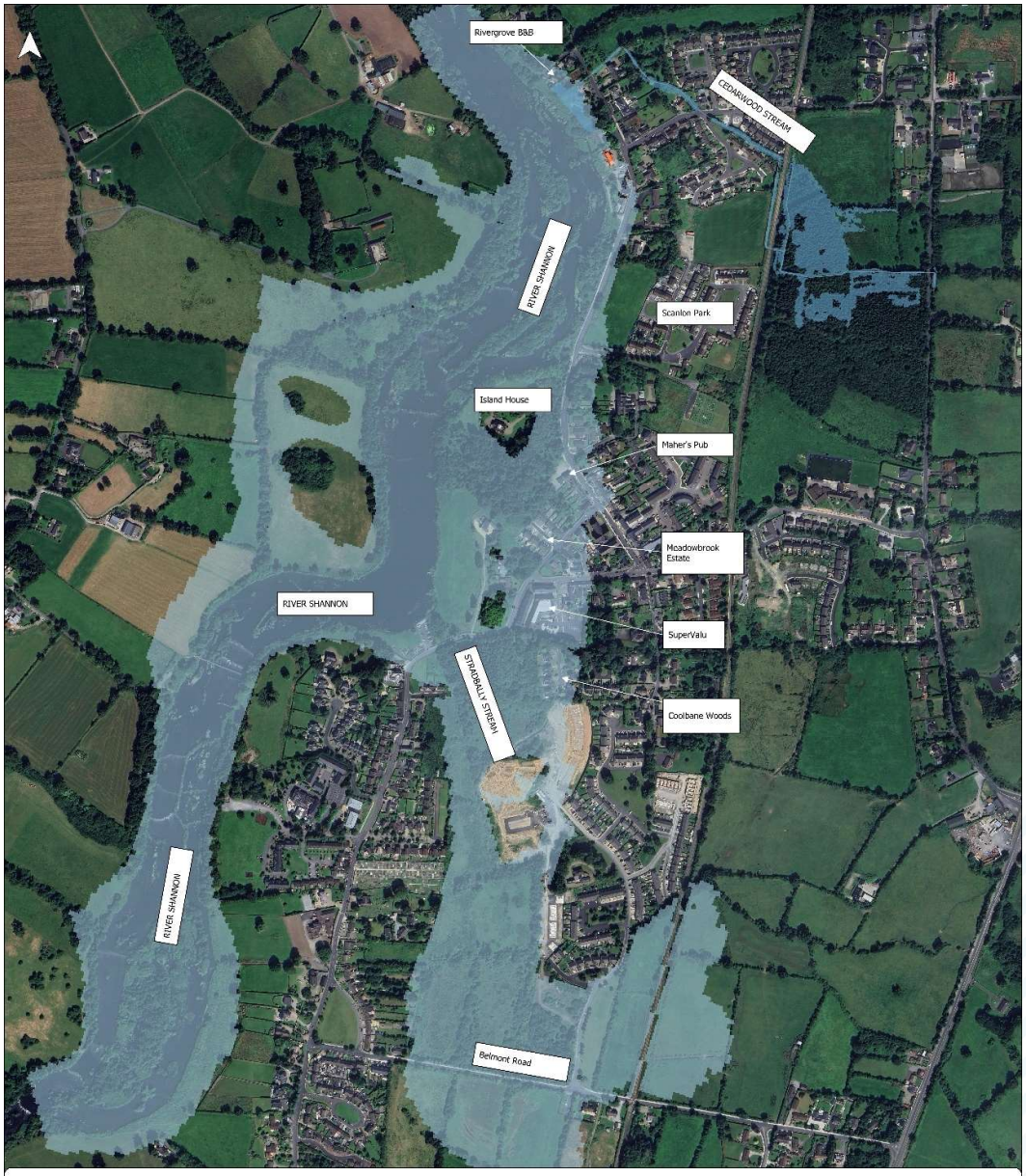

Rivergrove B&B
CEDARWOOD STREAM
RIVER SHANNON
Scanlon Park
Island House
Maher's Pub
Meadowbrook Estate
RIVER SHANNON
SuperValu
STRADBALLY STREAM
Coolbane Woods
RIVER SHANNON
Belmont Road
Legend
1% AEP (1 in 100-year) Flood Extent for Baseline Design Scenario (No flood defences)
Watercourse centerlines
Castleconnell FRS
Flood Extent Map
0
100
200 m
BARRY & PARTNERS
Contains OS data © Crown copyright and database right (2022)
Scale: 1:4,000

Figure 3-2: 1% AEP Flood Extent Map (Undefended)

3.2.3 Freeboard

Freeboard analysis has been carried out for all options and has taken into account:

- Uncertainty in flow calculations
- Uncertainty in hydraulic model floodplain roughness
- Type of defence being proposed (whether hard or soft, i.e. a wall or an embankment)

Due to the sinuosity of the Old River Shannon through Castleconnell, superelevation is experienced at bends in the river. The hydraulic model accounts for this and flood levels used in the design are the levels at the river banks.

Soft defences are vulnerable to long term consolidation of the earthworks (settlement) or local damage, so are normally assigned a higher freeboard than hard defences, such as walls.

Sensitivity testing was carried out as part of the hydraulic modelling and is detailed in the Hydraulics Report. Model runs with the defences in place (minus the freeboard allowance) were undertaken which demonstrated no significant impact due to modelling uncertainties. Therefore, the freeboard allowance adopted for scheme design is as follows:

- Hard defences 0.3m;
- Soft defences 0.5m.

The actual freeboard achieved in some areas is greater than those above, due to the minimum guarding height of 1.2m required for health and safety reasons. There is no requirement to provide additional freeboard for wave action and/or wind setup given the inland location of the proposed scheme, and the limited width of the floodplain.

4 Initial Screening of Potentially Viable Measures

4.1 Initial Screening of Potentially Viable Measures

Whilst the aim of this scheme is to protect Castleconnell village from flooding, it is important to look across the whole catchment for potential solutions. In addition, there will be many interactions and consequences arising from the flood measures and their impacts both upstream and downstream of Castleconnell need to be established and considered carefully. This section details all the flood risk management measures considered during the initial screening stage. These measures were assessed with regard to their viability in terms of the following criteria and are detailed in Table 4-1 below.

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

The constraints detailed in Section 2 were also taken into account when screening the possible measures.

For catchment scale solutions, the catchment has been assumed to extend from Parteen Basin to Castleconnell as any catchment upstream of this is unlikely to have a significant influence on Castleconnell due to the operation of Parteen Basin.

4.2 Screening of Flood Risk Management Approaches and Spatial Scales of Benefits

A review of Flood Risk Management (FRM) approaches has been undertaken to consider the different FRM methods that could potentially be viable and the spatial scales at which benefits could be realised. The spatial scale of benefits, and examples of measures that could be relevant to Castleconnell are listed in Table 4-1.

The initial findings of the desktop screening of measures for Castleconnell are presented in Table 4-2, with further explanation below the table.

Table 4-1. Examples of the FRM approaches considered for Castleconnell, grouped by the spatial scale of benefits.

Spatial Scale of benefits	Spatial Scale for Castleconnell FRS	FRM Approaches that apply to the spatial scale of benefits	Examples of the measures which could be appropriate for this study
Catchment scale measures.	The Lower Shannon Unit of Management as defined in the Shannon CFRAM.	FRM Approach 1: Re-purpose of existing non-flood management infrastructure	Ardnacrusha Hydropower Station turbines, spillway and embankments associated with the headrace and tailrace channels.
Measures which would benefit multiple settlements flood cells, and in exceptional cases could also benefit the sub-catchment.	At risk settlements downstream of Parteen Weir to the Shannon Estuary. Including Castleconnell, Springfield and Limerick.	FRM Approach 2: Catchment scale and disperse actions to reduce flow downstream	Storage or break/buffer between surface water network and fluvial channels. Distributed storage areas.
		FRM Approach 3: Inline storage on main watercourses or tributaries to reduce flow downstream	Single storage area. Cascading storage. Combinations of storage.
		FRM Approach 4: Diversion of flow around and away from risk	Relief channel around specific assets, culverts.

Spatial Scale of benefits	Spatial Scale for Castleconnell FRS	FRM Approaches that apply to the spatial scale of benefits	Examples of the measures which could be appropriate for this study
		areas	Longer length diversion channel.
Measures which could benefit a whole or part of a flood cell. Measure could reduce scale of other measures.	Castleconnell Scheme Area. Castleconnell Flood Cells.	FRM Approach 5: Improved conveyance of flow	Culvert or bridge replacement or enhancement. Maintenance of river corridor. Removal of floodplain or channel constraints.
		FRM Approach 6: Refurbish or enhance defences to achieve standard of protection	Extend existing defence lines. Raise existing defence crest levels. Increase storage capacity.
Containment measures are specific to a hydraulic flood cell.	Castleconnell Flood Cells.	FRM Approach 7: Containment of flood level	Flood walls Flood embankments
Design level and freeboard may be similar for nearby hydraulic flood cells, but for containment measures alignment, height above ground and profile would be specific to the topography, settlement pattern and receptors on each riverbank.			
Measures which apply to all spatial scales.		FRM Approach 8: Flood resilience, preparedness, and emergency response	Flood forecasting and warning. Emergency response plan

Table 4-2. How each FRM approach typically contributes to hydraulic and flood risk management objectives

FRM Approach	Potential of FRM Approach to Achieve Hydraulic and Flood Risk Outcomes						
	Reduces water level	Delays peak discharge	Reduces duration of flooding	Improved conveyance of flow (and reduces water level upstream of restrictions)	Contains high water levels	Reduces exposure and vulnerability	Potential for multi-functional benefits and integrated FRM
1. Re-purpose of existing non-flood management infrastructure	Yes	Yes	Yes	Yes	Yes	Yes	Yes
2. Catchment scale and disperse actions to reduce flow downstream	Yes	Yes	Yes	No	No	Yes	Yes
3. Inline storage on main watercourses or tributaries to reduce flow downstream	Yes	Yes	Yes	No	No	Yes	Yes
4. Diversion of flow around and away from risk areas	Yes	Yes	Yes	No	No	Yes	Yes

FRM Approach	Potential of FRM Approach to Achieve Hydraulic and Flood Risk Outcomes						
	Reduces water level	Delays peak discharge	Reduces duration of flooding	Improved conveyance of flow (and reduces water level upstream of restrictions)	Contains high water levels	Reduces exposure and vulnerability	Potential for multi-functional benefits and integrated FRM
5. Improved conveyance of flow.	Yes	No	No	Yes	No	Yes	Yes
6. Refurbish or enhance defences to achieve standard of protection.	No	No	No	Yes	Yes	Yes	Yes
7. Containment of flood level	No	No	No	No	Yes	Yes	Yes
8. Flood resilience, preparedness and emergency response	No	No	No	No	No	Yes	Yes

4.2.1 FRM Approach 1: Re-purpose of existing non-flood management infrastructure

Structural changes to the embankments at Parteen Basin and the headrace canal, and operational changes to the Ardnacrusha power station turbines, turbine operation, spillway to modify the flow regime through the power station and down the Old River Shannon could all potentially offer flood risk protection to the current and future climate change design standards. All of these are third party assets outside of the control of the project and so this approach can be considered highly complex. This would also likely require changes to Parteen Basin and Parteen Weir. The potential effect of these measures is highly uncertain and would require detailed routing modelling and impact assessment.

The scale of these assets suggests that the costs of changes, including the environmental, hydraulic and social impact assessments required would likely be well in excess of the flood risk benefits available. It is possible that additional benefits outside of the flood risk management scheme may be available, but these would be highly dependent the nature of any change by the asset owner or operator. These additional benefits could reduce flood risk to other receptors along the Old River Shannon and non-flood risk benefits such as ecosystem services or recreation.

Measures associated with this approach should only be considered for future flood risk management and reviewed as a monitoring measure within the climate change adaptation plan.

4.2.2 FRM Approach 2: Catchment scale and disperse actions to reduce flow downstream

The Parteen Basin and Parteen Weir present a notable break in connectivity of the hydrological and hydraulic regime of the Lower Shannon. Lough Derg provides additional and more substantial attenuation of upstream Shannon flows. The scale of catchment measures upstream of the Parteen Basin required will be disproportionate in order to provide a negligible reduction in flood flows on the Old River Shannon through Castleconnell. The operation of Parteen Weir and

Basin could diminish the impact of any upstream measures. Implementing upstream catchment management measures requires negotiation and management of the complex interaction between stakeholders, landowners and organisations. This approach would be complex, the scale of the measures required would require significant works to third party lands along the length of the River Shannon, the effectiveness of the results would be subject to operational and structural conditions at Parteen Basin, and the cumulative costs would be significant and largely disproportionate to the monetary benefits available in Castleconnell. For this approach to be viable, it would need to be considered in the context of a Flood Relief Scheme for all benefitting areas along the River Shannon.

There is the potential for significant benefits to environmental and cultural heritage criteria, however the economic and social effects are highly uncertain. There is also a risk that any modifications to Parteen Weir could increase flood risk upstream and may not be viable.

Measures associated with this approach are not viable for the Castleconnell Flood Relief Scheme. In the future they may form part of a wider catchment scale restoration project.

4.2.3 FRM Approach 3: Inline storage on main watercourses or tributaries to reduce flow downstream

For Castleconnell, this approach is subtly different to Approach 1, in that changes to the operating rules for Parteen Weir and Parteen Basin could be optimised to offer flood risk benefits to receptors along the Old River Shannon. Any change in operating rules would need careful review in terms of the safe operation and management of the Ardnacrusha power station and associated embankments along the headrace, tailrace and the Parteen Basin. There are also a range of factors that affect the extent by which the current regime can be modified. These include maximum rate of drop in water level in Parteen Basin to ensure the stability of the surrounding embankments, the capacity of the headrace canal, the effect of upstream winds and the necessary head of water to maximise the pass-through flow at the Ardnacrusha turbines. Similar to Approach 1, this approach requires changes to the operation of third-party assets outside of control of the flood risk scheme. The approach is highly complex with very uncertain effects. The estimated costs are projected to be lower than those associated with undertaking major works on the Ardnacrusha turbines and spillway.

Measures associated with this approach should only be considered for future flood risk management and reviewed as a monitoring measure within the climate change adaptation plan.

4.2.4 FRM Approach 4: Diversion of flow around and away from risk areas

There is partially settled land to the west of Castleconnell (along the right/Western bank of the Old River Shannon) where a flood relief or diversion channel could be developed. Despite this there are highly uncertain effects on social, environmental and cultural criteria, and significant land purchase would be required. Economic effects may be less uncertain than other criteria as economic activity in this area is mainly agriculture. The approach would be highly complex and costly.

It is possible that this approach could benefit other downstream flood receptors if a diversion can extend to bypass these risk areas. Any diversion channel would need to consider severance of landholdings and access issues, which may present significant challenges to implement. Potential impacts on flood levels downstream would also need to be carefully assessed.

Measures associated with this approach are technically possible and should progress for further analysis as either standalone measures or smaller measures to optimise a combination of measures.

4.2.5 FRM Approach 5: Improved conveyance of flow

There are a number of in-stream river features, such as weirs and islands, in the Old River Shannon through Castleconnell that result in increased water levels and can result in increased sediment on the riverbed. Improving conveyance is a potentially viable approach for the scheme area. Key limitations of this approach are the potential environmental and visual impacts associated with such works.

Measures associated with this approach are technically possible and should progress for further analysis as either standalone measures or smaller measures to optimise a combination of measures.

4.2.6 FRM Approach 6: Refurbish or enhance defences to achieve standard of protection

There are no existing formal flood defences (e.g. flood walls, embankments) in Castleconnell and so this approach is not applicable.

Measures associated with this approach are not applicable for the Castleconnell Flood Relief Scheme.

4.2.7 FRM Approach 7: Containment of flood level

FRM Approach 7 examines the potential impact of containing flows in bank or limiting the extent of the floodplain to protect risk receptors. Following a review of the flood mechanisms and impacted areas, this approach is considered potentially viable at an individual settlement level. The key limitation to this approach is the defence heights necessary (visual impact). Wall heights of greater than 1.5m are not typically considered acceptable in public areas.

Measures associated with this approach are technically possible and should progress for further analysis as either standalone measures or smaller measures to optimise a combination of measures.

4.2.8 FRM Approach 8: Flood resilience, preparedness, and emergency response

Increased resilience of local community and businesses to respond and recover. Flood forecasting and warning systems could deliver benefits to other communities between Parteen and Limerick. The slow response of the downstream sections of the Shannon combined with the influence of the operation of Parteen Basin and Parteen Weir mean that a forecasting is particularly suitable for this scheme. This approach does not reduce flood risk to properties but rather prepares the community to respond to a flood event in the most appropriate way.

Measures associated with this approach are technically possible and should progress for further analysis as either standalone measures or smaller measures to optimise a combination of measures.

4.3 Nature Based Solution Opportunities and Benefits

Nature Based Solutions (NBS) are typically measures that include planting and are implemented at ground level. They are designed to accommodate overland flow in a way that mimics natural processes, such as retention, storage and treatment. They aim to delay the rate at which surface water is conveyed, store excess volumes of water prior to releasing at a slower rate or infiltrating back to ground and filtering any potential debris or pollutants from the water. NBS can include amenity, biodiversity, water quantity and water quality benefits. However, due to the fact that most NBS are at ground level, their incorporation often requires large land take which can have a significant impact, particularly in urbanised areas. The local topography also has an impact on the effectiveness and suitability of NBS to manage overland flow across an area.

Nature Based Solutions can be implemented at different scales:

- International Scale – Generally relates to international policies which aim to prevent future increase in flood hazard.

- Catchment Scale – An approach to reduce runoff of manage sediment regime to protect downstream areas at risk. Typically expensive and uncertain approach to reducing flood levels or time to peak.
- Reach Scale – Measures local to a flood defence structure to reduce its scale, size or height. These are usually less expensive than catchment scale measures and have a greater degree of certainty regarding their effectiveness.
- Local Scale – Typically additions to engineering solutions such as maintenance regimes, wildflower meadow and tree planting etc. They can have significant local benefits but will have minimal benefits on a larger scale.
- Individual Scale – Measures that individuals can implement at their own property, such as green roofs, wildflower strips and community activities. These measures can be effective for small scale flooding of individual properties but often have negligible impact to the wider area.

Due to the large catchment of the Old River Shannon through Castleconnell, NBS would need to be considered at a catchment scale, reach scale or local scale. Catchment scale solutions could include upland afforestation, creation of floodplain and riparian woodland, upland/peatland restoration, riparian corridor restoration, barrier removal, online storage and wetland creation. Each of these measures would require large areas of land and in order to have a measurable impact on flood levels in Castleconnell would need to be implemented throughout the catchment, which is outside the control of the flood relief scheme.

Reach scale measures may include many of the same measures as outlined in the above paragraph, but on a smaller scale and aimed only at the reach of the Old River Shannon that has a direct impact on Castleconnell. Similarly, most of these measures would need to be implemented on lands that are outside the control of the flood relief scheme. Furthermore, they would not remove the need for hard defences but be required in addition to hard defences.

Local scale measures may include river restoration and maintenance, removal of barriers, introduction of SuDS measures within the village, floodplain restoration and detention areas.

Due to the characteristics of the Old River Shannon, the surrounding topography, the proximity of development within the village and the large upstream catchment influenced by Parteen Weir, there are limited Nature Based Solutions applicable to the area. Any potential changes to the operation of Parteen Weir and Ardnacrusha, or to the storage capacity in Lough Derg, as discussed in the paragraphs above, could form part of a Nature Based Solution. However, as previously mentioned these are third party assets and are outside the control of the flood relief scheme.

In summary, due to the large catchment of the River Shannon upstream of Castleconnell and the associated slow response of the river, a number of nature based solutions, would have negligible and ineffective impact on reducing peak flows.

Measures associated with this approach are not viable for the Castleconnell Flood Relief Scheme.

5 Potentially Viable Measures

5.1 Further Assessment of Potentially Viable Measures

Further to the initial screening, the following flood risk management measures were identified as potentially viable measures for Castleconnell and have been taken forward for further technical assessment in the following section. Those measures which are viable are then considered on an area-by-area basis in Section 6 taking into account the constraints faced at different parts of Castleconnell. The potentially viable measures consist of:

- Do nothing
- Do minimum
- Structural Measures
    - Direct defences
        - Reinforced Concrete (RC) Walls
        - Sheet Piles
        - Engineered Earth Embankments
        - Road Raising
        - Demountable Barriers
    - Individual Property Protection
- Non-Structural Measures
    - Diversion Channel
    - River Restoration Works

5.1.1 Do Nothing

The 'Do Nothing' scenario is defined as the option involving no future expenditure on flood defences or maintenance of existing defences/channels. The implication is that the existing risk of flooding persists in the study area and possibly worsens over time, due to existing opes, the reduction in structural integrity of the existing walls with age, and climate change impacts are felt. As this does not provide any benefit to Castleconnell in terms of flood risk, this is not a sustainable option, so it has not been considered.

5.1.2 Do Minimum

The "Do Minimum" measure consists predominantly of ongoing maintenance works or implementing additional minimal measures to reduce risk to specific areas with no strategy in place to improve flood protection. It would maintain the existing standard of protection in the current scenario and would likely lead to worsening impacts due to climate change. This would generally involve repairing and reinforcing existing walls now and as repairs are needed in the future together with the provision of non-return valves on existing outfalls and demountable barriers in the fisherman access opes. This is not a suitable option due to existing flood pathways where there are no barriers to flow (e.g., Maher's Pub car park and Island House) and the extensive emergency response operation required by LCCC on a recurring basis.

5.1.3 Structural Measures

The potentially viable measures highlighted in Section 4 are discussed further in the following sections. In the following sections each measure and its impacts are discussed in isolation.

5.1.3.1 Direct flood defences

This measure involves the construction of direct defences along the banks of the existing river or adjacent to properties that are at risk, to contain flood volumes and flows within the river channel and will take the form of embankments, reinforced concrete walls or sheet-piling.

The final choice of method, i.e. embankments or reinforced concrete / sheet piled walls, would be determined following further review of the detailed site investigation and subsequent detailed design. Due to the high-level nature of the Multi-Criteria Analysis (MCA) tool, it is not appropriate to use the full MCA processes to choose between construction techniques within the various areas. It is important that an appropriate form of measure is adopted in discussion with stakeholders and in considering buildability constraints along with the relative environmental impacts of the various options. In some situations, the lower environmental impact measure may be more expensive.

In general, it is considered that walls will be more suited to the northern part of Castleconnell, where there is insufficient available area to accommodate an embankment between the Mall and the SAC. Towards the south, there are opportunities to provide an earth embankment where sufficient space exists, namely to the west of Meadowbrook estate and to the west and south of Coolbane Wood. Road raising can be used as a defence both to the north, at the Scanlon Park junction and to the south, at the Coolbane Woods junction. Demountable barriers or flood gates can also be used where space constraints exist, and access is required to be maintained.

5.1.3.2 Individual property protection (IPP)

This measure would protect properties on an individual basis from the full impact of flooding, would increase resilience to flooding and reduce the periods of recovery and reoccupation. This typically consists of flood gates on private property, air brick covers and non-return valves to drains. Flood gates installed in doorways are effective to approximately 0.6m flood depth. Above this depth, the water pressure on the walls of typical domestic properties may cause structural damage. IPP would also include measures to seal or otherwise secure windows and vents and may involve tanking buildings above and below ground to resist the ingress of water.

Individual property protection measures are not considered feasible as standalone measures due to the large number of properties at risk, the excessive predicted flood depths, the difficulty in retrofitting IPP measures to older and protected buildings and the dependency on the homeowner to be present to install the units ahead of a flood event. It is also important that the flood barriers are stored securely and correctly so that they can be located easily and quickly, and the units and seals remain in good condition allowing them to work effectively when needed. It is not easy to ensure that this will be achieved when the units are located on private property and managed by members of the public.

It is important that a continuous and passive response to flood management is provided where possible. Because of the risks associated with the appropriate maintenance and timely erection of flood gates on private property, any measure involving IPP which places a significant number of people or properties behind these gates has been screened out as being non-technically viable. Flood gates will be considered where they are located in publicly accessible areas and can be managed, maintained and operated by Limerick City & County Council or appointed sub-contractors.

5.1.4 Non-Structural Measures

5.1.4.1 Diversion Channel

The combination of high flow rates and a confined river cross section with islands and heavy vegetation contributes to raised flood levels, increasing the risk of flooding within Castleconnell.

Whereas there is an existing western channel (approx. 800m long on the right bank, beginning on the opposite side of the river to the Mall Road and re-joining the Old River Shannon c. 150m upstream of Doonass Bridge), hydraulic modelling indicates that local widening of same will not

provide any meaningful reduction of flood levels for the northern part of Castleconnell and will not provide any reduction in flood level for the southern part of the village.

Therefore, a much greater diversion and/or diversion channel would need to be provided to convey the flood flows downstream, thus by-passing Doonass Footbridge and the narrowing of the Old River Shannon at this location. An option of lowering existing ground levels over a significant area along the right bank of the Old River Shannon from Ch0 to Ch2100, to the 1 in 5-year flood level was tested. This resulted in reduced flood levels throughout the village of up to 480mm. However, the reduction was not significant enough and new hard flood defences would still be required. Furthermore, the increased conveyance capacity within the river, increased flood levels downstream of the village. The results of this modelling exercise are shown in Figure 5-1

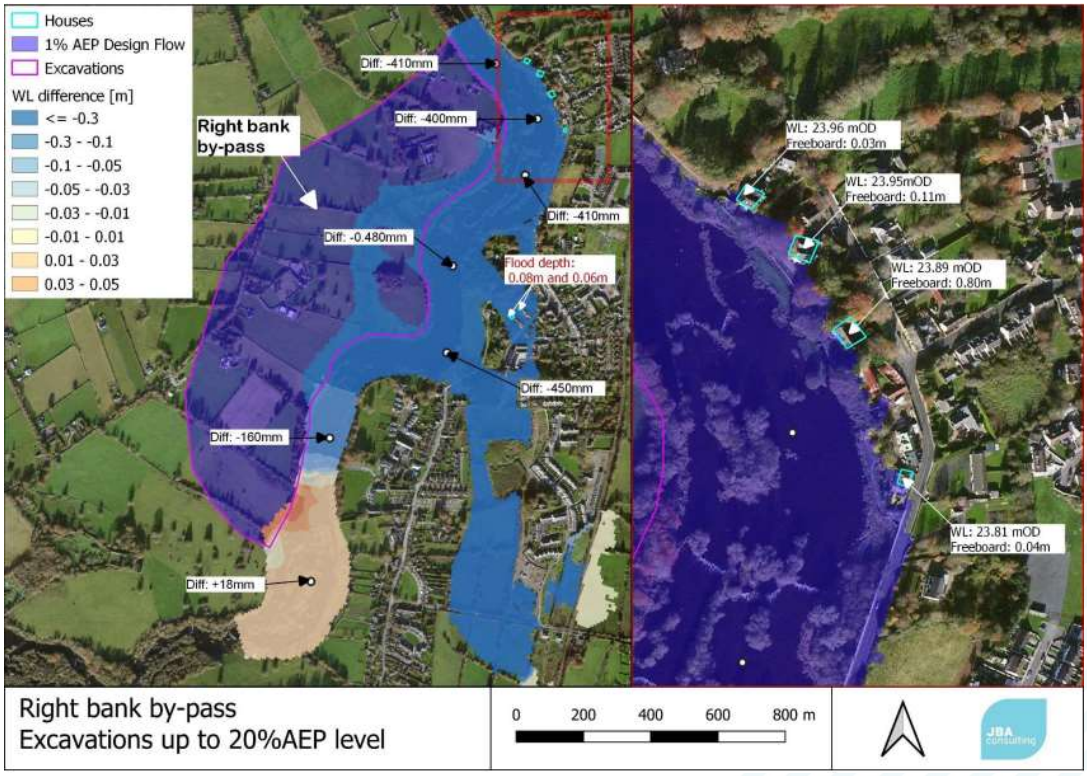


Figure 5-1: Right bank by-pass – Excavations to 20% AEP level (Flood extent for Old River Shannon and Stradbally Stream watercourses only, excludes Cedarwood Stream for display purposes)

To avoid significant impacts on the hydromorphology of the river, the right bank would need to be at a level to contain the 1 in 10-year flood flows with flows of greater magnitude breaking out into the diversion channel. For this reason, in addition to the remaining need for hard defences and the increased risk to properties downstream, this measure is not feasible.

There is already considerable upstream storage provided through the ESB managed Ardnacrusha Power Station and Parteen Weir, with extensive tracts of floodplain submerged during extreme floods.

Provision of sufficient additional storage, that does not impact on existing development was not found to be possible.

For all of these reasons, this measure was screened out at this stage.

5.1.4.2 River Restoration Works

As a result of the modified flow regime down the Old River Shannon due to Parteen Weir, the geomorphic characteristics have changed significantly over time. Increased riverbed levels due to siltation along with a number of man-made weirs and heavy vegetation growth has affected the conveyance capacity of the river through Castleconnell.

A range of river restoration works was tested within the model. These include:

- General maintenance of the riverbed and island vegetation to prevent silt and vegetation build up within the channel. This would result in a reduction in flood levels of c. 280-450mm from Rivergrove B&B to Chapel Hill however, the flood levels downstream of this were slightly increased. Furthermore, this measure alone would not reduce flood levels enough to remove the need for hard defences.

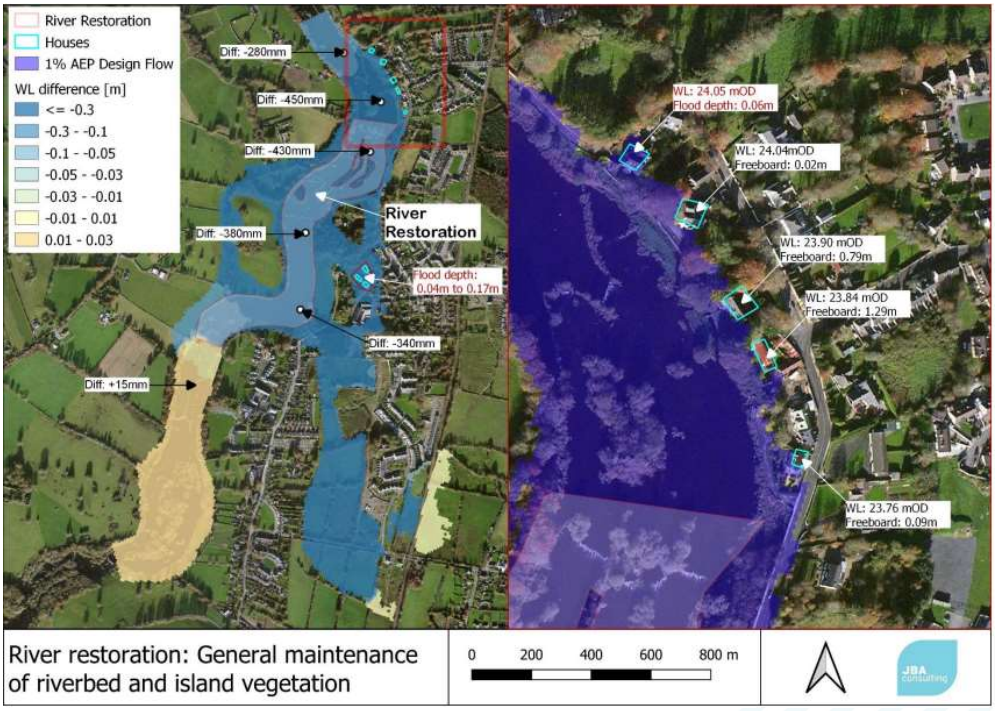


Figure 5-2: General maintenance of the riverbed and island vegetation (Flood extent for Old River Shannon and Stradbally Stream watercourses only, excludes Cedarwood Stream for display purposes)

- Softening of the bends at either side of the Old River Shannon. This would result in a reduction in flood levels of up to 240mm from Rivergrove B&B to Chapel Hill however, the flood levels downstream of this were slightly increased. This measure alone would not reduce flood levels enough to remove the need for hard defences.

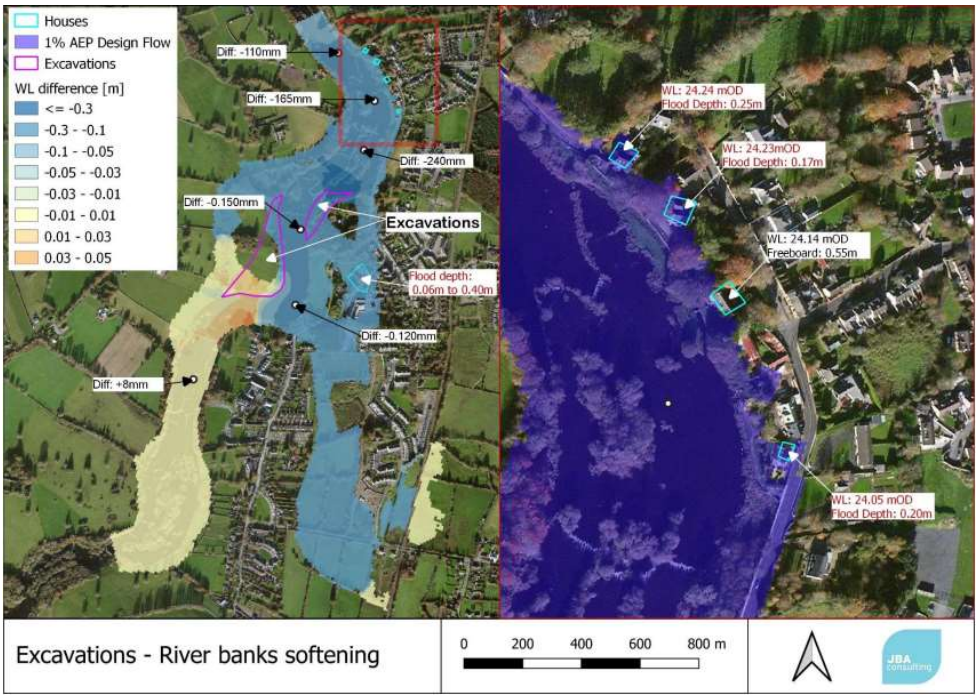


Figure 5-3: Removal of weirs and islands from the Old River Shannon (Flood extent for Old River Shannon and Stradbally Stream watercourses only, excludes Cedarwood Stream for display purposes)

- Removal of the instream weirs from the northern properties to Cloon Island, which are believed to trap sediment and debris. Hard defences were included to the centre and south of the village to test whether these river restoration works would remove the need for hard defences to the northern properties. This resulted in a reduction in flood levels of c. 65mm-195mm from Rivergrove B&B to Cloon Island however, the flood levels downstream of this were slightly increased. Once again, this measure alone would not reduce flood levels enough to remove the need for hard defences to the northern properties.

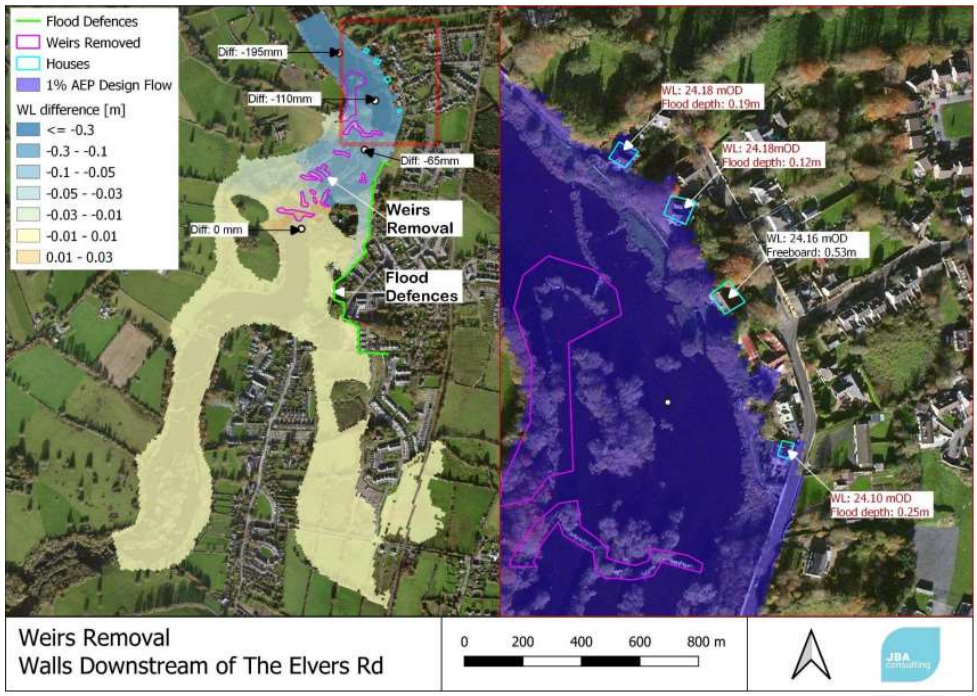


Figure 5-4: Removal of select weirs within the Old River Shannon and provision of hard defences downstream of the Elvers/Mall Road (Flood extent for Old River Shannon and Stradbally Stream watercourses only, excludes Cedarwood Stream for display purposes)

- Removal of the weirs and islands from the northern properties to Stormont House, which are believed to trap sediment and debris. Hard defences were included to the centre and south of the village to test whether these river restoration works would remove the need for hard defences to the northern properties. This would result in a reduction in flood levels of up to 490mm from Rivergrove B&B to Cloon Island however, the flood levels downstream of this were slightly increased. This measure alone would not reduce flood levels enough to remove the need for hard defences.

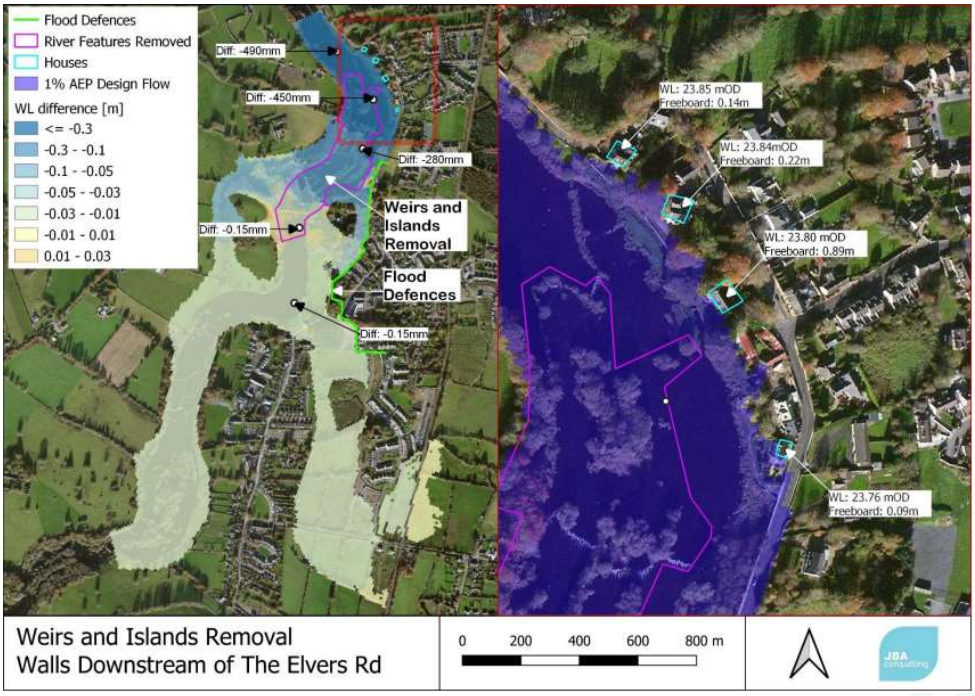


Figure 5-5: Removal of weirs and islands from the Old River Shannon (Flood extent for Old River Shannon and Stradbally Stream watercourses only, excludes Cedarwood Stream for display purposes)

- Widening of the channel at Doonass Footbridge and replacement of the existing bridge with a wider one. This did not provide any meaningful reduction in flood levels upstream meaning that hard defences would still be required.

While results varied, none of these measures resulted in a meaningful reduction in flood levels and all measures tested that improved conveyance through the village, resulted in increased flood levels downstream. Because of this, and the significant environmental impacts that would be associated with such measures, this measure was screened out at this stage.

6 Development of Flood Relief Options

The following options are a combination of the measures that were determined to be the most appropriate for Castleconnell village. Each of these options has considered how the scheme may need to be adapted in the future to allow for the impact of climate change on flows and the defences will allow for this future adaption in terms of alignment and height. This is discussed further in Section 7.

Table 6-1: Options Overview

Option	Brief Description
Option 1	- Flood defences in sections from Rivergrove B&B to Coolbane Woods. - Does not include protection to the Mall Road (Section A). - Uses Island House as part of the defences by cutting off Cloon Stream.
Option 2	- Flood defences in sections from Rivergrove B&B to Coolbane Woods. - Includes protection for the Mall Road (Section A). - Does not isolate Cloon Stream.
Option 3	- Flood defences in sections from Rivergrove B&B to Coolbane Woods. - Does not include protection to the Mall Road (Section A). - Does not isolate Cloon Stream.

It should be noted that some of the elements of the options are common to all, or some, of the options. In particular, the works to the northern and southern ends of the scheme are common to all three options. In addition, there is a need to upgrade the pluvial drainage network to account for changes in the systems downstream boundary conditions and to address existing capacity issues. These interventions do not form part of the optioneering process and are an element of work that will be resolved during the detailed design process. It is, however, known that pump stations will be required in some locations, and where these are identified these have been included in the options description for each.

6.1 Option 1

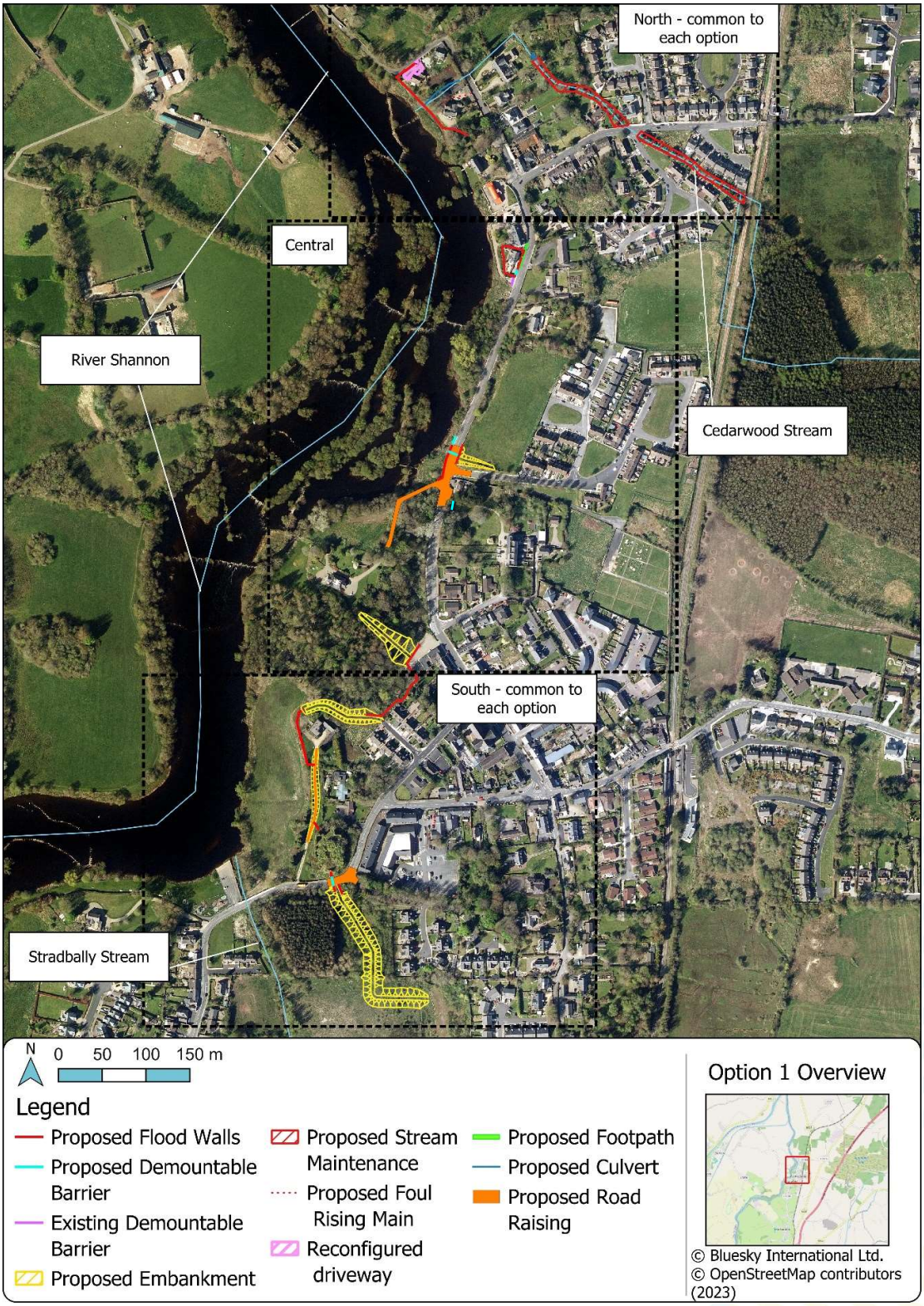


Figure 6-1: Overview of Option 1

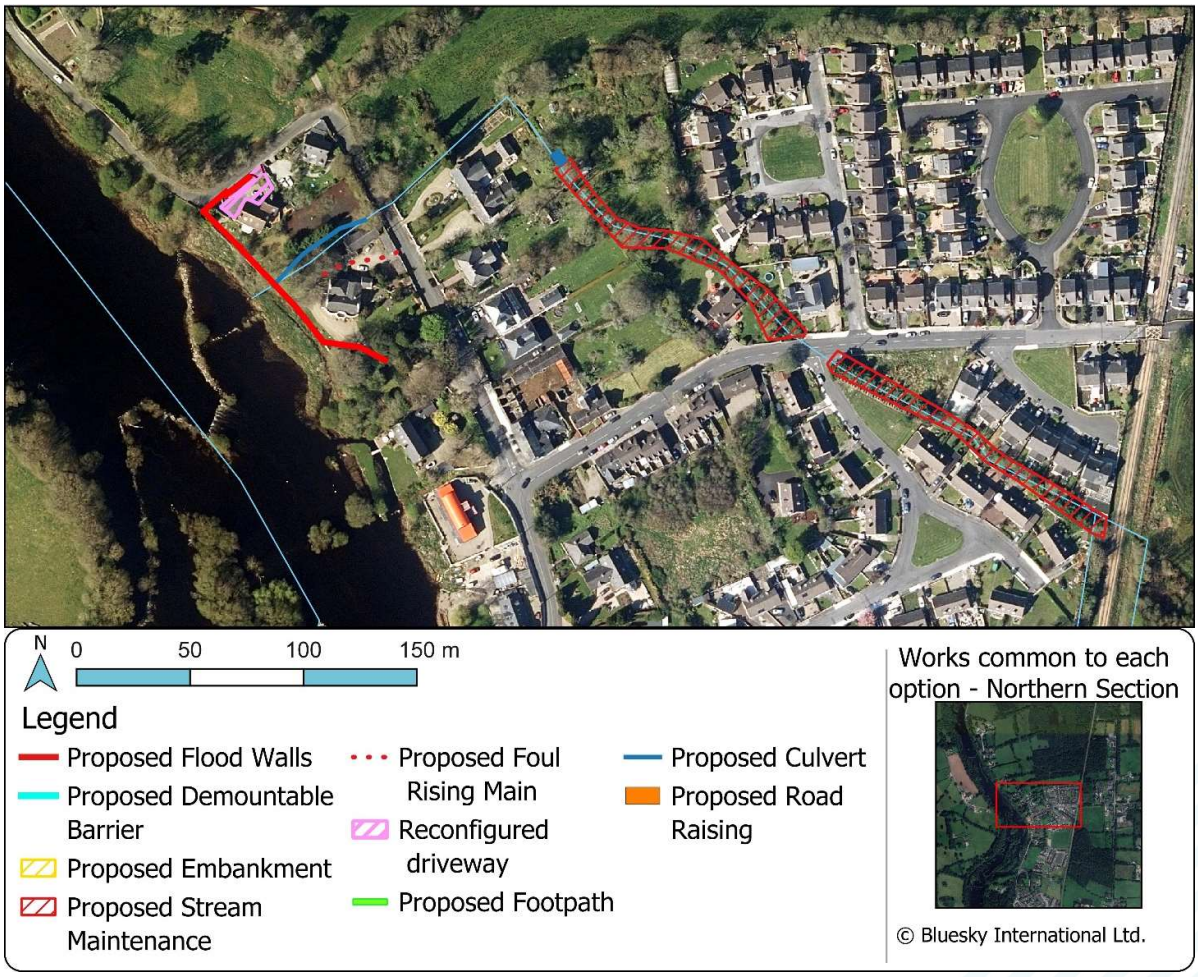


Figure 6-2 Option 1, north section (common to each option)

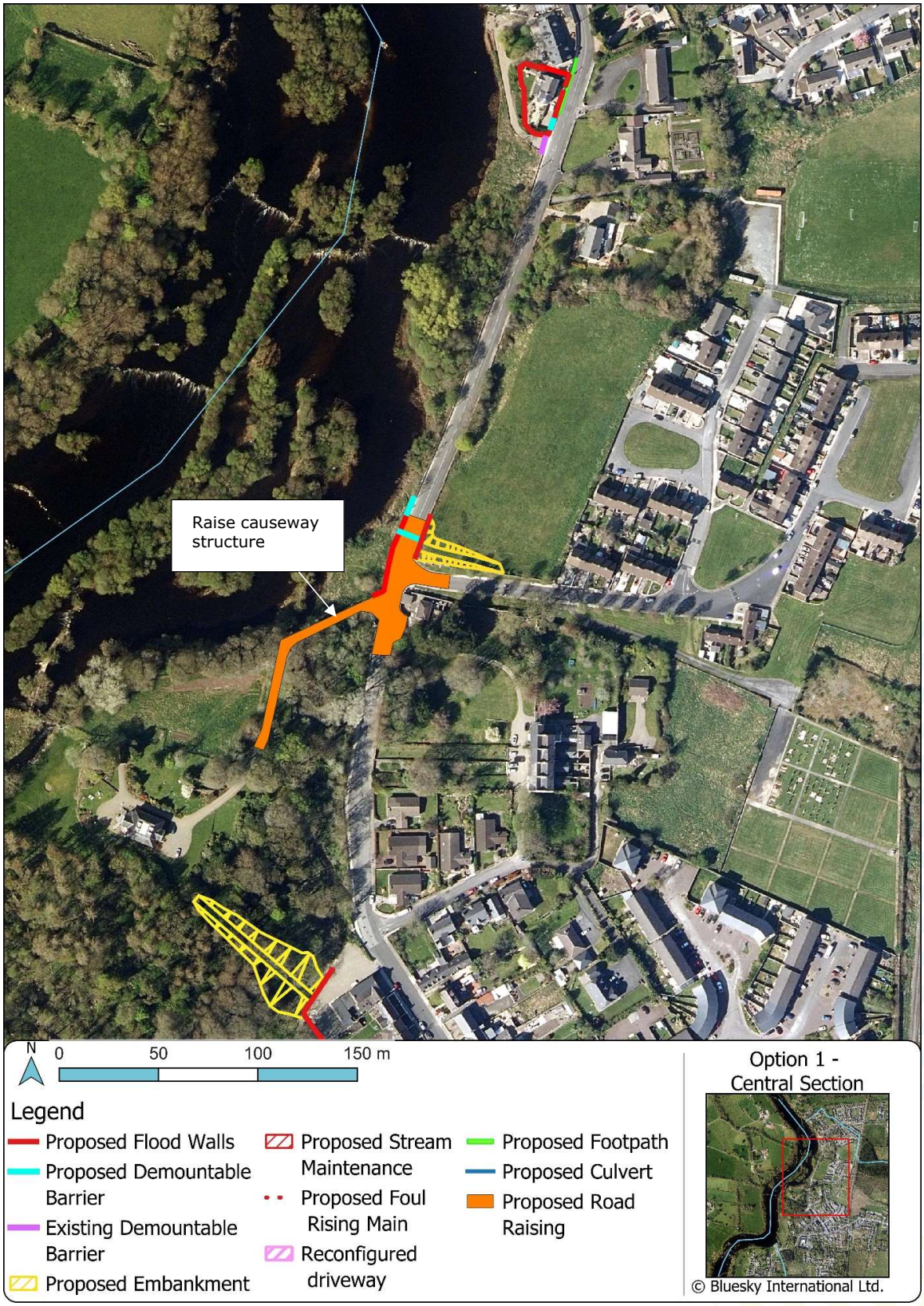


Figure 6-3 Option 1, central section

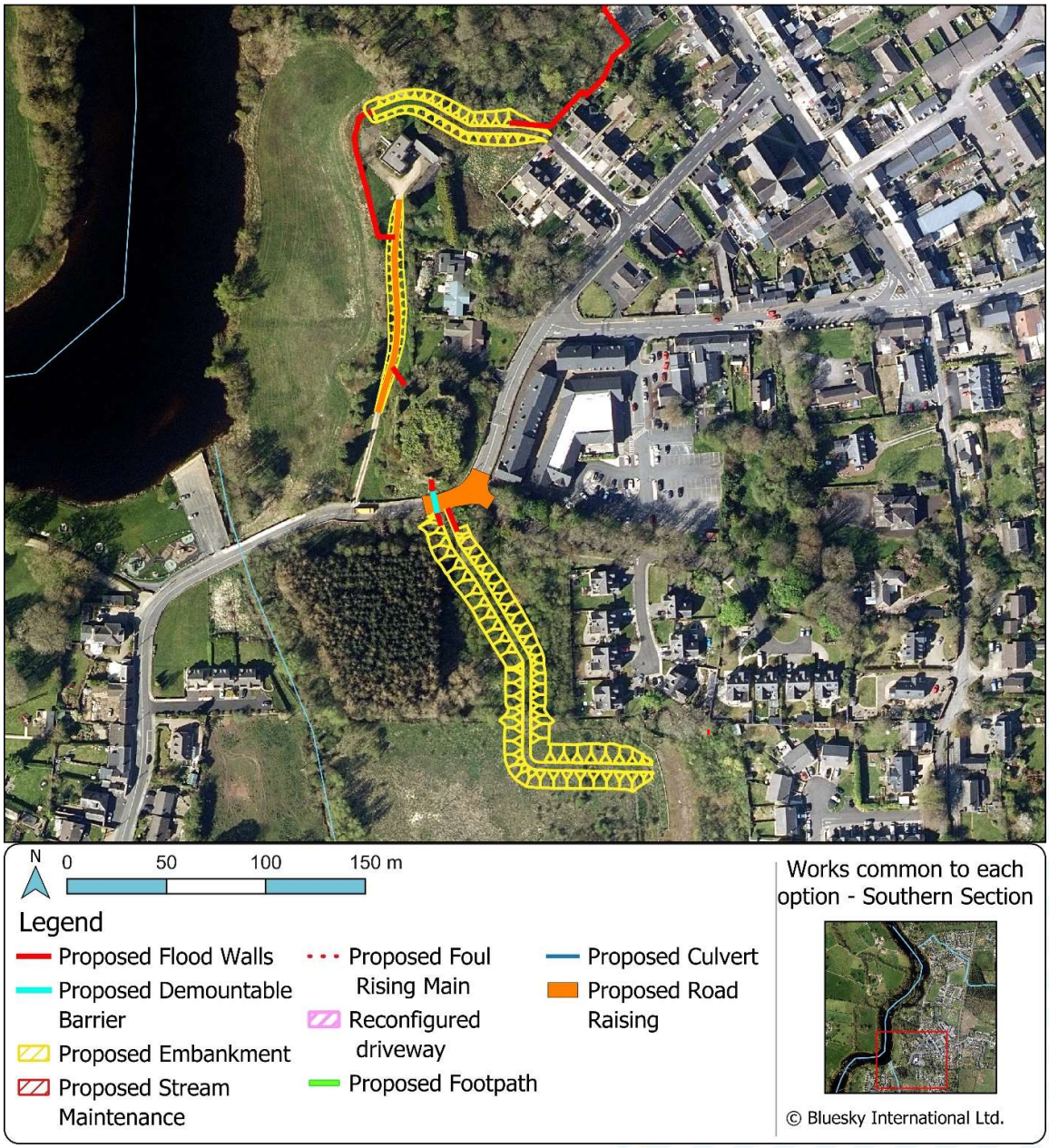


Figure 6-4 Option 1, south section (common to each option)

6.1.1 Potential Measures

Option 1 includes the following proposed defences. Text in *italics* indicates items which are common to each Option:

- *Replacement of the existing wall to the west of Rivergrove B&B with a new flood wall. The new flood wall extends across the existing entrance and a new entrance will be provided at higher ground further to the East. Relocating the entrance above the flood level omits the need for a demountable barrier at this location and provides passive flood protection to the property. Provision of a new low-level plinth inside the existing front boundary wall to the north of the B&B will avoid the need to replace the existing high stone wall. The proposed flood walls at this location will have a sheet piled foundation with a reinforced concrete plinth supporting a reinforced concrete flood wall which will be clad in stone similar to the existing wall. A short length of glass panels will be provided within the flood wall to maintain some of the view of the river from the property's conservatory.*
- *Replacement of the existing wall to the west of Grange House with a new flood wall that will continue along the southern side of the driveway until it ties in with high ground. Glass panels will be provided in sections, as agreed with the homeowner, to maintain views of the river from key areas of the house. The proposed flood wall at this location will have a sheet piled foundation with a reinforced concrete plinth supporting a reinforced concrete flood wall which will be clad in stone similar to the existing wall. The open section of the Cedarwood Stream adjacent to the Mill Building will remain open, and a new culvert will be provided from the downstream point of this open section to outfall to the River Shannon through the proposed flood wall. In order to avoid removal of the open stream feature in the garden, there will be a minor diversion of the Cedarwood Stream so that the new culvert is constructed to the north of the open stone feature. The discharge point for this culvert will remain the same to avoid any negative impacts on the receiving SAC and hydrophilous tall herb. A pumped water fountain type arrangement will be installed on the open feature to maintain the appearance and sound of flowing water. A new pumped foul connection will be provided to the public foul sewer to replace the existing free outfall from the house to the Cedarwood Stream open stream feature.*
- Replacement of the wall surrounding Mall House with a new reinforced concrete flood wall that will be clad in stone similar to the existing wall. Where the northern face of the house is constructed against the boundary wall, a proposed ramp from the boundary wall to the corner of Dunkineely House will cut off flows from the west. A demountable barrier will be provided at the vehicular entrance to Mall House. The footpath at the pedestrian entrance will be raised above the flood level to retain pedestrian access. A safety railing will be provided at the roadside of the raised footpath. It is not possible to 'design out' this demountable barrier without either removing the vehicular entrance or raising a significant length of public road, which would have a knock-on effect to the neighbouring properties. There is an existing demountable barrier at the entrance to Dunkinely House.
- *Provision of demountable barrier in the main fisherman access point through the existing Mall all, known locally as Broderick's slip. This has been identified as a key access point to the river for boating and fishing. Alternatively, ramped access was considered however was not brought forward due to reasons of construction in the SAC - the required height of such a ramp would be 1.2m meaning that it would extend over a length of c. 15-20m on each side of the ramp top. This would also result in the permanent loss of a significant area within the SAC at this location.*
- Replacement of the Island House causeway/bridge, which is a protected structure, to the MRFS level and raising of the entrance road to Island House to provide unimpeded access during flood events. Sluice gates to be fitted to the arches within the new

bridge, which will be closed in advance of a flood event and re-opened after the event has passed.

- Road raising across the whole Island House/Scanlon Park junction, to the '504 event' 1% AEP level. Provision of a demountable flood barrier across the Mall Road north of the Scanlon Park junction to defend up to the 'Baseline Design Event (limitations in operational conditions)' with an allowance for freeboard. Construction of an embankment in the southwest corner of Mall field. In order to omit the demountable barrier, the entire junction would need to be raised by c. 0.95m to the design defence level. This would prevent access for vehicles to reverse directly back to the substation, which ESB indicated would not be acceptable. Therefore, such a solution would require relocation of the substation to another location, such as Mall Field, where the required access can be provided. Access to the pumping station and Tonville would also be impacted.
- No defences required from Island House to Maher's Pub.
- Construction of an embankment across Cloon Stream from Maher's Pub to Cloon Island. Culverts through the embankment with sluice gates/penstocks fitted, to be closed in advance of a flood event and re-opened after the event has passed. As both ends of Cloon Stream will have sluice gates, there will be no flow when the gates are closed during a flood event.
- *Provision of a new flood wall to the rear of Maher's Pub car park. It is proposed to set back the wall along the rear (western) boundary by c. 6m to remain outside of the Root Protection Zone (RPZ) of the Cedar tree (which is used by herons for nesting). This wall will be constructed of reinforced concrete and clad with a stone similar to the existing surrounding walls. The flood wall extends along the northern boundary of nr. 7 Meadowbrook Estate, terminating at the end of the cul-de-sac. The section of wall from the rear of Maher's Pub to the downstream embankment will have a sheet piled foundation with a reinforced concrete plinth supporting a reinforced concrete flood wall. Some sections will be clad with stone where required. A section of the existing boundary wall at the end of the Meadowbrook cul-de-sac will be removed, and a gate will be provided through the wall to provide emergency access to Stormont House and for maintenance of the embankment in the Stormont House grounds only. There will be no access for members of the public through the gate.*
- *Provision of an embankment along the rear of Meadowbrook Estate, from nr. 7 Meadowbrook Estate and north of Stormont House.*
- *A low-level reinforced concrete flood wall along the west of Stormont House, inside the existing castellated wall. This wall will be clad with stone similar to the adjacent castellated wall.*
- *Raising ground levels along the Stormont House entrance road.*
- *A short length of low-level reinforced concrete flood wall to tie in with rock at the Castle in two locations, one to the east of the entrance to Stormont House and the second adjacent to the road raising at the Coolbane Woods junction. These walls will be concealed by earth at either side.*
- *Road raising to the '504 event' 1% AEP level at the Coolbane Woods junction adjacent to the Castle. Provision of a demountable flood barrier to the west of the junction, to defend up to the 'Baseline Design Event (limitations in operational conditions)' with an allowance for freeboard. The alternative to this would be to raise c. 160m of the Chapel Hill Road by up to 1m, which would also require replacement of the existing stone walls on either side of the road.*
- *Proposed embankment along the southern boundary of the Coolbane Wood entrance road and along the rear of house no.'s 1-4, to tie into higher ground to the south.*

- *Removal of overgrown vegetation from the Cedarwood Stream, from its interface with the railway crossing to property Coole House, as part of the construction works. Regular inspection and maintenance thereafter to manage future vegetation that may impact conveyance.*
- *Replacement of the existing circular culvert at property Coole House with a larger rectangular culvert. Widening of the existing channel for a distance of c. 15m immediately upstream of this culvert to ensure improved conveyance.*
- *To manage surface water runoff during times of flooding when outfalls are surcharged, a series of high-level overflows will be constructed in select manholes to convey surface water to two temporary pump sumps (one in Maher's Pub car park and another in the lands at Coolbane Woods) and a permanent pump at the Scanlon Park junction. Alterations in terms of alignments and pipe sizes may be made to select surface water sewers to convey the necessary flows, to be confirmed at detailed design stage.*

6.1.2 Design Constraints

There is very little working area available at a number of the elements of the proposed works. Access for construction of the flood wall to protect Rivergrove B&B and Grange House will be particularly challenging, with the river on one side and private gardens on the other.

The existing ground levels to some of the properties north of the Mall Road, particularly Grange House, are such that significant defence heights are required. Therefore, raising the driveway above the flood level was not an option given the limited space available, existing threshold level of the house and proximity of the adjacent SAC. For this reason, there was no other option but to replace the existing stone wall with a new flood wall.

At the proposed road raising locations, the proposed road level will be that of the 1% AEP flood level for the "504 event", which provides a high level of passive protection up to this scenario. Demountable flood barriers will be installed on top of this to protect against the 1% AEP flood level for the baseline design scenario.

The road raising at the Scanlon Park junction and entrance to Island House has been amalgamated into one large tabletop ramp, which will extend south to accommodate all adjacent entrances.

6.1.3 Ongoing maintenance, ownership and responsibilities

Each proposed measure will have its own bespoke management plan.

Regular inspections of the defence assets/structures will be needed, together with investigations of its performance after each flood event. Monitoring of seepage will be recommended.

Responsibility for erection of the demountable flood barriers and lowering of the sluice gates ahead of a flood event will remain with Limerick City & County Council and/or nominated contractors. For this reason, they have all been proposed at publicly accessible locations.

A maintenance plan will be developed whereby Limerick City & County Council and/or nominated maintenance contractors will inspect and install the demountable barriers and sluice gates in the form of regular trial events to examine them for any defects and to ensure that staff are trained and familiar with the installation process.

A routine inspection and maintenance plan will be developed whereby Limerick City & County Council and/or nominated maintenance contractors will inspect the Cedarwood Stream from the railway to the culvert replacement and carry out any maintenance to manage overgrowth that may affect conveyance in the channel. Access to the culvert will be via the property driveway. Access to the stream for maintenance from the railway to Glenbrook will be via the Cloon & Commons Road by foot and hand tools where possible. If a mini-excavator is required, a partial/temporary road closure will be implemented to allow for lifting the machine into the stream with a mobile crane.

A formal invasive treatment programme will be implemented whereby invasive surveys will be carried out annually and where invasive species are surveyed, a treatment programme will be put in place by Limerick City & County Council and/or nominated specialists.

6.1.4 Environmental Assessment

The potential environmental impacts associated with Option 1 are considered below. The likely impact was assessed in the following categories:

- Hydrology, hydrogeology and hydromorphology
- Biodiversity
- Cultural Heritage
- Landscape and visual amenity
- Construction and access impacts

For each of the above, we have carried out the environmental assessment based on the areas highlighted in Figure 6-1 above, i.e., north, central, and south.

6.1.4.1 Hydrology, hydrogeology and hydromorphology

Option 1 - North

During construction, temporary moderate negative effects are possible on hydrology and hydromorphology. Works to the Cedarwood Stream and the construction of walls along the bank of the River Shannon have the potential to increase sedimentation and runoff entering the nearby waterways. Mitigation measures for managing the risk to water quality are feasible, such as adherence to best practice guidance, pollution prevention and sediment management measures such as the use of bio-oils and lubricants, oil booms, spill kits, and silt fences, supervision by an ECoW, and safe concreting measures during wall construction. These will ensure that impacts to hydromorphology and hydrology are reduced to slight negative.

During the operational period, the introduction of a culvert at the open stream feature at Grange House on the Cedarwood Stream will lead to a permanent slight negative effect on hydromorphology. As the culvert is short and will be designed in accordance with IFI guidance as outlined in the EIAR, the effect is not expected to be significant.

Option 1 – Central

During construction, temporary significant negative effects are possible on hydrology and hydromorphology. Construction of the causeway and the embankment at Island House would cross over the Cloon Stream could cause significant negative effects during construction due to sedimentation and disturbance to the watercourse, and permanent negative effects during operation due to changes to the stream's hydromorphology. Temporary slight negative effects are possible on hydrology and hydromorphology during construction of the short section of retaining wall adjacent to the embankment at Scanlon Park. Construction of flood walls and embankment have the potential to increase sedimentation and runoff entering the nearby waterways, however these defences are set back further away from the River Shannon than aforementioned elements of the scheme. Mitigation measures for managing the risk to water quality are feasible, such as adherence to best practice guidance, pollution prevention and sediment management measures such as the use of bio oils and lubricants, oil booms, spill kits, and silt fences, supervision by an ECoW, and safe concreting measures during construction. These will ensure that impacts to hydromorphology and hydrology are reduced to moderate negative during construction.

Operational stage impacts in this area are not expected to be significant. Consideration will be given to the installation of petrol interceptors where space permits, for surface water ourfalls to the river, which would result in a long term positive impact.

Option 1 – South

During construction, temporary slight negative effects are possible on hydrology and hydromorphology. Construction of flood walls and embankment have the potential to increase sedimentation and runoff entering the nearby waterways, however these defences are set back further away from the River Shannon than other elements of the scheme. Also, mitigation measures for managing the risk to water quality are feasible, such as adherence to best practice guidance, pollution prevention and sediment management measures such as the use of oil booms, spill kits, and silt fences, supervision by an ECoW, and safe concreting measures during wall construction. These will ensure that impacts to hydromorphology and hydrology are further reduced.

Operational stage impacts in this area are not expected to be significant. Consideration will be given to the installation of petrol interceptors where space permits, for surface water ourfalls to the river, which would result in a long-term positive impact.

6.1.4.2 Biodiversity

Option 1 – North

The construction of flood walls and works to the Cedarwood Stream culvert will take place within the Lower River Shannon SAC. Construction within the SAC could lead to negative effects due to disturbance, loss of habitat, and pollution or increased sedimentation. The scheme has undergone Screening for Appropriate Assessment and a full Appropriate Assessment/Natura Impact Statement.

Removal of riparian vegetation to make way for access or for the proposed flood walls could lead to slight negative impacts. These would be temporary to short-term as vegetation removed could be replaced where necessary.

Moderate negative impacts on fish and aquatic species are possible during instream works or works adjacent to the riverbank due to the potential for accidental release of pollutants or increases in sedimentation, and temporary changes to habitat connectivity. These are impacts that can be mitigated during construction, such as the adoption of a surface water management plan including appropriate barrier controls, pollution and spill prevention measures, the use of bio oils and lubricants, phased installation of silt fences along the site boundary where works are taking place, and periodic monitoring by an Ecological Clerk of Works (ECoW).

Once operational, a slight negative impact will result from the introduction of the culvert at the open stream feature at Grange House. This will be designed adhering to IFI guidance to reduce impacts to fish. Overall, the impact on biodiversity in this area will be moderate negative.

Option 1 – Central

During construction, there is the potential for significant negative effects on the biodiversity of this area due to the construction of the raised causeway and embankments within the heavily wooded area around Island House, which is within the Lower River Shannon SAC.

The invasive species Giant Hogweed is present in the area around Island House; construction of the embankment could lead to accidental spread of the species, which could lead to a permanent moderate negative effect on habitats and species in this area. Mitigation measures to control the spread of invasive species will be devised for the preferred option.

Specific mitigation measures for the works in this area for the minimisation of impacts to trees are outlined in the EcIA and include the presence of an ECoW and qualified arborist. The arborist will have authority to stop works at any point and will provide insight into root structure to avoid roots in the area. If required, the arborist will recommend crowning and best removal of tree limbs to avoid tree loss. If tree loss is unavoidable, a full assessment will take place on bank stability and root structure.

Where possible, trees will be retained, however the required footprint of the embankment means that some tree removal is inevitable. The flood wall at the rear of Maher's Pub car park will be set back by 6m to avoid damage to the root protection zone of the Cedar tree that contains multiple

heron's nests. If removal of trees with heron's nests is required at construction stage, this could lead to significant negative impacts in the operational phase of the scheme.

Option 1 – South

Construction of the embankment and walls at Stormont House is within the SAC and could lead to negative effects due to disturbance, loss of habitat, and pollution or increased sedimentation. The scheme has undergone a Screening for Appropriate Assessment and a full Appropriate Assessment/Natura Impact Statement.

The construction of the embankment at Coolbane Woods will require vegetation removal within an area identified as affinity to alluvial woodland, which could lead to moderate negative impacts. To offset this impact, it is proposed to compensate for this by enhancing an adjacent area so that it will naturally develop into alluvial woodland.

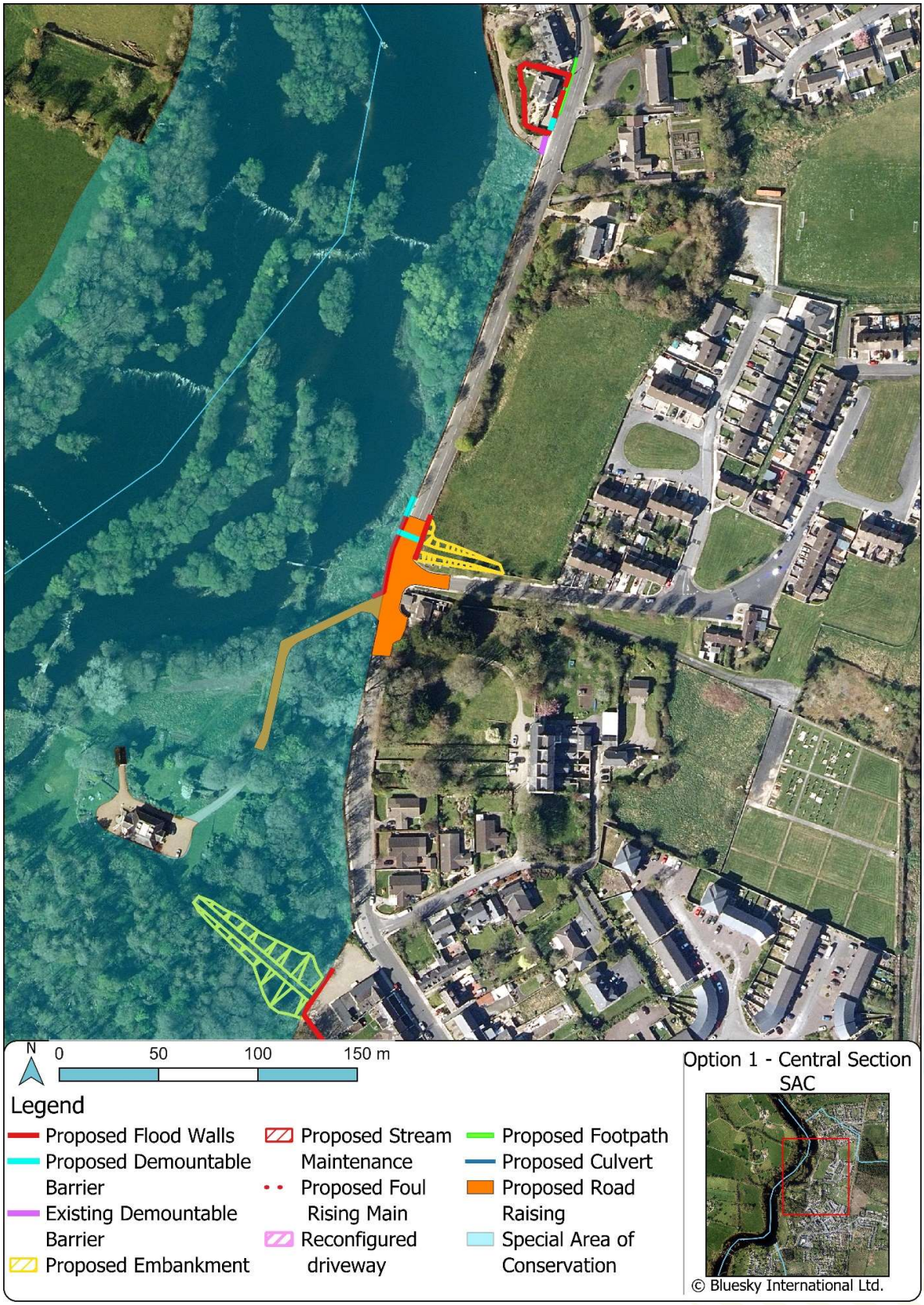


Figure 6-5: Option 1 Central section, showing SAC boundary

6.1.4.3 Cultural Heritage

Option 1 – North

The works for Option 1 are within an Architectural Conservation Area (ACA), and nine structures listed on the Record of Protected Structures (RPS) are in the vicinity. One of these RPS buildings, Grange House (RPS No. 1075) will have flood walls constructed along its boundary with the River Shannon. This will impact the curtilage of the property, but will not affect the structure itself, so a permanent moderate negative effect is expected. Consideration was given to strengthening of the existing walls however, this is not possible due to the existing construction of the wall, the level difference on each side, the underlying ground conditions, the extent of raising required and the proximity of the adjacent SAC. Other features in this area will have no impact or a slight impact only.

Option 1 – Central

Mall House (NIAH No. 21807034) at the northern side of this area is listed on the National Inventory of Architectural Heritage. The proposed defences will not impact the house directly but will have a slight negative impact on its setting and views. Island House (RPS No. 1085) itself is a protected structure, however the boundary walls which are to be altered are not. Once these walls are replaced to a similar condition (i.e., by re-using original wall materials where possible or sourcing similar materials), the original wall can be demolished. Much of the work in this area is inside an ACA. While permanent impacts to protected structures are not anticipated, proposed measures may impact on the setting of these sites. The expected impact is therefore moderate negative.

The causeway/bridge to Cloon Island is on the RPS (RPS No. 5056). Significant alterations to this stone bridge are proposed, which will lead to a significant negative impact.

Option 1 – South

Construction works and the introduction of flood walls in the vicinity of Castleconnell Castle (LI001-003) will have a slight permanent impact on its setting but will not be significant and will not affect the Castle itself. Construction work will take place in the Zone of Notification of the Castle however, so mitigation measures will be required. Impacts to other cultural heritage receptors in this area will be slight negative or have no impacts.

6.1.4.4 Landscape

Option 1 – North

Permanent moderate negative effects on visual amenity are expected in this area due to the construction of flood defence walls along the Old River Shannon, directly affecting views from two houses. To reduce the impacts sections of glass panels have been proposed in the flood wall at these two properties, as agreed with the homeowners, to maintain views of the river from key locations within their properties and gardens.

During construction, temporary slight negative effects will occur due to works adjacent to the River Shannon along two houses and a short section of public road. Machinery and excavations will be visible from the road and the two residences. These effects will be temporary and not significant and will be mitigated against by operating plans to be put in place by the appointed contractor, such as the erection of hoarding and restriction of working hours.

Option 1 – Central

Flood walls will be constructed around one house, resulting in permanent moderate negative effects on visual amenity. The provision of flood walls at Maher's Pub will also lead to a slight negative effect. Permanent effects on visual amenity and landscape are not expected due to the road raising or embankment at Scanlon Park.

During construction, temporary slight negative effects will occur due to the construction works. Machinery and excavations will be visible from the road and nearby residences. These effects will be temporary and not significant and will be mitigated against by operating plans to be put in

place by the appointed contractor, such as the erection of hoarding and restriction of working hours. These impacts will not be significant.

Option 1 – South

Construction of flood walls will lead to permanent moderate negative effects for one house, with its views towards the River Shannon affected. Views from houses in Coolbane Woods will not be impacted due to the construction of an embankment, which will be c. 1m lower than the existing boundary wall to the rear of the properties. Therefore, the overall impact here will be a slight negative.

During construction, temporary slight negative impacts on visual amenity are likely due to the use of machinery and construction works. Machinery and excavations will be visible from the road and nearby residences. These effects will be temporary and not significant and will be mitigated against by operating plans to be put in place by the appointed contractor, such as the erection of hoarding and restriction of working hours. These impacts will not be significant.

6.1.4.5 Construction Impacts and Operational Access

Option 1 – North

Construction works will involve the use of private property for access resulting in a potential temporary slight negative effect for residents with the potential for disturbance and restricted access. This will be limited to the construction phase. Measures to mitigate impact on access and residential amenity will be outlined in the operating plans to be devised by the contractor. Access will be required to private property during the operational stage for inspection of defences and repair if necessary.

Option 1 – Central

There is the potential for temporary slight negative effects for residents, pedestrians and road users through disturbance associated with construction works at the Island House/Scanlon Park entrances, at Maher's Pub car park and raising of the footpath at Mall House. Measures to mitigate impact on access and residential amenity will be outlined in the operating plans and traffic management plans, which should include access for emergency vehicles, to be devised by the contractor. The extent of road raising required means that partial or full road closures will be required.

Once operational, access to Castleconnell village from the north will be restricted by the demountable flood barrier across Mall Road at the Scanlon Park entrance. This impact will occur only during flooding. The impact will be moderate but intermittent, with alternative routes to and from the village available.

Once operational, the Mall Road between Island House and Shannon Stores will no longer be impacted during flooding, ensuring that access is available at all times. This will be an overall benefit.

Option 1 – South

There is the potential for temporary slight negative effects for residents, pedestrians and road users through disturbance associated with construction works in this area. Measures to mitigate impact on access and residential amenity will be outlined in the operating plans to be devised by the contractor, however the extent of road raising required means that partial or full road closures are likely to occur.

Once operational, access to Castleconnell village from the south will be restricted by the demountable flood barrier across Chapel Hill. This impact will occur only during flooding. The impact will be moderate but intermittent, with alternative routes to and from the village available. Once operational, the roads from Meadowbrook Estate and SuperValu to the Coolbane Woods junction will no longer be impacted during flooding, ensuring that access is available at all times. This will be an overall benefit.

6.2 Option 2

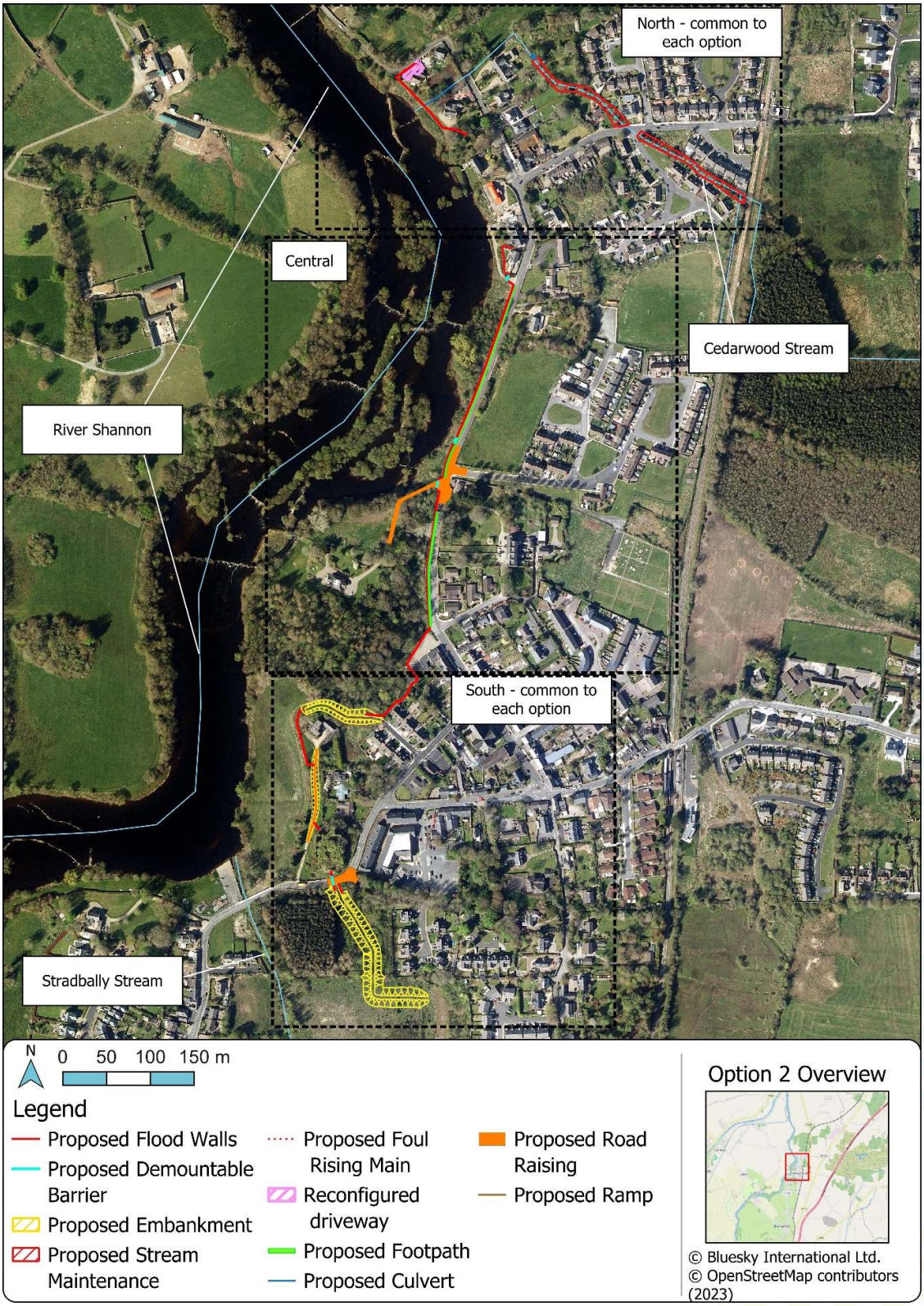


Figure 6-6: Overview of Option 2

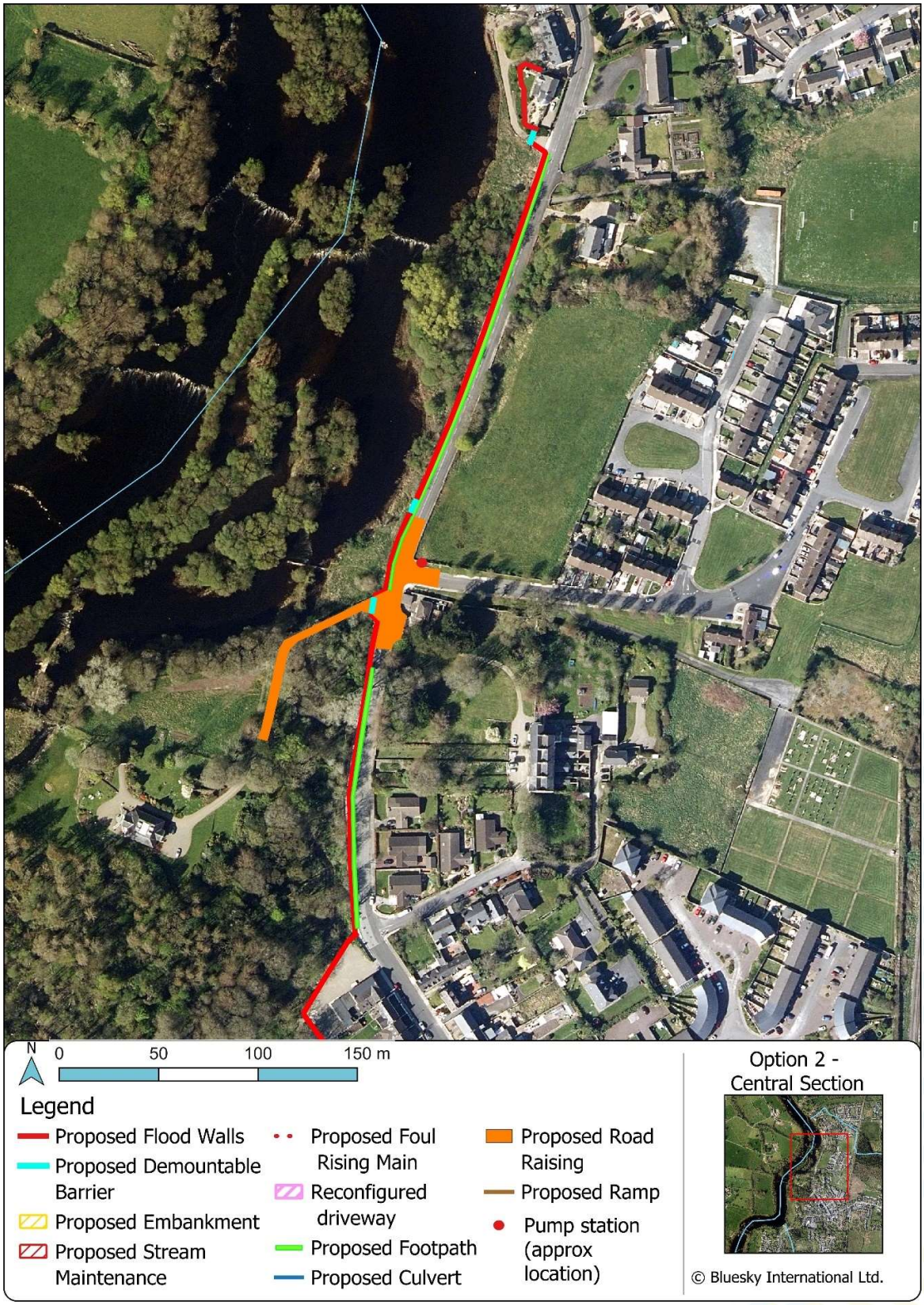


Figure 6-7 Option 2, Central section

6.2.1 Potential Measures

Option 2 comprises the following proposed defences. Text in *italics* indicates items which are common to each Option:

- *Replacement of the existing wall to the west of Rivergrove B&B with a new flood wall. The new flood wall extends across the existing entrance and a new entrance will be provided at higher ground further to the east. Relocating the entrance above the flood level omits the need for a demountable barrier at this location and provides passive flood protection to the property. Provision of a new low-level plinth inside the existing front boundary wall to the north of the B&B will avoid the need to replace the existing high stone wall. The proposed flood walls at this location will have a sheet piled foundation with a reinforced concrete plinth supporting a reinforced concrete flood wall which will be clad in stone similar to the existing wall. A short length of glass panels will be provided within the flood wall to maintain some of the view of the river from the conservatory.*
- *Replacement of the existing wall to the west of Grange House with a new flood wall that will continue along the southern side of the driveway until it ties in with high ground. Glass panels will be provided in sections, as agreed with the homeowner, to maintain views of the river from key areas of the house. Ground levels between the driveway and the wall will be raised flush with the driveway to minimize the height of the wall from the garden. The proposed flood wall at this location will have a sheet piled foundation with a reinforced concrete plinth supporting a reinforced concrete flood wall which will be clad in stone similar to the existing wall. The open section of the Cedarwood Stream adjacent to the Mill Building will remain open, and a new culvert will be provided from the downstream point of this open section to outfall to the River Shannon through the proposed flood wall. In order to avoid removal of the open stream feature in the garden, there will be a minor diversion of the Cedarwood Stream so that the new culvert is constructed to the north of the open stone feature. The discharge point for this culvert will remain the same to avoid any negative impacts on the receiving SAC and hydrophilous tall herb. A pumped water fountain type arrangement will be installed on the open feature to maintain the appearance and sound of flowing water. A new pumped foul connection will be provided to the public foul sewer to replace the existing free outfall from the house to the Cedarwood Stream open stream feature.*
- Replacement of the wall to the north, west and south of Mall House with a new reinforced concrete flood wall that will be clad in stone similar to the existing wall. Where the northern face of the house is constructed against the boundary wall, a proposed ramp from the boundary wall to the corner of Dunkineely House will cut off flows from the west. The northern wing wall and hedge to the main entrance of Dunkineely House will be removed and demountable barriers will be provided in the gateway (one existing vehicular entrance plus one proposed pedestrian entrace). Protection is not required to the front of Mall House because the Mall Road is protected.
- *Provision of a new demountable flood barrier to the entrance on Dunkineely House (immediately to the south of Mall House). The alternative to a demountable barrier at this location would be to raise the driveway for a length of approximately 60m and/or the adjacent stone wall. This would involve potential impacts to the adjacent alluvial woodland. As the river runs immediately adjacent to a section of the wall under normal flow conditions, significant works would be required in the SAC to mitigate against pollution during construction. Such works would prevent the flow path onto the public road but would not provide access for the property. This would involve further raising of the driveway along its entire length up to the house. It should be noted that alternative access is available through a gated entrance to the north of the*

house, however, this should only be used as an emergency access due to the restricted sightlines on the road.

- The existing wall to the west of Mall Road is to be replaced by a new flood wall. This new structure will be set back and constructed outside the Special Area of Conservation (SAC) and alluvial woodland area, ensuring minimal environmental impact.. This wall will be constructed of reinforced concrete and clad with stone from the existing wall, where possible, on the dry side and with a similar locally sourced stone on the wet side. The capping from the existing wall will be re-used where possible.
- *Provision of demountable barrier in the main fisherman access point through the existing Mall wall, known locally as Broderick's slip. This has been identified as a key access point to the river for boating and fishing. Alternatively, a ramped access was considered however was not brought forward due to reasons of construction in the SAC - the required height of such a ramp would be 1.2m meaning that it would extend over a length of c. 15-20m on each side of the ramp top. This would also result in the permanent loss of a significant area within the SAC at this location.*
- Provision of a ramp at the entrance to Island House, to the '504 event' 1% AEP flood level (23.70m). Provision of a demountable flood barrier on top of this to defend up to the 'Baseline design event (limitations in operational conditions)' with an allowance for freeboard. Nominal raising of the Scanlon Park junction, approx. 100mm, will be required to accommodate this. Raising of the driveway to Island House by c. 250mm. Provision of a new handrail along either side of the causeway. Removal of the sluice gates on the causeway structure to allow flow through Cloon Stream.
- The existing wall between Island House and Maher's Pub will be replaced with a new flood wall, set back for most of its length. However, approximately 55 metres of the wall, immediately south of the entrance to Island House, will be aligned with the existing wall due to the narrowness of the adjacent road.. This wall will be constructed of reinforced concrete and clad with a stone similar to the existing.
- *Provision of a new flood wall to the rear of Maher's Pub car park. It is proposed to set back the wall along the rear (western) boundary by c. 6m to remain outside of the RPZ of the Cedar tree (which is used by herons for nesting). This wall will be constructed of reinforced concrete and clad with a stone similar to the existing surrounding walls. The flood wall extends along the northern boundary of nr. 7 Meadowbrook Estate, terminating at the end of the cul-de-sac. The section of wall from the rear of Maher's Pub to the downstream embankment will have a sheet piled foundation with a reinforced concrete plinth supporting a reinforced concrete flood wall. Some sections will be clad with stone where required. A section of the existing boundary wall at the end of the Meadowbrook cul-de-sac will be removed, and a gate will be provided through the wall to provide emergency access to Stormont House and for maintenance of the embankment in the Stormont House grounds only. There will be no access for members of the public through the gate.*
- *Provision of an embankment along the rear of Meadowbrook Estate, from nr. 7 Meadowbrook Estate and north of Stormont House*
- *A low-level reinforced concrete flood wall along the west of Stormont House, inside the existing castellated wall. This wall will be clad with stone similar to the adjacent castellated wall.*
- *Raising ground levels along the Stormont House entrance road.*
- *A short length of low-level reinforced concrete flood wall to tie in with rock at the Castle in two locations, one to the east of the entrance to Stormont House and the second adjacent to the road raising at the Coolbane Woods junction. These walls will be concealed by earth at either side.*

- *Road raising to the '504 event' 1% AEP level at the Coolbane Woods junction adjacent to the Castle. Provision of a demountable flood barrier to the west of the junction, to defend up to the 'Baseline Design Event (limitations in operational conditions)' with an allowance for freeboard. The alternative to this would be to raise c. 160m of the Chapel Hill Road by up to 1m, which would also require replacement of the existing stone walls on either side of the road.*
- *Proposed embankment along the southern boundary of the Coolbane Woods entrance road and along the rear of house no.'s 1-4, to tie into higher ground to the south.*
- *Removal of overgrown vegetation from the Cedarwood Stream, from its interface with the railway crossing to property Coole House, as part of the construction works. Regular inspection and maintenance thereafter to manage future vegetation that may impact conveyance.*
- *Replacement of the existing circular culvert at property Coole House with a larger rectangular culvert. Widening of the existing channel for a distance of c. 15m immediately upstream of this culvert to ensure improved conveyance.*
- *To manage surface water runoff during times of flooding when outfalls are surcharged, a series of high-level overflows will be constructed in select manholes to convey surface water to two temporary pump sumps (one in Maher's Pub car park and another in the lands at Coolbane Woods) and a permanent pump at the Scanlon Park junction. Alterations in terms of alignments and pipe sizes may be made to select surface water sewers to convey the necessary flows, to be confirmed at detailed design stage.*

6.2.2 Design Constraints

There is very little working area at a number of the elements of the proposed works. Access for construction of the flood wall to protect Rivergrove B&B and Grange House will be particularly challenging, with the river on one side and the private gardens on the other.

The existing ground levels to some of the properties north of the Mall Road, particularly Grange House, are such that significant defence heights are required. Therefore, raising the driveway above the flood level was not an option given the limited space available, existing threshold level of the house and proximity of the adjacent SAC. For this reason, there was no other option but to replace the existing stone wall with a new flood wall.

Due to the proximity of the SAC, the proposed defences will be designed to mitigate negative impacts. The proposed flood walls alongside the Mall Road and between Island House and Maher's Pub have been designed so that all works will remain outside of the SAC, except for a 55m section immediately south of Island House where works will be required within the SAC due to the narrowness of the road. There is an existing gas main present beneath the footway, which will require diverting to accommodate the offset flood wall. The proposed set-back flood walls will allow for a minimum footpath width of 1.8m and road width of 5.5m.

At the Coolbane Woods junction, the proposed road level will be that of the 1% AEP flood level for the "504 event", which provides a high level of passive protection up to this scenario. Demountable flood barriers will be installed on top of this to protect against the 1% AEP flood level for the baseline design scenario.

The proposed defences will allow for the sluice gates on the Island House bridge to be removed, thus maintaining the flow path through Cloon Stream.

6.2.3 Ongoing maintenance, ownership and responsibilities

Each proposed measure will have its own bespoke management plan.

Regular inspections of the defence assets/structures will be needed, together with investigations of its performance after each flood event. Monitoring of seepage will be recommended.

Responsibility for erection of the demountable flood barriers ahead of a flood event will remain with Limerick City & County Council and/or nominated contractors. For this reason, they have all been proposed at publicly accessible locations.

A maintenance plan will be developed whereby Limerick City & County Council and/or nominated maintenance contractors will inspect and install the demountable barriers once per year to examine them for any defects and to ensure that staff are trained and familiar with the installation process.

A routine inspection and maintenance plan will be developed whereby Limerick City & County Council and/or nominated maintenance contractors will inspect the Cedarwood Stream from the railway to the culvert replacement and carry out any maintenance to manage overgrowth that may affect conveyance in the channel. Access to the culvert will be via the property driveway. Access to the stream for maintenance from the railway to Glenbrook will be via the Cloon & Commons Road by foot and hand tools where possible. If a mini-excavator is required, a partial/temporary road closure will be implemented to allow for lifting the machine into the stream with a mobile crane.

A formal invasive treatment programme will be implemented whereby invasive surveys will be carried out annually and where invasive species are surveyed, a treatment programme will be put in place by Limerick City & County Council and/or nominated specialists.

6.2.4 Environmental Assessment

The potential environmental impacts associated with Option 2 are considered below. The likely impact was assessed in the following categories:

- Hydrology, hydrogeology and hydromorphology
- Biodiversity
- Cultural Heritage
- Landscape and visual amenity
- Construction and access impacts

For each of the above, we have carried out the environmental assessment based on the areas highlighted in Figure 6-6 above, i.e., north, central, and south.

6.2.4.1 Hydrology, hydrogeology and hydromorphology

Option 2 - North

During construction, temporary moderate negative effects are possible on hydrology and hydromorphology. Clearance works and culvert installation along the Cedarwood Stream and the construction of walls along the bank of the River Shannon have the potential to increase sedimentation and runoff entering the nearby waterways. Mitigation measures for managing the risk to water quality are feasible, such as adherence to best practice guidance, pollution prevention and sediment management measures such as the use of bio oil and lubricants, oil booms, spill kits, and silt fences, supervision by an ECoW, and safe concreting measures during wall construction. These will ensure that impacts to hydromorphology and hydrology are reduced to slight negative.

During the operational period, the introduction of a culvert on the Cedarwood Stream will lead to a permanent slight negative effect on hydromorphology. As the culvert is short and will be designed in accordance with IFI guidance as outlined in the EcIA, the effect will not be significant.

Option 2 – Central

During construction, temporary moderate negative effects are possible on hydrology and hydromorphology. Construction of flood walls along the length of the Mall Road and rebuilding of the boundary wall along Island House have the potential to increase sedimentation and runoff entering the nearby waterways through the SAC habitat along the walls. The total length of

works is greater than in Option 1 or 3, leading to a greater impact than those options. Mitigation measures for managing the risk to water quality are feasible, such as adherence to best practice guidance, pollution prevention and sediment management measures such as the use of oil booms, spill kits, and silt fences, supervision by an ECoW, and safe concreting measures during wall construction. A file note has also been prepared which outlines the design of the proposed wall and the proposed construction methodology. The file note shows that the proposed flood wall will be constructed from within the road area, i.e., not on the river side of the existing wall. This early detailed design will ensure that potential construction stage impacts are kept to moderate, despite the length of the proposed wall.

Operational stage impacts in this area are expected to be not significant. As the proposed wall is approx. 1m back from the existing wall, an approx. 1m wide strip along the full length of wall will re-naturalise over time and become an extension of the existing riparian zone. This could lead to a positive long-term impact when compared with the existing situation. Therefore, the installation of petrol interceptors will be undertaken where space permits, for surface water outfalls to the river, which would also be a long-term positive impact.

Option 2 – South

During construction, temporary slight negative effects are possible on hydrology and hydromorphology. Construction of flood walls and embankment have the potential to increase sedimentation and runoff entering the nearby waterways, however these defences are set back further away from the River Shannon than the other elements of the scheme. Also, mitigation measures for managing the risk to water quality are feasible, such as adherence to best practice guidance, pollution prevention and sediment management measures such as the use of oil booms, spill kits, and silt fences, supervision by an ECoW, and safe concreting measures during wall construction. These will ensure that impacts to hydromorphology and hydrology are further reduced.

Operational stage impacts in this area are not expected to be significant.

6.2.4.2 Biodiversity

Option 2 – North

The construction of flood walls and works to the Cedarwood Stream culvert will take place within the Lower River Shannon SAC. Construction within the SAC could lead to negative effects due to disturbance, loss of habitat, and pollution or increased sedimentation. The scheme has undergone Screening for Appropriate Assessment and a full Appropriate Assessment, Natura Impact Statement.

Removal of riparian vegetation to make way for access or for the proposed flood walls could lead to slight negative impacts. These would be temporary to short-term as vegetation removed could be replaced where necessary.

Moderate negative impacts on fish and aquatic species are possible during instream works or works adjacent to the riverbank due to the potential for accidental release of pollutants or increases in sedimentation, and temporary changes to habitat connectivity. These are impacts that can be mitigated during construction, such as the adoption of a surface water management plan including appropriate barrier controls, pollution and spill prevention measures, the use of bio oils and lubricants, phased installation of silt fences along the site boundary where works are taking place, and periodic monitoring by an Ecological Clerk of Works (ECoW).

Once operational, a slight negative impact will result from the introduction of the culvert instream between Rivergrove B&B and Grange House. This will be designed adhering to IFI guidance to reduce impacts to fish. Overall, the impact on biodiversity in this area will be moderate negative.

Option 2 – Central

During construction, there is the potential for temporary moderate negative effects on the biodiversity of this area due to the construction of flood walls and embankments within the heavily wooded area around Island House, which is part of the Lower River Shannon SAC.

The invasive species Giant Hogweed is present in the area around Island House; construction of the flood wall could lead to accidental spread of the species, which could lead to a permanent moderate negative effect on habitats and species in this area. Mitigation measures to control the spread of invasive species will be devised for the preferred option.

As the defences in this area for Option 2 are mostly outside the wooded area, impacts are expected to be slight negative when compared to Option 1.

The wall which will be built along the full length of Mall Road in this option will be constructed in the existing road/footpath area. The works will take place outside the riparian habitat and Annex I Alluvial Woodland. The existing wall will be removed and the area between it and the proposed wall will be backfilled and allowed to naturalise as part of the riparian habitat. This will allow for an increase in the riparian habitat while ensuring that works do not take place within it. An extract from the file note discussing wall construction is shown below, showing the proposed wall set back approx. 1m from the existing wall. As discussed above, due to the narrowness of the road, the new flood wall for a length of c. 55m immediately south of Island House will be replaced along the existing alignment. This will result in temporary works in the SAC while the foundation of this section of wall will extend into the SAC permanently. Removal of select trees will also be required.

Removal of the sluice gates on the Island House causeway structure will result in a long-term positive impact.

While construction stage impacts are greater in Option 2 than in Option 3, due to the greater level of construction here, the setback of the wall will lead to a long-term positive impact in the operational stage. As the proposed wall is approx. 1m back from the existing wall, an approx. 1m wide strip along the full length of wall will re-naturalise over time and become an extension of the existing riparian zone. The overall impact on biodiversity is therefore judged to be moderate.

The flood wall at the rear of Maher's Pub car park will be set back by 6m to avoid damage to the root protection zone of the Cedar tree that contains multiple heron's nests. If removal of trees with heron's nests is required at construction stage, this could lead to significant negative impacts in the operational phase of the scheme.

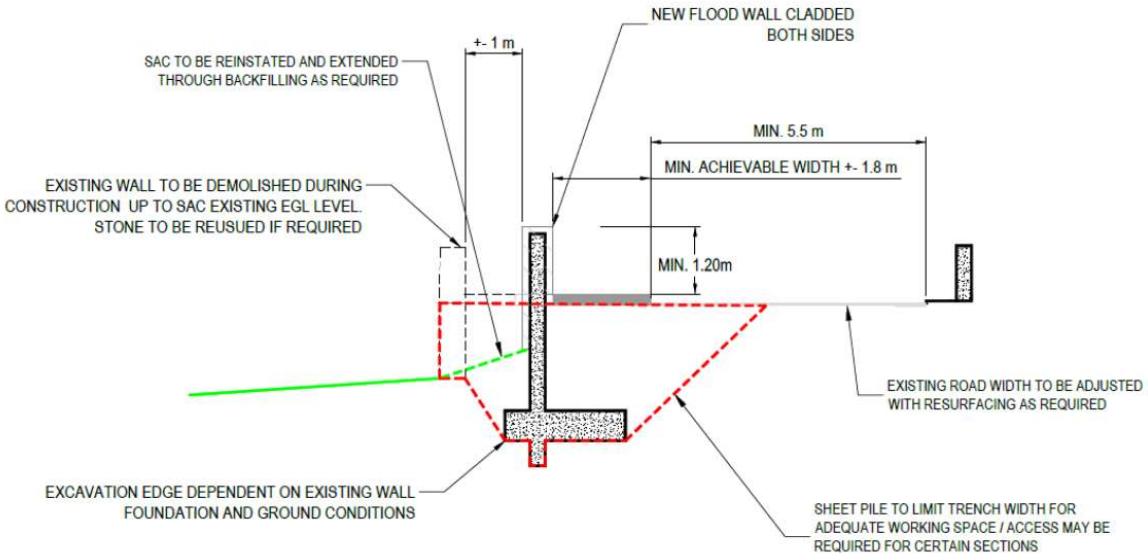


Figure 6-8: Proposed flood wall cross section, showing that it will be constructed within the road area and away from the riparian habitat

Option 2 – South

Construction of the embankment and walls at Stormont House is within the SAC and could lead to negative effects due to disturbance, loss of habitat, and pollution or increased sedimentation. The scheme has undergone Screening for Appropriate Assessment and a full Appropriate Assessment/Natura Impact Statement.

The construction of the embankment at Coolbane Woods will require vegetation removal within an area identified as affinity to alluvial woodland, which could lead to moderate negative impacts. To offset this impact, it is proposed to compensate for this by enhancing an adjacent area so that it will naturally develop into alluvial woodland.

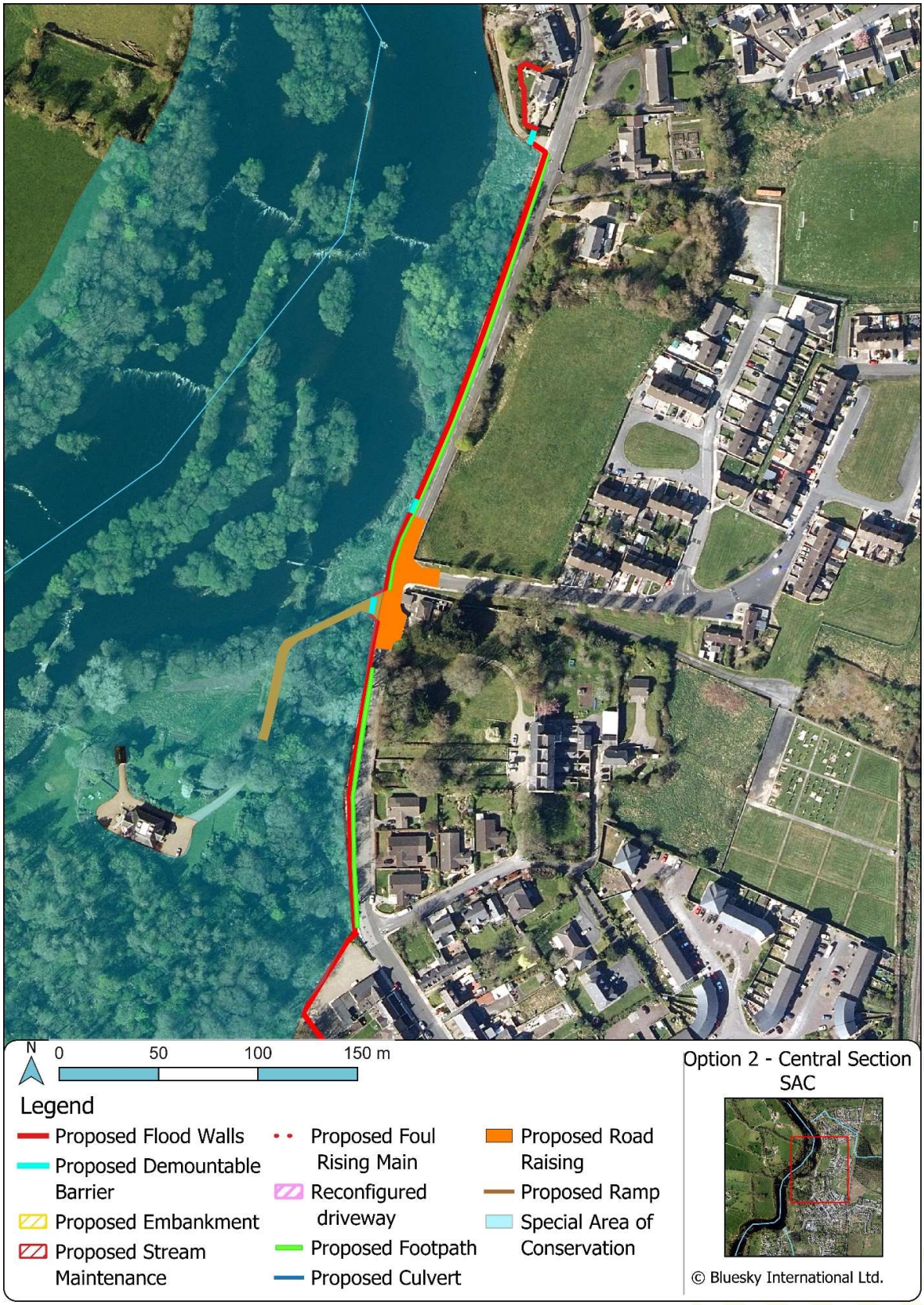


Figure 6-9: Option 2 central section, showing SAC boundary

6.2.4.3 Cultural Heritage

Option 2 – North

The works for Option 2 are within an Architectural Conservation Area (ACA), and nine structures listed on the Record of Protected Structures (RPS) are in the vicinity. One of these RPS buildings, Grange House (RPS 1075) will have flood walls constructed along its boundary with the River Shannon. This will impact the curtilage of the property, but will not affect the structure itself, so a permanent slight negative effect is expected. Consideration was given to strengthening of the existing walls however, this is not possible due to the existing construction of the wall, the level difference on each side, the underlying ground conditions, the extent of raising required and the proximity of the adjacent SAC. Other features in this area will have no impact or a slight impact only.

Option 2 – Central

Mall House (NIAH No. 21807034) at the northern side of this area is listed on the National Inventory of Architectural Heritage. The proposed defences will not impact the house directly but will have a slight negative impact on its setting and views. Island House itself is also protected structure (RPS No. 1085), however the boundary walls (adjacent to the Mall Road) which are to be altered are not. The wall adjacent to the Mall Road, from Mall House to Island House is not listed on the NIAH nor RPS however, it is of cultural and landscape significance. Consideration was given to strengthening of the existing walls however, this is not possible due to the existing construction of the wall, the level difference on each side, the underlying ground conditions and the proximity of the adjacent SAC and alluvial woodland. To mitigate against any potential negative impact these walls are replaced to a similar condition (i.e., by re-using original wall materials or sourcing similar materials), and the original wall will be demolished. Although the new Mall wall flood wall will be constructed of reinforced concrete, it will be faced with stone taken from the demolished wall and similar locally sourced stone in a random pattern to match the existing wall. Much of the work in this area is inside an ACA. While permanent impacts to protected structures are not anticipated, proposed measures may impact on the setting of these sites. The expected impact is therefore moderate negative.

Removal of the sluice gates on the Island House causeway structure, listed on the RPS, will result in a long-term positive impact.

Option 2 – South

Construction works and the introduction of flood walls in the vicinity of Castleconnell Castle (LI001-003) will have a slight permanent impact on its setting but will not be significant and will not affect the Castle itself. Construction work will take place in the Zone of Notification of the Castle however, so mitigation measures will be required. Impacts to other cultural heritage receptors in this area will be slight negative or have no impacts.

6.2.4.4 Landscape

Option 2 – North

Permanent moderate negative effects on visual amenity are expected in this area due to the construction of flood defence walls along the Old River Shannon, directly affecting views from two houses. To reduce the impacts sections of glass panels have been proposed in the flood wall at these two properties, as agreed with the homeowners, to maintain views of the river from key locations within their properties and gardens.

During construction, temporary slight negative effects will occur due to works adjacent to the River Shannon along two houses and a short section of public road. Machinery and excavations will be visible from the road and the two residences. These effects will be temporary and not significant and will be mitigated against by operating plans to be put in place by the appointed contractor, such as the erection of hoarding and restriction of working hours.

Option 2 – Central

Flood walls will be constructed around one house, resulting in permanent moderate negative effects on visual amenity. The provision of flood walls at Maher's Pub and along the length of Mall Road will also lead to slight negative effects, with views of the River Shannon along Mall Road to be restricted, however, the proposed flood wall will be just 300mm higher than the existing wall.

During construction, temporary slight negative effects will occur due to the construction works. Machinery and excavations will be visible from the road and nearby residences. These effects will be temporary and not significant and will be mitigated against by operating plans to be put in place by the appointed contractor, such as the erection of hoarding and restriction of working hours.

Option 2 – South

Construction of flood walls will lead to permanent moderate negative effects for one house, with its views towards the River Shannon affected. Views from houses in Coolbane Woods will not be impacted due to the construction of an embankment, which will be 1m lower than the existing boundary wall to the rear of the properties. Therefore, the overall impact at this location will be a slight negative.

During construction, temporary slight negative impacts on visual amenity are likely due to the use of machinery and construction works. Machinery and excavations will be visible from the road and nearby residences. These effects will be temporary and not significant and will be mitigated against by operating plans to be put in place by the appointed contractor, such as the erection of hoarding and restriction of working hours. These impacts will not be significant.

6.2.4.5 Construction Impacts and Operational Access

Option 2 - North

Construction works will involve the use of private property for access resulting in a potential temporary slight negative effect for residents with the potential for disturbance and restricted access. This will be limited to the construction phase. Measures to mitigate impact on access and residential amenity will be outlined in the operating plans to be devised by the contractor. Access will be required to private property during the operational stage for inspection of defences and repair if necessary.

Option 2 – Central

There is the potential for temporary negative effects for residents, pedestrians and road users through disturbance associated with construction works at the Island House entrance, at Maher's Pub car park and along the Mall Road. Measures to mitigate impact on access and residential amenity will be outlined in the operating plans and traffic management plans, which should include access for emergency vehicles, to be devised by the contractor. The extent of works along the Mall Road will result in partial or full temporary road closures during construction.

Once operational, no impacts to access are expected for members of the public as the flood walls remove any need for a demountable flood barrier across the Mall Road. Access to the Mall Road will be improved as the road will be protected from flooding up to the design event.

Option 2 – South

There is the potential for temporary slight negative effects for residents, pedestrians and road users through disturbance associated with construction works in this area. Measures to mitigate impact on access and residential amenity will be outlined in the operating plans to be devised by the contractor, however the extent of road raising required means that partial or full road closures are likely to occur.

Once operational, access to Castleconnell village from the south will be restricted by the demountable flood barrier across Chapel Hill. This impact will occur only during flooding. The

impact will be moderate but intermittent, with alternative routes to and from the village available.

Once operational, the roads from Meadowbrook Estate and SuperValu to the Coolbane Woods junction will no longer be impacted during flooding, ensuring that access is available at all times. This will be an overall benefit.

6.3 Option 3

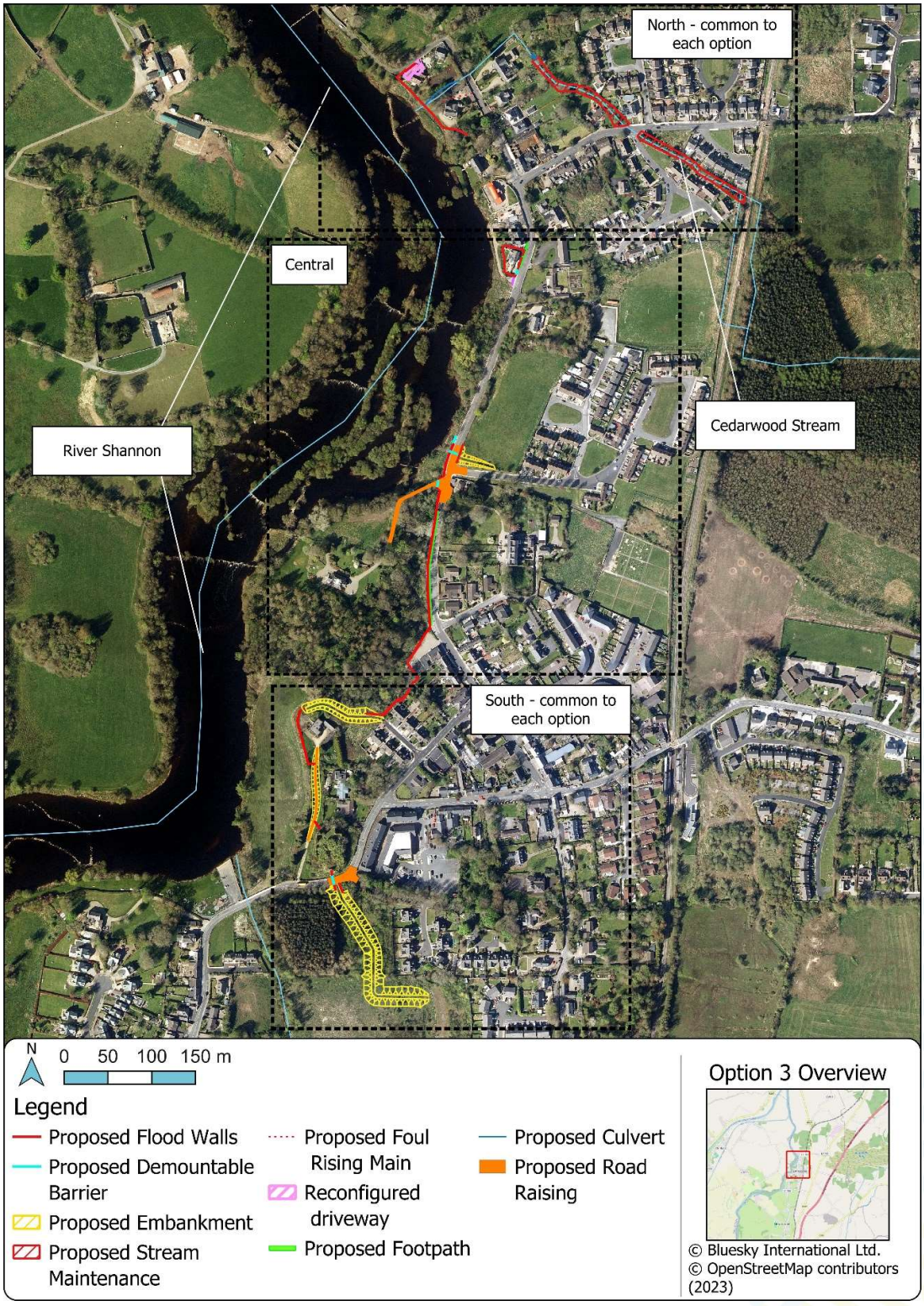


Figure 6-10: Overview of Option 3

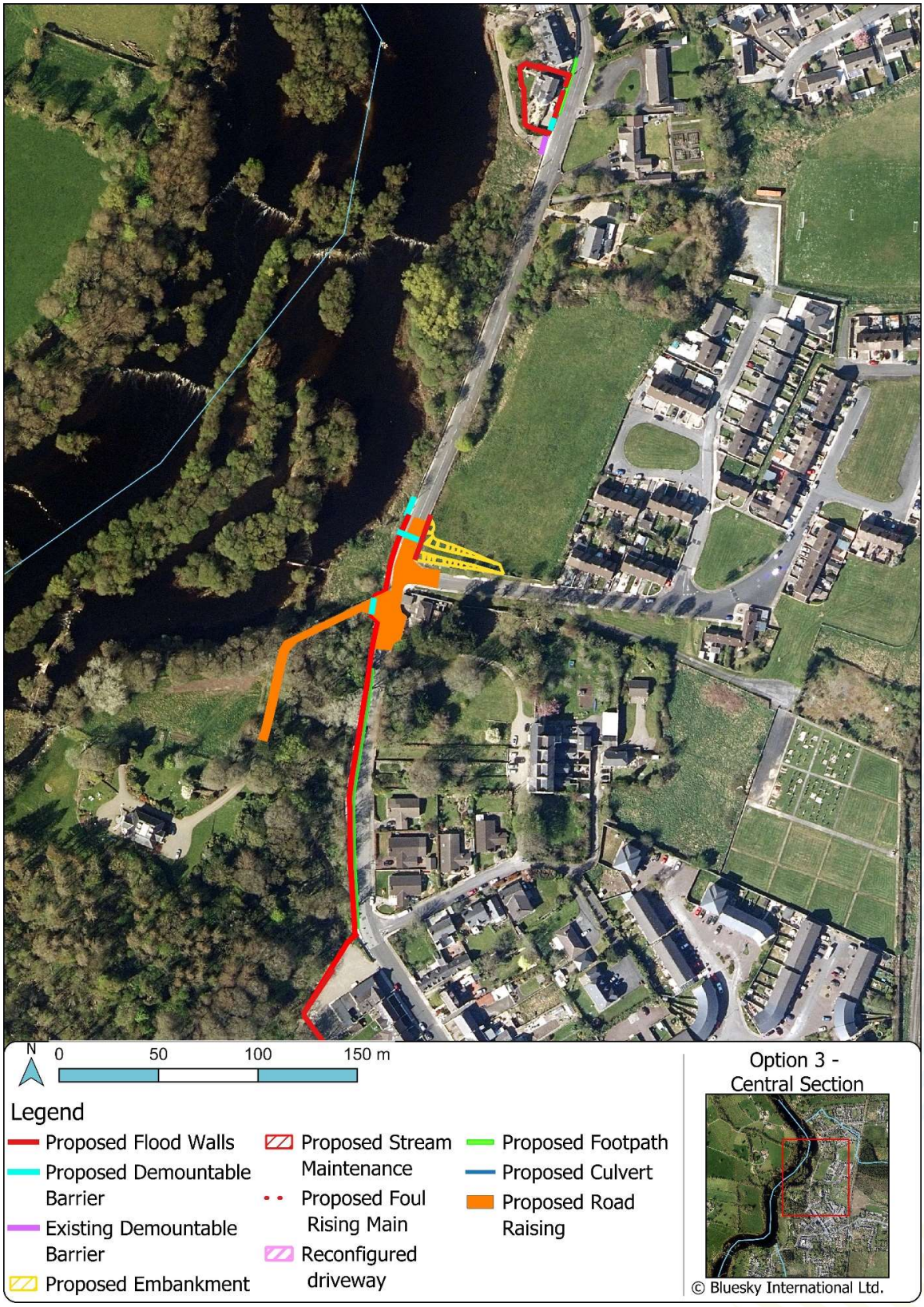


Figure 6-11 Option 3, central section

6.3.1 Potential Measures

Option 3 comprises the following proposed defences. Text in *italics* indicates items which are common to each Option:

- *Replacement of the existing wall to the west of Rivergrove B&B with a new flood wall. The new flood wall extends across the existing entrance and a new entrance will be provided at higher ground further to the east. Relocating the entrance above the flood level omits the need for a demountable barrier at this location and provides passive flood protection to the property. Provision of a new low-level plinth inside the existing front boundary wall to the north of the B&B will avoid the need to replace the existing high stone wall. The proposed flood walls at this location will have a sheet piled foundation with a reinforced concrete plinth supporting a reinforced concrete flood wall which will be clad in stone similar to the existing wall. A short length of glass panels will be provided within the flood wall to maintain some of the view of the river from the conservatory.*
- *Replacement of the existing wall to the west of Grange House with a new flood wall that will continue along the southern side of the driveway until it ties in with high ground. Glass panels will be provided in sections, as agreed with the homeowner, to maintain views of the river from key areas of the house. The proposed flood wall at this location will have a sheet piled foundation with a reinforced concrete plinth supporting a reinforced concrete flood wall which will be clad in stone similar to the existing wall. The open section of the Cedarwood Stream adjacent to the Mill Building will remain open, and a new culvert will be provided from the downstream point of this open section to outfall to the River Shannon through the proposed flood wall. In order to avoid removal of the open stream feature in the garden, there will be a minor diversion of the Cedarwood Stream so that the new culvert is constructed to the north of the open stone feature. The discharge point for this culvert will remain the same to avoid any negative impacts on the receiving SAC and hydrophilous tall herb. A pumped water fountain type arrangement will be installed on the open feature to maintain the appearance and sound of flowing water. A new pumped foul connection will be provided to the public foul sewer to replace the existing free outfall from the house to the Cedarwood Stream open stream feature.*
- Replacement of the wall surrounding Mall House with a new reinforced concrete flood wall that will be clad in stone similar to the existing wall. Where the northern face of the house is constructed against the boundary wall, a proposed ramp from the boundary wall to the corner of Dunkineely House will cut off flows from the west. A demountable barrier will be provided at the vehicular entrance to Mall House. The footpath at the pedestrian entrance will be raised above the flood level to retain pedestrian access. It is not possible to 'design out' this demountable barrier without either removing the vehicular entrance or raising a significant length of public road, which would have a knock-on effect on the neighbouring properties.
- *Provision of a demountable barrier in the main fisherman access point through the existing Mall wall, known locally as Broderick's slip. This has been identified as a key access point to the river for boating and fishing. Alternatively, ramped access was considered however, was not brought forward due to reasons of construction in the SAC - the required height of such a ramp would be 1.2m meaning that it would extend over a length of c. 15-20m on each side of the ramp top. This would also result in the permanent loss of a significant area within the SAC at this location.*
- Road raising across the whole Island House/Scanlon Park junction, to the '504 event' 1% AEP level. Provision of a demountable flood barrier across the Mall Road north of the Scanlon Park junction to defend up to the 'Baseline Design Event (limitations in operational conditions)' with an allowance for freeboard. Construction of an embankment in the southwest corner of Mall field. Provision of a demountable flood

barrier at the Island House entrance. Raising of the driveway to Island House by c. 250mm.

In order to omit the demountable barrier across the Mall Road, the entire junction would need to be raised by c. 0.95m to the design defence level. This would prevent access for vehicles to reverse directly back to the substation, which ESB indicated would not be acceptable. Therefore, such a solution would require relocation of the substation to another location, such as Mall Field, where the required access can be provided. Access to the pumping station and Tonville would also be impacted.

In order to omit the demountable barrier across the Island House entrance, the causeway and castellations would need to be raised by c. 1m, which would require significant works to a protected structure and significant works in the SAC.

- The existing wall between Island House and Maher's Pub will be replaced with a new flood wall, set back for most of its length. However, approximately 55 metres of the wall, immediately south of the entrance to Island House, will be aligned with the existing wall due to the narrowness of the adjacent road.. This wall will be constructed of reinforced concrete and clad with a stone similar to the existing.
- *Provision of a new flood wall to the rear of Maher's Pub car park. It is proposed to set back the wall along the rear (western) boundary by c. 6m to remain outside of the RPZ of the Cedar tree (which is used by herons for nesting). This wall will be constructed of reinforced concrete and clad with a stone similar to the existing surrounding walls. The flood wall extends along the northern boundary of nr. 7 Meadowbrook Estate, terminating at the end of the cul-de-sac. The section of wall from the rear of Maher's Pub to the downstream embankment will have a sheet piled foundation with a reinforced concrete plinth supporting a reinforced concrete flood wall. Some sections will be clad with stone where required. A section of the existing boundary wall at the end of the Meadowbrook cul-de-sac will be removed, and a gate will be provided through the wall to provide emergency access to Stormont House and for maintenance of the embankment in the Stormont House grounds only. There will be no access for members of the public through the gate.*
- *Provision of an embankment along the rear of Meadowbrook Estate, from nr. 7 Meadowbrook Estate and north of Stormont House.*
- *A low-level reinforced concrete flood wall along the west of Stormont House, inside the existing castellated wall. This wall will be clad with stone similar to the adjacent castellated wall.*
- *Raising ground levels along the Stormont House entrance road.*
- *A short length of low-level reinforced concrete flood wall to tie in with rock at the Castle in two locations, one to the east of the entrance to Stormont House and the second adjacent to the road raising at the Coolbane Woods junction. These walls will be concealed by earth at either side.*
- *Road raising to the '504 event' 1% AEP level at the Coolbane Woods junction adjacent to the Castle. Provision of a demountable flood barrier to the west of the junction, to defend up to the 'Baseline Design Event (limitations in operational conditions)' with an allowance for freeboard. The alternative to this would be to raise c. 160m of the Chapel Hill Road by up to 1m, which would also require replacement of the existing stone walls on either side of the road.*
- *Proposed embankment along the southern boundary of the Coolbane Wood entrance road and along the rear of house no.'s 1-4, to tie into higher ground to the south.*
- *Removal of overgrown vegetation from the Cedarwood Stream, from its interface with the railway crossing to property Coole House, as part of the construction works.*

Regular inspection and maintenance thereafter to manage future vegetation that may impact conveyance.

- *Replacement of the existing circular culvert at property Coole House with a larger rectangular culvert. Widening of the existing channel for a distance of c. 15m immediately upstream of this culvert to ensure improved conveyance.*
- *To manage surface water runoff during times of flooding when outfalls are surcharged, a series of high-level overflows will be constructed in select manholes to convey surface water to two temporary pump sumps (one in Maher's Pub car park and another in the lands at Coolbane Woods) and a permanent pump at the Scanlon Park junction. Alterations in terms of alignments and pipe sizes may be made to select surface water sewers to convey the necessary flows, to be confirmed at detailed design stage.*

6.3.2 Design Constraints

There is very little working area at a number of the elements of the proposed works. Access for construction of the flood wall to protect Rivergrove B&B and Grange House will be particularly challenging with the river on one side and private gardens on the other.

The existing ground levels to some of the properties north of the Mall Road, particularly Grange House, are such that significant defence heights are required. Therefore, raising the driveway above the flood level was not an option given the limited space available, existing threshold level of the house and proximity of the adjacent SAC. For this reason, there was no other option than to replace the existing stone wall with a new flood wall.

Due to the proximity of the SAC, the proposed defences will be designed to mitigate negative impacts. The proposed flood wall between Island House and Maher's Pub has been designed so that all works will remain outside of the SAC, except for a 55m section immediately south of Island House where works will be required in the SAC due to the narrowness of the road. There is an existing gas main present beneath the footway, which may require diversion to accommodate the offset flood wall. The proposed set-back flood walls will allow for a minimum footpath width of 1.8m and road width of 5.5m.

At the proposed road raising locations, the proposed road level will be that of the 1% AEP flood level for the "504 event", which provides a high level of passive protection up to this scenario. Demountable flood barriers will be installed on top of this to protect against the 1% AEP flood level for the baseline design scenario.

The road raising at the Scanlon Park junction and entrance to Island House has been amalgamated into one large tabletop ramp, which will extend south to accommodate all adjacent entrances.

The proposed defences will allow for the sluice gates on the Island House bridge to be removed, thus maintaining the flow path through Cloon Stream.

6.3.3 Ongoing maintenance, ownership and responsibilities

Each proposed measure will have its own bespoke management plan.

Annual inspections of the defence assets/structures will be needed, together with investigations of its performance after each flood event. Monitoring of seepage will be recommended.

Responsibility for erection of the demountable flood barriers gates ahead of a flood event will remain with Limerick City & County Council and/or nominated contractors. For this reason, they have all been proposed at publicly accessible locations.

A maintenance plan will be developed whereby Limerick City & County Council and/or nominated maintenance contractors will inspect and install the demountable barriers and sluice gates once per year to examine them for any defects and to ensure that staff are trained and familiar with the installation process.

A routine inspection and maintenance plan will be developed whereby Limerick City & County Council and/or nominated maintenance contractors will inspect the Cedarwood Stream from the railway to the culvert replacement and carry out any maintenance to manage overgrowth that may affect conveyance in the channel. Access to the culvert will be via the property driveway. Access to the stream for maintenance from the railway to Glenbrook will be via the Cloon & Commons Road by foot and hand tools where possible. If a mini-excavator is required, a partial/temporary road closure will be implemented to allow for lifting the machine into the stream with a mobile crane.

A formal invasive treatment programme will be implemented whereby invasive surveys will be carried out annually and where invasive species are surveyed, a treatment programme will be put in place by Limerick City & County Council and/or nominated specialists.

6.3.4 Environmental Assessment

The potential environmental impacts associated with Option 3 are considered below. The likely impact was assessed in the following categories:

- Hydrology, hydrogeology and hydromorphology
- Biodiversity
- Cultural Heritage
- Landscape and visual amenity
- Construction and access impacts

For ease of discussion, we have carried out the environmental assessment based on the areas highlighted in Figure 6-10 above, i.e., north, central, and south.

6.3.4.1 Hydrology, hydrogeology and hydromorphology

Option 3 - North

During construction, temporary moderate negative effects are possible on hydrology and hydromorphology. Works to the Cedarwood Stream and the construction of walls along the bank of the River Shannon have the potential to increase sedimentation and runoff entering the nearby waterways. Mitigation measures for managing the risk to water quality are feasible, such as adherence to best practice guidance, pollution prevention and sediment management measures such as the use of bio oils and lubricants, oil booms, spill kits, and silt fences, supervision by an ECoW, and safe concreting measures during wall construction. These will ensure that impacts to hydromorphology and hydrology are reduced to slight negative.

During the operational period, the introduction of a culvert on the Cedarwood Stream will lead to a permanent slight negative effect on hydromorphology. As the culvert is short and will be designed in accordance with IFI guidance as outlined in the EcIA, the effect will not be significant.

Option 3 – Central

During construction, temporary moderate negative effects are possible on hydrology and hydromorphology. Construction of flood walls around one house at the northern end of Mall Road and works to flood walls, road raising and an embankment at the Island House/Scanlon Park entrance have the potential to increase sedimentation and runoff entering the nearby waterways. Temporary slight negative effects are possible on hydrology and hydromorphology during construction of the short section of retaining wall adjacent to the embankment at Scanlon Park. Construction of flood walls and embankment have the potential to increase sedimentation and runoff entering the nearby waterways, however these defences are set back further away from the River Shannon than aforementioned elements of the scheme. Mitigation measures for managing the risk to water quality are feasible, such as adherence to best practice guidance, pollution prevention and sediment management measures such as the use of bio oils and lubricants, oil booms, spill kits, and silt fences, supervision by an ECoW, and safe concreting

measures during wall construction. These will ensure that impacts to hydromorphology and hydrology due to instream works are reduced to slight negative.

Operational stage impacts in this area are expected to be not significant.

Option 3 – South

During construction, temporary slight negative effects are possible on hydrology and hydromorphology. Construction of flood walls and embankment have the potential to increase sedimentation and runoff entering the nearby waterways, however these defences are set back further away from the River Shannon than other elements of the scheme. Also, mitigation measures for managing the risk to water quality are feasible, such as adherence to best practice guidance, pollution prevention and sediment management measures such as the use of oil booms, spill kits, and silt fences, supervision by an ECoW, and safe concreting measures during wall construction. These will ensure that impacts to hydromorphology and hydrology are further reduced.

Operational stage impacts in this area are not expected to be significant.

6.3.4.2 Biodiversity

Option 3 – North

The construction of flood walls and works to the Cedarwood Stream culvert will take place within the Lower River Shannon SAC. Construction within the SAC could lead to negative effects due to disturbance, loss of habitat, and pollution or increased sedimentation. The scheme has undergone a Screening for Appropriate Assessment and a full Appropriate Assessment/Natura Impact Statement.

Removal of riparian vegetation to make way for access or for the proposed flood walls could lead to slight negative impacts. These would be temporary to short-term as vegetation removed could be replaced where necessary.

Moderate negative impacts on fish and aquatic species are possible during instream works or works adjacent to the riverbank due to the potential for accidental release of pollutants or increases in sedimentation, and temporary changes to habitat connectivity. These are impacts that can be mitigated during construction, such as the adoption of a surface water management plan including appropriate barrier controls, pollution and spill prevention measures, the use of bio oils and lubricants, phased installation of silt fences along the site boundary where works are taking place, and periodic monitoring by an Ecological Clerk of Works (ECoW).

Once operational, a slight negative impact will result from the introduction of the culvert instream between Rivergrove B&B and Grange House. This will be designed adhering to IFI guidance to reduce impacts to fish. Overall, the impact on biodiversity in this area will be moderate negative.

Option 3 – Central

During construction, there is the potential for temporary moderate negative effects on the biodiversity of this area due to the construction of flood walls and embankments within the heavily wooded area around Island House, which is also designated as the SAC.

The invasive species Giant Hogweed is present in the area around Island House; construction of the embankment could lead to accidental spread of the species, which could lead to a permanent moderate negative effect on habitats and species in this area. Mitigation measures to control the spread of invasive species will be devised for the preferred option.

As the defences in this area for Option 3 are outside the wooded area, impacts are expected to be slight negative when compared to Option 1. Impacts are also reduced compared to Option 2 as there is less construction of flood wall along the Mall Road. Moderate impacts are still possible

during wall construction as this will occur along the SAC boundary, however it will not be significant as the amount of construction required is reduced.

Option 3 – South

Construction of the embankment and walls at Stormont House is within the SAC and could lead to negative effects due to disturbance, loss of habitat, and pollution or increased sedimentation. The scheme has undergone Screening for Appropriate Assessment and a full Appropriate Assessment/Natura Impact Statement.

The construction of the embankment at Coolbane Woods will require vegetation removal which could lead to moderate negative impacts. To offset this impact, it is proposed to compensate for this by enhancing an adjacent area so that it will naturally develop into alluvial woodland.

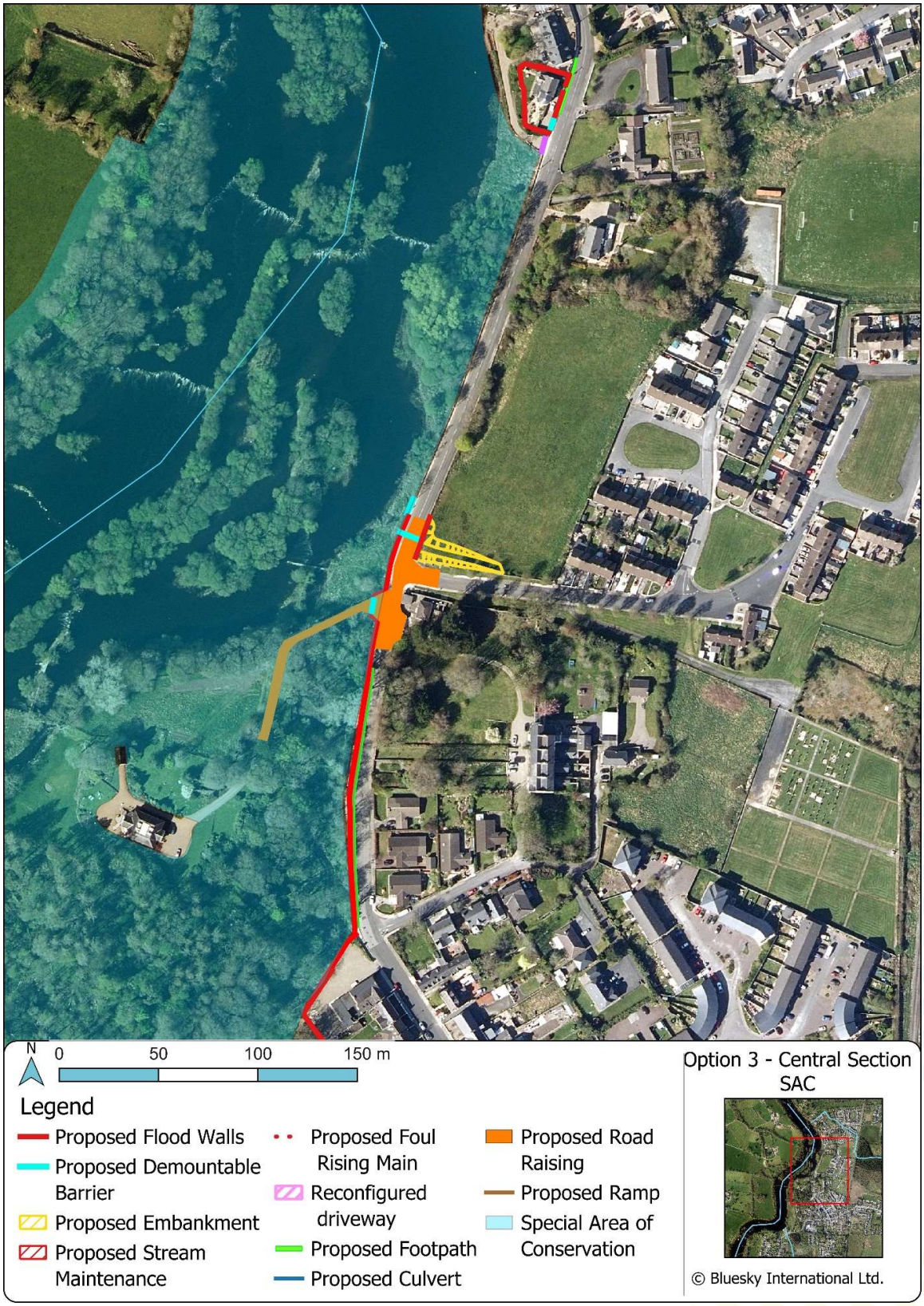


Figure 6-12: Option 3 central section, showing SAC boundary

6.3.4.3 Cultural Heritage

Option 3 – North

The works for Option 3 are within an Architectural Conservation Area (ACA), and nine structures listed on the Record of Protected Structures (RPS) are in the vicinity. One of these RPS buildings, Grange House (RPS 1075), will have flood walls constructed along its boundary with the River Shannon. This will impact the curtilage of the property, but will not affect the structure itself, so a permanent moderate negative effect is expected. Consideration was given to strengthening of the existing walls however, this is not possible due to the existing construction of the wall, the level difference on each side, the underlying ground conditions, the extent of raising required and the proximity of the adjacent SAC. Other features in this area will have no impact or a slight impact only.

Option 3 – Central

Mall House (NIAH No. 21807034) at the northern side of this area is listed on the National Inventory of Architectural Heritage. The proposed defences will not impact the house directly but will have a slight negative impact on its setting and views. Island House itself is a protected structure (RPS No. 1085), however the boundary walls which are to be altered are not. Once these walls are replaced to a similar condition (i.e., by re-using original wall materials where possible or sourcing similar materials), the original walls can be demolished. Much of the work in this area is inside an ACA. While permanent impacts to protected structures are not anticipated, proposed measures may impact on the setting of these sites. The expected impact is therefore moderate negative.

The causeway/bridge to Cloon Island is on the RPS (RPS 5056). The alterations to this structure are minimal, which will have a slight impact only.

Option 3 – South

Construction works and the introduction of flood walls in the vicinity of Castleconnell Castle (LI001-003) will have a slight permanent impact on its setting but will not be significant and will not affect the Castle itself. Construction work will take place in the Zone of Notification of the Castle however, so mitigation measures will be required. Impacts to other cultural heritage receptors in this area will be slight negative or have no impacts.

6.3.4.4 Landscape

Option 3 – North

Permanent moderate negative effects on visual amenity are expected in this area due to the construction of flood defence walls along the Old River Shannon, directly affecting views from two houses. To reduce the impacts sections of glass panels have been proposed in the flood wall at these two properties, as agreed with the homeowners, to maintain views of the river from key locations within the properties and gardens.

During construction, temporary slight negative effects will occur due to works adjacent to the River Shannon along two houses and a short section of public road. Machinery and excavations will be visible from the road and the two residences. These effects will be temporary and not significant and will be mitigated against by operating plans to be put in place by the appointed contractor, such as the erection of hoarding and restriction of working hours.

Option 3 – Central

Flood walls will be constructed around one house, resulting in permanent moderate negative effects on visual amenity. The provision of flood walls at Maher's Pub will also lead to a slight negative effect. Permanent effects on visual amenity and landscape are not expected due to the road raising or embankment at Scanlon Park.

During construction, temporary slight negative effects will occur due to the construction works. Machinery and excavations will be visible from the road and nearby residences. These effects will be temporary and not significant and will be mitigated against by operating plans to be put in

place by the appointed contractor, such as the erection of hoarding and restriction of working hours.

Option 3 – South

Construction of flood walls will lead to permanent moderate negative effects for one house, with its views towards the River Shannon affected. Views from houses in Coolbane Woods will also be impacted due to the construction of an embankment, which will be 1m lower than the existing boundary wall to the rear of the properties. Therefore, the overall impact at this location will be slight negative.

During construction, temporary slight negative impacts on visual amenity are likely due to the use of machinery and construction works. Machinery and excavations will be visible from the road and nearby residences. These effects will be temporary and not significant and will be mitigated against by operating plans to be put in place by the appointed contractor, such as the erection of hoarding and restriction of working hours. These impacts will not be significant.

6.3.4.5 Construction Impacts and Operational Access

Option 3 - North

Construction works will involve the use of private property for access resulting in a potential temporary slight negative effect for residents with the potential for disturbance and restricted access. This will be limited to the construction phase. Measures to mitigate impact on access and residential amenity will be outlined in the operating plans to be devised by the contractor. Access will be required to private property during the operational stage for inspection of defences and repair if necessary.

Option 3 – Central

There is the potential for temporary slight negative effects for residents, pedestrians and road users through disturbance associated with construction works at the Island House/Scanlon Park entrances. Measures to mitigate impact on access and residential amenity will be outlined in the operating plans and traffic management plans, which should include access for emergency vehicles, to be devised by the contractor. The works from Scanlon Park to Maher's Pub will result in partial or full road closures during construction.

Once operational, access to Castleconnell village from the north will be restricted by the demountable flood barrier across Mall Road at the Scanlon Park entrance. This impact will occur only during flooding. The impact will not be significant, with alternative routes to and from the village available.

Once operational, the Mall Road between Island House and Shannon Stores will no longer be impacted during flooding, ensuring that access is available at all times. This will be an overall benefit.

Option 3 – South

There is the potential for temporary moderate negative effects for residents, pedestrians and road users through disturbance associated with construction works in this area. Measures to mitigate impact on access and residential amenity will be outlined in the operating plans and traffic management plans, which should include access for emergency vehicles, to be devised by the contractor. Partial or full road closures are likely to be required for the road raising.

Once operational, access to Castleconnell village from the south will be restricted by the demountable flood barrier across Chapel Hill. This impact will occur only during flooding. The impact will be moderate but intermittent, with alternative routes to and from the village available.

Once operational, the roads from Meadowbrook Estate and SuperValu to the Coolbane Woods junction will no longer be impacted during flooding, ensuring that access is available at all times. This will be an overall benefit.

6.4 Summary of Environmental Assessment of Options

The potential effect of each measure was assessed using the impact classification terminology outlined below:

Legend	
High potential effect	
Moderate potential effect	
Slight/no potential effect	

It should be noted that the above classification was used for the comparative assessment of options only and does not reflect the eventual assessment of potential impacts of the proposed development as outlined in the Environmental Impact Assessment (EIA) Screening or other environmental assessments.

The three options have been discussed and their likely environmental impacts assessed in the sections above. The options have been assessed in three distinct areas, i.e., north, central, and south as shown in Figure 6-1, Figure 6-6, and Figure 6-10. The proposed defences in the north and south sections are identical across all three options. These areas therefore have the same potential impacts across each option and will be discussed briefly here before the central section is discussed in greater detail.

The northern section requires flood walls to be built to protect Rivergrove B&B and Grange House, and works to a culvert and foul rising main at Grange House. The construction of the flood walls close to the banks of the River Shannon is likely to lead to temporary moderate negative effects on hydrology and hydromorphology. The construction will likely lead to increased sedimentation and could cause accidental pollution events if not properly managed. The area is also adjacent to the Lower River Shannon SAC and construction access will require the removal of some riparian vegetation, leading to temporary moderate negative effects on biodiversity. The area is within an ACA, and Island House is listed on the RPS, meaning permanent moderate negative effects are likely to cultural heritage, while the walls will create a permanent moderate negative effect on visual amenity.

The defences in the southern section are set back further from the River Shannon, meaning temporary slight negative effects are expected to hydrology and hydromorphology. Construction adjacent to the Lower River Shannon SAC and vegetation removal to make way for the embankment at Coolbane Woods will likely lead to temporary moderate negative effects on biodiversity. The embankment and flood walls will also lead to permanent moderate negative effects on visual amenity. The use of a demountable flood barrier across the road at Coolbane Woods will cause an intermittent moderate negative effect on access to and from Castleconnell, however alternative routes are available when the barrier is in use.

The central section of the scheme differs between the three options. Option 1 would see significant negative impacts to hydrology and hydromorphology, and biodiversity due to the construction of an embankment and road raising within the wooded area around Island House and over the Cloon Stream, which is designated as the Lower River Shannon SAC. The footprint of the embankment would require the removal of several trees, which are valuable habitat and support a heronry, among other species. The embankment crossing over Cloon Stream would lead to significant effects on water quality and hydromorphology during construction and operation. Other impacts in this area are likely to be moderate negative.

Option 2 requires flood walls along the full length of the Mall Road, adjacent to the riverbank but set back approx. 1m from the existing wall. The length of construction in Option 2 is greater than Option 3, meaning there is greater potential for temporary moderate negative impacts on hydrology and hydromorphology, and on biodiversity. A detailed file note on the design and construction methodology of the wall shows that works will not take place within the riparian zone, meaning the highest negative effects during construction are avoided.

Option 3 has much reduced flood wall length along the Mall Road, with road raising and an embankment at the entrance to Scanlon Park instead. This reduces the likely construction impact to hydrology and hydromorphology and biodiversity compared with Option 2. Impacts to biodiversity are also lower than in Option 1 as construction is limited to adjacent to the wooded area around Island House rather than within the wooded area. However, as flood walls will not be constructed along the full length of Mall Road, access for residents to and from Castleconnell will be negatively impacted during times of flood, with demountable flood barriers in place at the Island House/Scanlon Park junction and crossing the Mall Road.

Option 1 is therefore the least preferred with regard to environment, with significant effects likely to hydrology and hydromorphology, biodiversity and cultural heritage. Options 2 and 3 are similar in their impacts to hydrology and hydromorphology, and biodiversity, with flood wall construction along Mall Road adjacent to the SAC and Island House. Option 2 has greater construction needs, with a resulting greater construction stage impact to these areas. However, the long-term positive impact of setting the wall back from the existing, with an approx. 1m wide strip added to the riparian zone, will partially offset the construction stage impact of Option 2. Option 3 will require a demountable flood barrier across Mall Road, negatively impacting access during flooding, whereas Option 2 keeps Mall Road open during flooding, with positive impacts for residents. The preferred option from an environmental perspective is therefore Option 2.

Table 6-2: Assessment of Options

	North			Central			South		
Option	1	2	3	1	2	3	1	2	3
Hydrology, hydrogeology, hydromorphology									
Biodiversity									
Cultural Heritage									
Landscape and visual amenity									
Construction impacts									
Operational access									
Comments	The northern section is identical in all 3 options. Moderate negative effects are possible to hydrology due to construction works in close proximity to the River Shannon. Impacts to biodiversity are also expected to be moderate in the northern section, due to disturbance and habitat loss during construction.			Alterations to the Cloon Island bridge will lead to significant negative impacts on cultural heritage. This structure is listed on the Limerick Record of Protected Structures (RPS) and the proposed alterations will negatively affect the structure. Construction within the wooded area could lead to significant negative effects during construction on both biodiversity and hydrology and hydromorphology. The construction of the embankment at Island House would directly impact the Cloon Stream during construction and operation.	Potential negative impacts to hydrology and hydromorphology and biodiversity in Options 1 and 2. Due to the extended length of wall and greater construction needs, this impact will be greater than in Option 3 However, the long-term positive from increasing the riparian area adjacent to the wall partially offsets the negatives of construction.	No significant negative impacts are expected in this area. The reduction in wall length along the Mall will reduce potential impacts on hydrology and hydromorphology compared to Option 2, while impacts to biodiversity will be less than in Option 1, as embankments and road raising are not required within the woodland around Island House.	The southern section is identical in all 3 options. Impacts to hydrology in this section will be less significant than in the central and northern sections as the measures are set back further from the Shannon. Construction adjacent to the Lower River Shannon SAC and in the wooded area west of Coolbane Woods could lead to moderate negative impacts. During flooding, the demountable barrier at the entrance to Coolbane Woods will impact access into and out of Castleconnell, however alternative routes are available.		

6.5 Summary of Measures and Potential Flood Relief Options

Following the screening stage, a number of potentially viable measures have been identified to protect against flooding in the baseline design event. This section further develops the potentially viable measures into options. Multi Criteria Assessment (MCA) for each option will be carried out to aid in the selection of the preferred option. Table 6-3 provides a summary of options.

Table 6-3: Summary of Options

Flood Cell (Refer to Figure 3-1)	Option 1	Option 2	Option 3
A	Flood walls to the rear of the northern properties adjacent to the river. Culverting of the Cedarwood Stream through Grange House, from the downstream end of the open section at the Mill Building to its outfall to the River Shannon. Proposed pumped foul connection from Grange House to the public foul sewer to the north.		
B	Ramp within the property of Dunkineely House, from the flood wall on the northern boundary of Mall House to the corner of Dunkineely House.		
C	Flood wall around the entire perimeter of Mall House. Demountable barrier to the vehicular entrance at the front of the property. Ramped access required to the pedestrian entrance to provide safe pedestrian access only during a flood event.	Flood wall to the rear and sides of Mall House. No defences required to the front of the property and full access during flood event.	Flood wall around the entire perimeter of Mall House. Demountable barrier to the vehicular entrance at the front of the property. Ramped access required to the pedestrian entrance to provide safe pedestrian access only during a flood event.
D	No defences to Mall Road Section A.	Set-back flood wall along Mall Road Section A.	No defences to Mall Road Section A.
E1	Road raising of entire Scanlon Park Junction. Demountable barrier across the Mall Road. Re-construction of the Island House causeway to the MRFS level. Sluice gates to be fitted to the culverts through the bridge, which will be closed during flood events to isolate the Cloon Stream. No defences required between Island House and Maher's Pub.	Road raising and demountable flood barrier across the Island House entrance. No demountable across the Mall Road.	Road raising of entire Scanlon Park Junction. Demountable barrier across the Mall Road. Demountable flood barrier across the Island House entrance.
E2	Embankment across Cloon Stream from Maher's Pub to Cloon Island. Provision of culverts through this embankment with sluice gate/penstock arrangement to cut flows	Set-back flood wall along Mall Road Section B. Flood wall alongside Maher's Pub car park to the Meadowbrook cul-de-sac.	

	off during a flood event.	
F1	Embankment from Meadowbrook Estate to Stormont House. Low-level flood wall adjacent to existing wall. Road raising along entrance road.	
F2	Road raising and demountable barrier across Chapel Hill Road.	
F3	Embankment to the rear of Coolbane Woods.	
G	Removal of overgrown vegetation from the Cedarwood Stream, from its interface with the railway crossing to property Coole House, as part of the construction works. Annual inspection and maintenance thereafter to manage future vegetation that may impact conveyance. Replacement of the existing circular culvert at property Coole House with a larger rectangular culvert. Widening of the existing channel for a distance of c. 15m immediately upstream of this culvert.	

Final Flood Defence Levels

The Scheme FDL varies throughout the village and is summarised in the table hereunder. The full table of modelled water levels at every reporting location, for each of the modelled scenarios is summarised in Table 5-5 in the Hydraulics Report.

Table 6-4: Defence heights

Flood Cell	Flood Level	Defence Level	Existing Ground Level	Defence Height	Flood Measure	Option
A	24.48mOD	24.78mOD	Varies 22.79mOD – 23.73mOD	Varies 1.3m* – 2.1m*	Wall	All
B	24.17mOD (at Dunkineely House)	24.62mOD	Varies c. 24.23mOD	0.44m	Ramp	All
C	24.17mOD	24.47mOD	23.72mOD	1.1-2.5m*	Wall	All
		24.47mOD	23.80mOD	0.67m	Demountable Barriers	1,3
		24.47mOD	23.87mOD	0.60m	Footpath Ramp	1,3
D	Varies 23.94mOD – 24.17mOD	Varies 24.54mOD – 24.91mOD	Varies 23.34mOD – 23.71mOD	1.25m* (guarding height)	Wall	2
E1	23.94mOD	23.70mOD	Varies 23.04mOD – 23.51mOD	Up to 0.65m	Road Raising (across junction)	1,3
		Varies 23.22mOD -23.61mOD	Varies 23.04mOD – 23.51mOD	Up to 0.20m	Road Raising (across junction)	
		23.70mOD	23.31mOD	0.40m	Ramp at IH Entrance	
		23.47mOD	23.26mOD	0.21m	Road Raising (on Causeway)	
		24.24mOD	-	0.54m	Demountable Barrier	All
		24.44mOD	Varies 23.15mOD – 24.44mOD	Up to 1.3m	Embankment	1,3
		24.90mOD	-	1.2m* (guarding height)	Wall	All
	24.39mOD (MRFS)	24.69mOD	23.27mOD	-	Raised causeway	1
E2	Varies 23.46mOD – 23.60mOD	23.76mOD – 24.25mOD	Varies 22.0mOD - 23.22mOD	Varies 1.25m* (guarding height) – 1.7m	Wall	All
		23.76mOD	Varies 19.9mOD	Up to 3.8m (at	Embankment	1

			– 23.46moD	centre of stream)		
F1	23.40mOD – 23.46mOD	23.90mOD	Varies 22.0mOD – 23.0mOD	0.7m – 1.7m	Embankment	All
		23.7mOD	23.10mOD	0.5-0.7m*	Wall	All
		Varies 23.82mOD-24.18mOD	Varies 23.22mOD – 23.63mOD	Up to 0.9m	Road Raising	All
F2	23.40mOD	Varies 23.19mOD-23.42mOD	22.83mOD - 23.14mOD	Up to 0.35m	Road Raising (beneath demountable barrier)	All
		23.70mOD	-	0.5m	Demountable Barrier	All
F3	23.40mOD	23.90mOD	Varies 21.38mOD – 23.0mOD	Up to 2.5m	Embankment	

- * Where the flood wall will act as a retaining wall the existing ground level and defence heights given are those on the dry side.

7 Climate Change Adaptability

7.1 Introduction to Climate Change Adaptation

Climate change is an important consideration in any scheme to ensure it remains operational into the future. Predicted increases in rainfall and flows will put pressure on the scheme performance. Climate change analysis has been carried out on the proposed scheme Option 2 to examine the necessary changes required to ensure it remains operational into the future when considering the MRFS.

To carry out this work, the baseline model was run for the Mid-Range Future Scenario (MRFS) to assess the overall impacts. Subsequently, the present-day scheme option (Option 2) was tested with the MRFS flows to identify any changes or additional areas at risk in a future event with the scheme in place.

Following the establishment of the key mechanisms at risk areas, testing of potential adaptations was carried out. From the performance of the proposed scheme in climate change scenarios, a climate change adaptability plan was created. This was based on adaptation pathway decision tree analysis and is documented in the following sections to ensure an adaptable scheme into a range of potential futures.

7.2 Adaptation Pathways

For Castleconnell there are two main avenues that can be considered – extending and raising defences and/or a regional climate change approach to managing the River Shannon at a catchment scale. The increase in flood level from the present day to the MRFS is approximately 0.5m and the increase in flood level from MRFS to HEFS is approximately a further 0.2m.

7.2.1 Key Scheme Objectives

Options 1 and 3 protect the village centre, residential properties and utility infrastructure, but not the Mall Road. Pedestrian and cycle access can be maintained through the proposed route in the development plan and road traffic access remains through slight inconvenience of R525. Option 1 provides access to Island House during the design flood event whereas Options 2 and 3 do not.

Option 2 protects from Rivergrove B&B to Coolbane Woods, without providing access to Island House during flood event but provides road traffic access to the village centre which was a key consideration raised repeatedly by locals at each public participation event. Protection of road access for the junction of the Mall and Commons Road is key for resilience.

The wastewater treatment plant and sub-station at the Scanlon Park junction requires either protection or relocation. The sub-station is only required to service the pumping station.

Foul sewer pumping station at Scanlon Park and sewer network are potential pollution sources and there is potential impact of flood water inputs to the foul system in the form of overflows and network/treatment capacity.

7.2.2 Design Constraints

The key design constraint for the MRFS scheme is the ability to adapt the current scheme defences to allow for raising and increased storage. These aspects have therefore been considered as resilience measures that are to be built into the scheme in the form of foundations and groundwork designs such that future changes can be made with limited cost and difficulty. Alignments of the proposed defences have also taken this into consideration to prevent the need to further realign defences in the future.

Data analytics and predictive modelling will continue to be used to understand flood risks better and to inform decision making. This can include the use of sensors and remote monitoring to gather real-time data on water levels and flow rates. It is proposed to install a water level gauge in Castleconnell as part of the proposed scheme. This will be used during flood events as additional information to inform the timely erection of demountable barriers and to calibrate any

future hydraulic model with actual measured water levels. Consideration will be given to installation of a flow gauge if an appropriate location can be determined.

7.2.3 Scale of Defences

Defence heights and lengths will increase in the MRFS due to the increased levels simulated in the model. The extent by which defences will have to be raised will vary depending on location. Landscaping and ecological impacts of raised defences will have to be considered in the future to ensure the defences not only provide the necessary protection but also do not result in any conflicts with environmental and landscape aspects.

The defence heights to the northern properties in the present-day scenario are driven by flood levels, ranging up to 1m high at Rivergrove B&B and Mall House and up to 2m at Grange House. These heights are all higher than the existing walls at the properties and will create an obstruction to the view of the river. Further raising of these walls by up to 0.5m for the MRFS or 0.7m for the HEFS may not to be considered acceptable to the residents.

The relocated entrance at Rivergrove B&B will provide some element of passive protection against the MRFS but does not include any allowance for freeboard. Therefore, a demountable barrier will be required across the entrance in larger climate change flood events to provide protection against the flow path from the north in the design event.

The open section of the Cedarwood Stream adjacent to the old Mill Building on the grounds of Grange House does not experience out of bank flows in the present-day scenario however, the MRFS scheme would require closure of this channel. This may have significant impacts on the Mill Building which is a protected structure.

There are three properties to the North of the village that do not require protection in the present-day scenario however, two of these will require protection in the MRFS and the third will require protection in the HEFS. It is expected that protection would be provided through a new flood wall, similar to the present-day solution for the neighbouring properties.

The defence height of the flood wall along the Mall Road from Mall House to Maher's Pub and adjacent to the Maher's Pub car park, in the present-day scenario is driven by guarding height meaning that the increase from present-day to MRFS is just 0.2m. Therefore, raising of defences is considered a viable solution at these locations.

The life expectancy of a typical demountable barrier or flood gate is approx. 25 years. A review of flood levels should take place ahead of replacement of the demountable barriers at Dunkineely House, the fisherman's access through the Mall wall, Island House and at Chapel Hill to determine whether higher flood barriers are required.

The height of the flood wall from the rear of Maher's Pub to the cul-de-sac in Meadowbrook is driven by the flood levels, resulting in a height of up to 1.8m adjacent to House No. 7. Therefore, raising the wall here may not be considered acceptable to the residents.

There is sufficient space to raise the proposed high-level embankment from the cul-de-sac at Meadowbrook to Stormont House to cater for the MRFS and HEFS however, raising of the low-level embankment would result in a land take of the majority of the remaining garden to the northwest of Stormont House. All embankments will be constructed with the base width associated with the MRFS heights, and side slopes of 1 in 3. This means that the width of the top of the embankment will be greater in the current scenario, to allow for an appropriate crest width of 4m (as per OPW and LCCC maintenance requirements) once they have been raised to the MRFS height.

The proposed low-level flood wall to the west of Stormont House is driven by flood levels in the present-day scenario, resulting in an approx. 0.7m high wall. While raising this is unlikely to impede views of the river from the house, it will entirely conceal the existing castellated boundary wall.

Raising of the embankment to the west and south of Coolbane Woods is not expected to impact the adjacent properties. As per the Meadowbrook embankment, the base widths have been designed for the MRFS height for ease of adaption.

7.3 Climate Change Adaption Summary

The potential adaptations for the climate change scenario look to enhance the current scheme design to protect into the future. The need for larger foundations and adaptable construction details (e.g. embankment widths and the extent of glass panels provided) are the key measures needed to allow adaptation of the scheme in the future. The construction costs associated with construction of defences to the MRFS level for the present-day scheme are not cost beneficial at present day and so are proposed as future adaptation works instead when they are required.

There is a limit to the level of protection provided by option 1 and future adaptation will be required sooner, with the first action likely to be construction of the Mall Road Wall which shifts the scheme into Option 2.

If not constructed the Mall Road is the weak point of the scheme as there is a limit to the height of the demountable defences on the road and defences at Mall House.

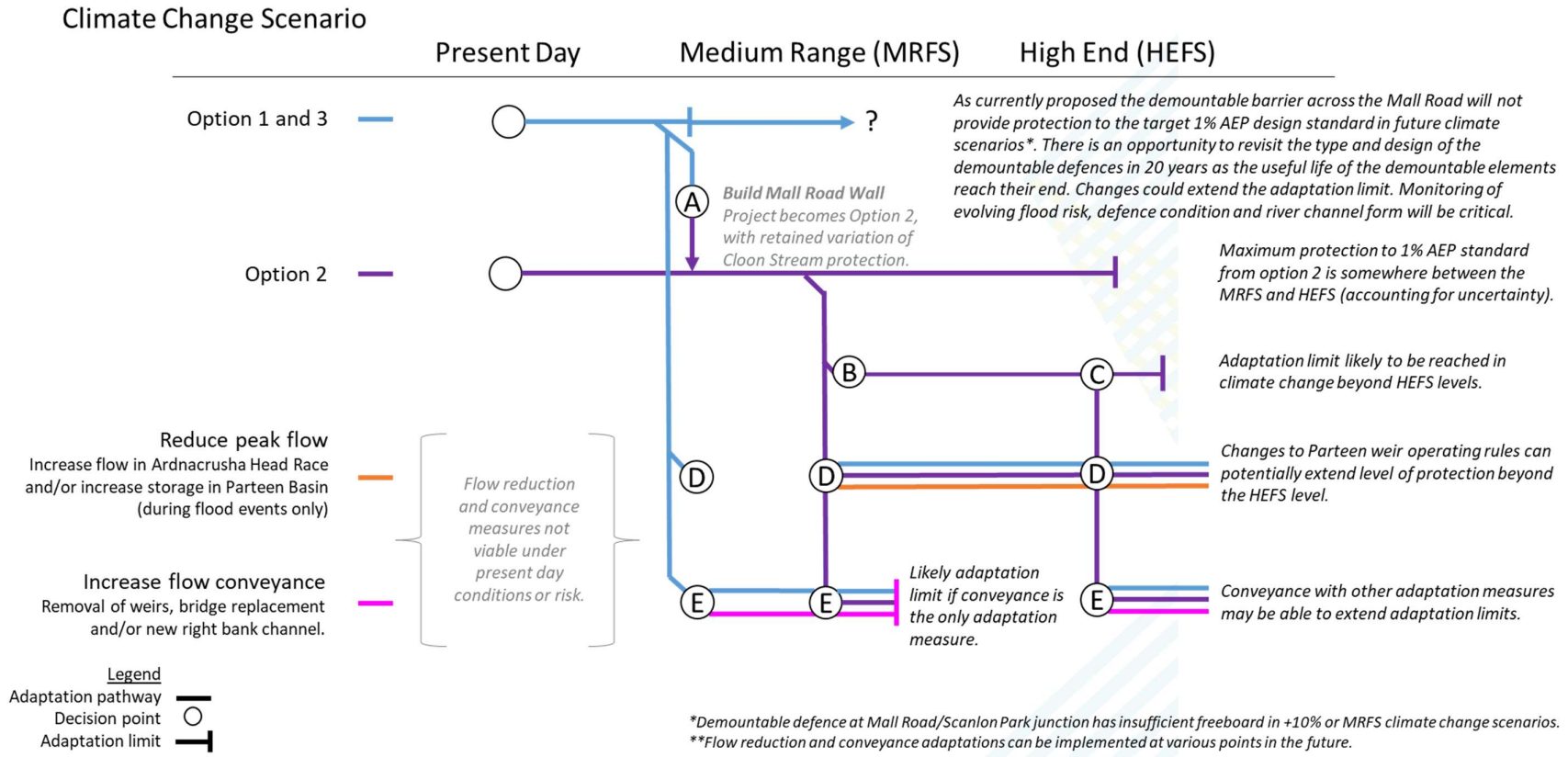
With Option 2 relatively simple adaptation is possible to provide protection up to the HEFS flood level through walls or demountable structures to raise the as-proposed defence crest levels where required.

Foundations for the current defences should be constructed so that this raising is possible without rebuilding the walls and embankments. Where the flood defences provide protection to a single property without affecting flood risk to any adjacent properties or public areas, it will be at the discretion of each homeowner whether they are in favour of raising the defences or accepting a lower standard of protection against the MRFS.

Defence heights become excessive in areas such as the northern properties and at Meadowbrook Estate. Whether the flood scheme can be adapted to protect vulnerable properties and features under future climate change conditions or only extend the lifetime up to a point when flooding becomes inevitable can only be answered with sufficient confidence with ongoing monitoring of flood and river flow changes, river morphology and form changes, and condition of the defence structures and scheme as a whole. The resilience of key utilities currently located under the Mall Road and the substation/pumping station will also influence the viability of various properties in the future.

Possible changes in policies (e.g. upstream Shannon level and operation of Ardnacrusha and/or Parteen Weir for power supply policy) were not analysed as these are outside the control of the project. To provide protection to the HEFS or beyond additional measures to reduce peak flow and/or increase flow conveyance will be required. However, initial model runs (as discussed in Section 5) suggest that this alone is unlikely to provide adequate protection against the expected rise in flood levels. If these are not viable then policy measures will be required (e.g. resilient re-development, relocation, flood warning and property resilience (note. Property resilience is not effective beyond certain flood depths).

These adaptation pathways and associated limitations are illustrated in Figure 7-1.



Adaptation Decisions

A. Raise crest of option 1 or 3 defences with permanent or demountable structures or build Mall Road Wall.
B. Raise crest level of option 2 with permanent or demountable structures. Protect extra properties exposed to future risk.
C. Further raising of option 2 crest levels.
D. **Reduce peak flow (with or without Mall Road Wall).
E. **Increase flow conveyance (with or without Mall Road Wall).

Figure 7-1: Adaptation Pathways

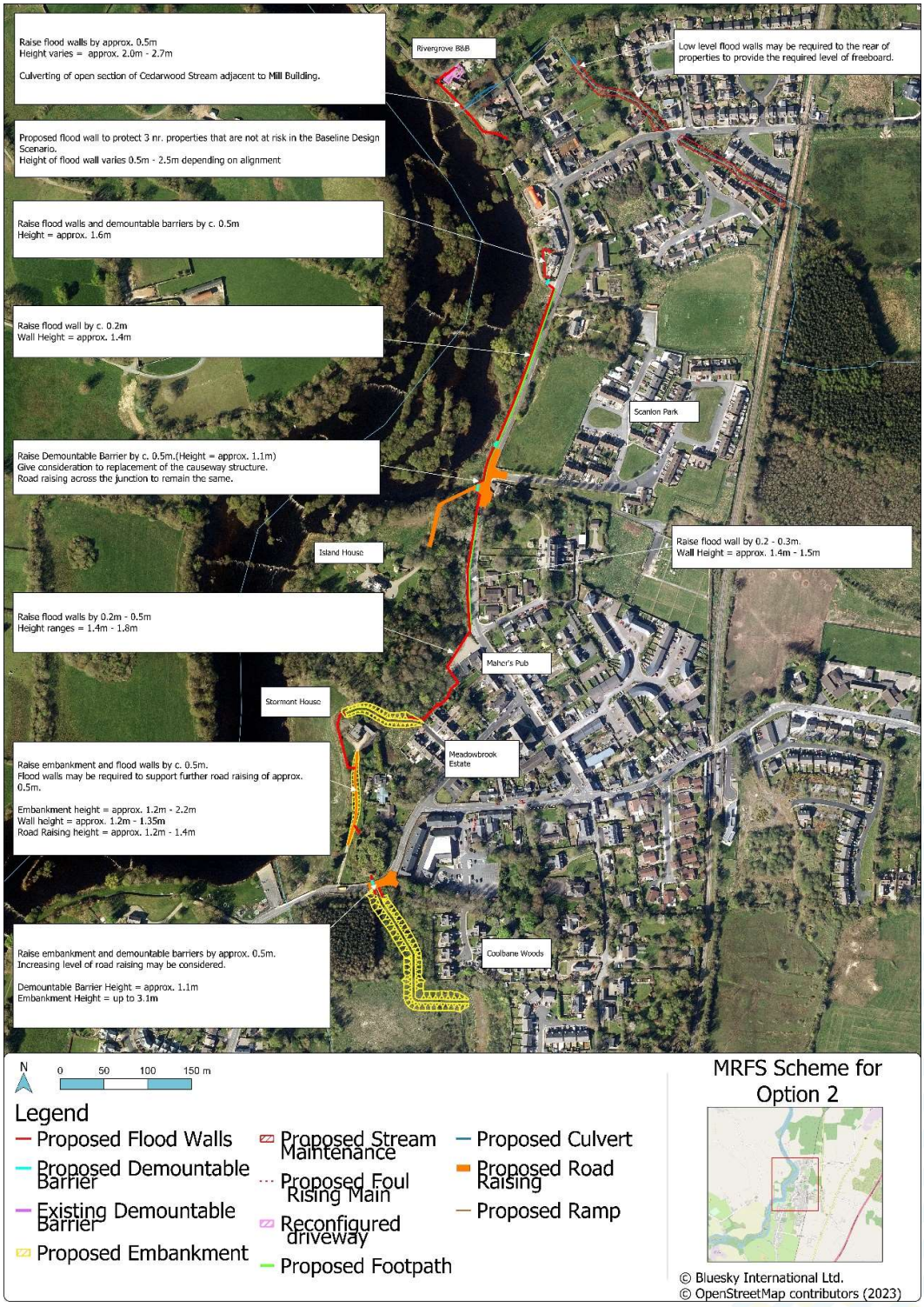


Figure 7-2: Potential MRFS Scheme

8 Economic Appraisal of Shortlisted Options

The scope of this assessment is to derive flood damages for the scheme. The economic flood damages of the scheme have been calculated in the form of Annual Average Damages (AAD), based on a range of probabilities and a resulting expected Net Present Value (NPV) of damages. This section provides the results and supporting data for the assessment. An initial assessment of benefits using the OPW approach (September 2018) found the scheme to be non-cost beneficial, risking the need to curtail the scheme to a smaller area or preventing the scheme from progressing any further. As some of the proposed defences would provide a greater standard of protection (e.g. walls constructed to guarding height), an alternative methodology was used to assess the benefits. This methodology seeks to fully value the future damages to examine whether this is a means of justifying the scheme economically.

The following methodology follows the Technical Methodology Note – Cost Benefit Analysis (CBA) from CFRAM (Sept 2018). A high-level assessment was undertaken to determine whether the latest OPW guidance (2022) was likely to significantly change the scale of damages. This assessment found that while some of the new guidelines increased the calculated damages, other elements decreased them and overall, the difference was not significant. For this reason, it was agreed that the new guidance would not be applied due to the advanced nature of the economic assessment at the time of draft guidelines.

8.1 Option Benefits

Benefits of a scheme can be divided into either tangible or intangible benefits.

Tangible benefits are those to which it is possible to assign monetary values. In general, the benefit is assigned a calculation equivalent to the monetary loss that would occur if the scheme were not in place. These include a reduction in:

- Infrastructure Preservation: Long-term savings by protecting existing infrastructure such as roads, bridges, and utilities from flood damage.
- Direct damage to buildings and contents.
- Indirect property, community and business.

Intangible benefits are those to which it is not possible to assign a monetary value from recognised economic principles. Monetary values placed on these benefits are therefore subjective. Intangible benefits include:

- Community Resilience: Avoidance of the inconvenience of post flood recovery/enhanced ability of the community to withstand and quickly recover from flood events.
- Health and Safety: Reduction in health-related costs by preventing waterborne diseases and injuries associated with flooding.
- Quality of Life: Improved overall living conditions in the community, leading to increased attractiveness for residents and potential investors. Avoidance of anxiety, inconvenience and ill health.
- Cultural Heritage Preservation: Protection of historical sites and culturally significant landscapes, which can be important for local identity and tourism.
- Attractiveness for Investment: A secure and well-protected area is more attractive to investors and new businesses, potentially leading to economic growth.

For this appraisal, the range of benefits comprise the following:

- Tangible benefit – Residential properties avoided flooding.
- Tangible benefit – Non-residential properties avoided flooding.
- Infrastructure utility cost damages avoided.
- Emergency services costs damages avoided.

- Intangible benefits for residential properties and some locally owned commercial properties.

8.1.1 Baseline and Climate Scenarios Flood Damage Data

Flood damages are a potential tangible benefit of the scheme that have been calculated using the baseline design scenario. To carry out this assessment flood damage data is used.

The land use in a flood prone area (often referred to as the Benefit Area) influences the likely damage characteristics and costs. Houses are affected differently from offices and warehouses, which in turn suffer different kinds of costs of damage from those experienced in industrial premises. Various land use sectors have been chosen to assess the impact of different depths of flooding on each. Flood damage data for the residential, retail, distribution, office and manufacturing sectors are provided in the Multi Coloured Manual (MCM) 2019. Detailed descriptions of these data sets are provided in Chapters 4 and 5 of the Manual. Additional costs for emergency services in dealing with flooding are also given in Chapter 6 of the Manual. All cost data in the MCM are in sterling values.

In the MCM, for a particular property, the damage due to flooding is a function of both flooding depth and its duration. Depths considered in the residential dwellings sector range from -0.3m to +3.0m in relation to the ground floor of the buildings. Information is tabulated for flood durations less than 12 hours.

The MCM provides a set of databases for retail, commercial and industrial flood damage. The Flood Hazard research Centre (FHRC) derived the depth/damage data sets based on data collections and discussions with representatives from a range of non-residential properties.

8.1.2 Property Categorisation Assumptions

The geodirectory database (property point attributes) from An Post Geodatabase was used in GIS shapefile format. Each point was assigned a building polygon derived from the OSI vector mapping. Some outbuildings have been retained in the receptor database where they could incur damages.

Threshold levels for each property were assigned from the survey contract. For the un-surveyed buildings, the MEAN DTM value within perimeter was calculated in GIS and used as threshold.

To link these data to the property descriptions and hence damage curves outlined in the Multi-Coloured Manual the following assumptions were made:

- Residential damages would be based on the sector average for each type of property with the sector average applied where no category was available. No age or social class data was included in the assessment.
- Commercial property damages have been based on a conversion of the An Post GeoDirectory data to MCM codes using conversion tables provided by the OPW. Site visits and Google street view were used to aid the identification of property types to ensure the correct MCM code has been applied.
- Unknown properties were verified by using Google street view and Google Maps.

FRISM©JBA (JBAs bespoke GIS based flood damage estimation tool) was used to estimate direct damages per property per event. The following parameters have been applied:

- The depth of flooding at each receptor is the maximum flood level within the perimeter of the property boundary.
- MCM2019 curves have been used. Residential properties have been split by type. Using floor area from building footprint obtained from OSI vector mapping to factor depth-damage curve per m2. Floor area has been calculated using GIS analysis.
- Residential curves from 2019 applied.

- Damage curve conversion factor: CPI for inflation from 2019 to 2020, Purchasing Price Parity for conversion of £ to €.

8.1.3 Property Capping Assumptions

The present value damages for any given property should not exceed its current valuation. This is to prevent justification for a flood mitigation scheme being based on the repeated flooding of a property over the project life when it would be more cost beneficial to simply purchase the property. The capping values have been assigned to each property based on:

- Commercial rates as supplied for a nearby flood relief scheme and where not available the values were scaled from other FRSs.
- Residential property values were chosen as most reasonable value from daft.ie and property tax valuation.

8.1.4 Infrastructure Utility Assets and Emergency Sector

For the area, economic damages to infrastructural utility assets (e.g. electrical sub-stations, gas installations and pipe-work, telecommunications assets, etc.) was calculated as 20% of total direct property costs. Costs to emergency services (excluding the Limerick City & County Council event response such as sandbags, pumps etc.) have been included in the economic damages and have been calculated as 8.1% of the total direct property costs for the town.

8.1.5 Intangible and Indirect Damages

Flood events can cause significant stress, anxiety and ill health to potentially affected people, during and then after a flood. Individuals generally also incur some costs due to their properties flooding that are not directly related to damage, such as evaluation, temporary accommodation, loss of earnings, increased travel and shopping costs, etc.

For residential properties, the intangible and indirect flood damages were set equal to the total (direct) property damage.

8.1.6 Discounting and Present Value Damages (PVd)

Given a choice between receiving a specific sum now and the same amount sometime later, most people will express a preference for the present sum. The tangible benefits accruing from a flood alleviation scheme will not provide cash sums to the beneficiaries; however, they will prevent a negative cash flow (avoidance of associated flooding costs) from the individuals.

The avoidance of fixed negative cash flow now is also preferable to avoidance sometime in the future. The "social time preference" (STP) can be measured by an appropriate Discount Rate (STPDR) and is taken as the compound rate of interest 'r' (% per annum) by which 'y' Euros in 'x' years' time is equal to one euro now.

The benefits arising from a flood relief scheme commence on the completion of the scheme and exist for the life of the works. To obtain a method of the overall benefit in present day monetary values, it is necessary to:

- Estimate the average damage arising each year of the project life, termed the Average Annual Damages (AAD)
- Discount the AAD to present values using the appropriate discount rate.
- Total the present values to obtain the overall damages.

The Department of Finance's discount rate for public investment is 4%. The lifetime over which the damages are discounted is taken as 50 years. For computation purposes, it is assumed that the residual value of the scheme at the end of the period is nil. This may be regarded as somewhat conservative, since works typically have a design life of 100 years.

8.1.7 Calculation of Annual Average Damage (AAD) and Present Value of Damages (PVd)

The Annual Average Damage (AAD) was calculated as the sum of the damage values of each probability, up to and including the 0.1% AEP event as the upper bounding event. This includes benefits incurred in probabilities that are in excess of the target design standard and allows for the above-scheme-standard benefits to be included in the appraisal. Three different methods of calculating the AAD were investigated with the 'hockey stick' approach being selected as the most appropriate approach. In this approach, the AAD was increased on an exponential basis up to 10% of the 50-year climate change AAD at the 15-year pivot point, and then the remaining 90% to year 50 of the appraisal.

The Average Annual Damage, discounted at a rate of 4% per annum, is then calculated over a time-horizon of 50 years to produce a Net Present Value of the potential flood damage. This represents the Net Present Value of the benefit of the Scheme.

8.1.8 Modelling Scenarios

The present day baseline scenario assumes Ardnacrusha Power Station functions with limitations in operational conditions (258m3/s flowing down the head race canal due to two turbines being out of operation or one turbine and the spillway being out of operation) as described in Section 3.2 of this report, resulting in a peak flow of 591 m3/s downstream of Parteen Weir during the 1% AEP baseline design event.

For the climate change scenarios, the flows upstream of Parteen Weir were increased by 10% and then the Ardnacrusha flow of 258m3/s was subtracted. The 1.1 climate change factor (or 10% uplift) is used as the most appropriate climate change scenario for the Shannon. This reflects the slow responding and large catchment area.

The Present Value Benefit (PVb) of each option scenario, in the present day only and the increase from present day to future climate change conditions is the difference between the baseline damages and option scenario residual damages.

8.1.9 Present-day and Climate Scenario Baseline Damages

Climate change uplifts in flow have assumed a lower bound value of 10%, that would be fully realised in 50-years' time. The foundations of the scheme elements are however designed to a 20% uplift flow.

The detailed information of the process of calculating the damages is described in the Initial Damages File Note.

In all of the scenarios, the Meadowbrook estate and Maher's pub contribute a significant proportion of the overall damages. The properties to the north of Island House on the Mall have some notable damages in specific events. Maps with onset of flooding for each property are presented in Figure 8-1 and Figure 8-2 below.

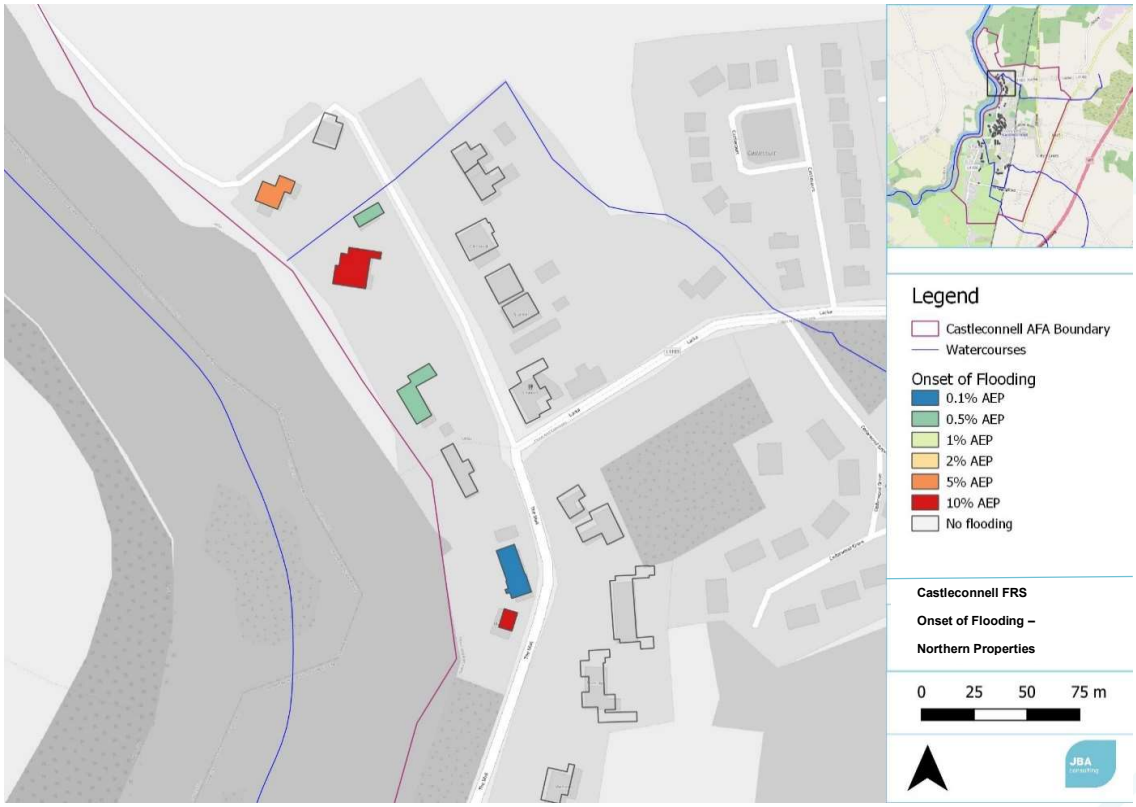


Figure 8-1: Map showing the onset of flood damages to properties, Baseline Current Scenario. Northern properties

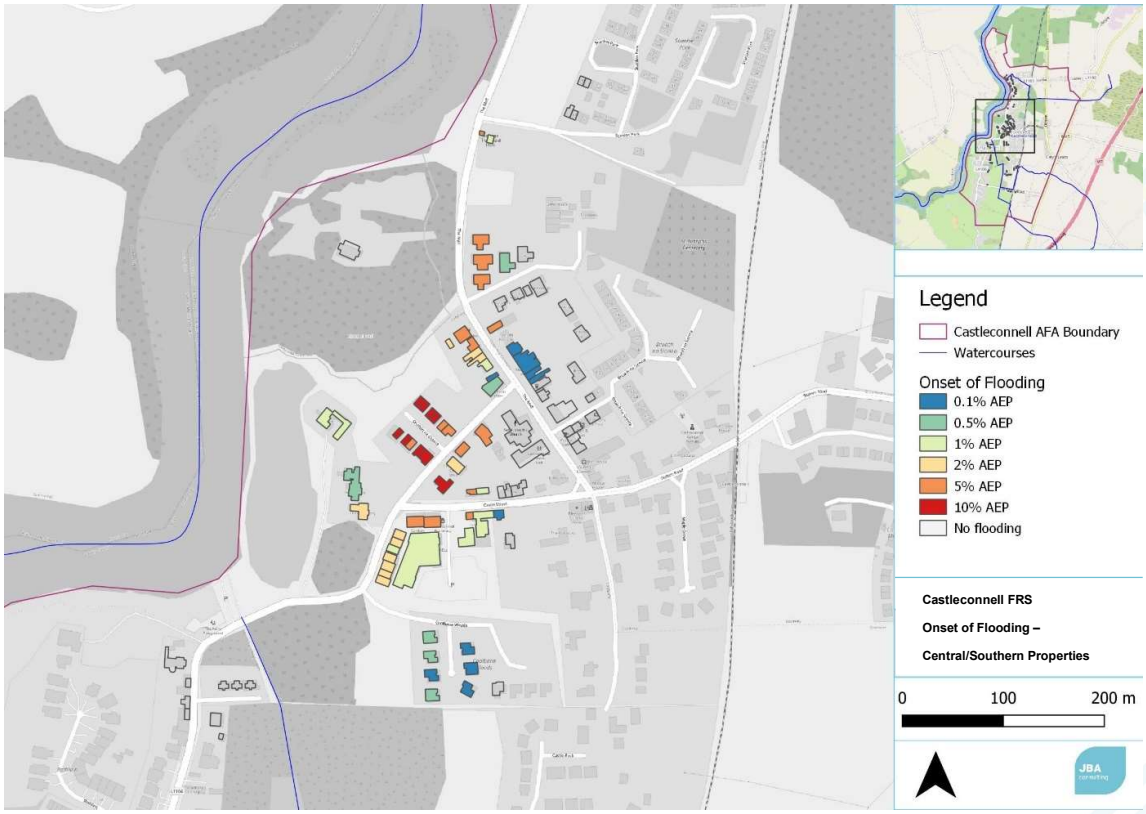


Figure 8-2: Map showing the onset of flood damages to properties, Baseline Current Scenario. Southern properties

Figure 8-3 shows the damage curves for the baseline in the present day, and climate change scenarios (flows increased by 10% and 20% (MRFS)) and Figure 8-4 shows the number of properties at risk per probability for the baseline in the present day, and climate change scenarios.

The operational costs which are incurred in the baseline for flood event response have been based on records from Limerick City & County Council for the 2009 event. Over the appraisal period they are included as a benefit because they are a cost avoided as a result of the scheme. This is balanced on the cost side by the whole life costs of maintaining and operating the scheme.

The damages for each option are the same as the same receptors are provided a consistent SoP and do not change between options.

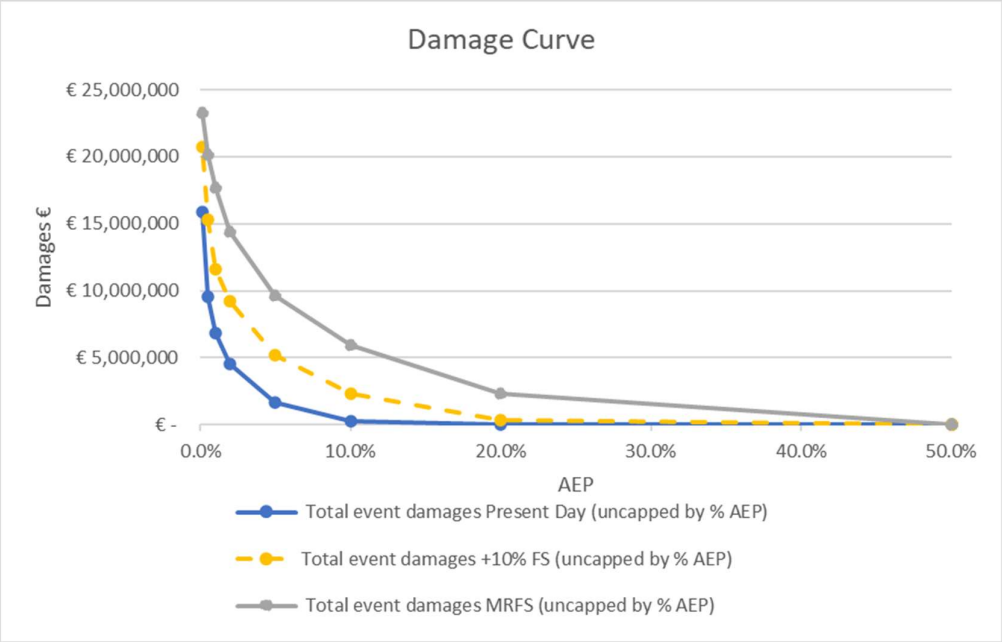


Figure 8-3: Damage curve for baseline event showing the present day, +10% climate change and the MRFS climate change scenarios.

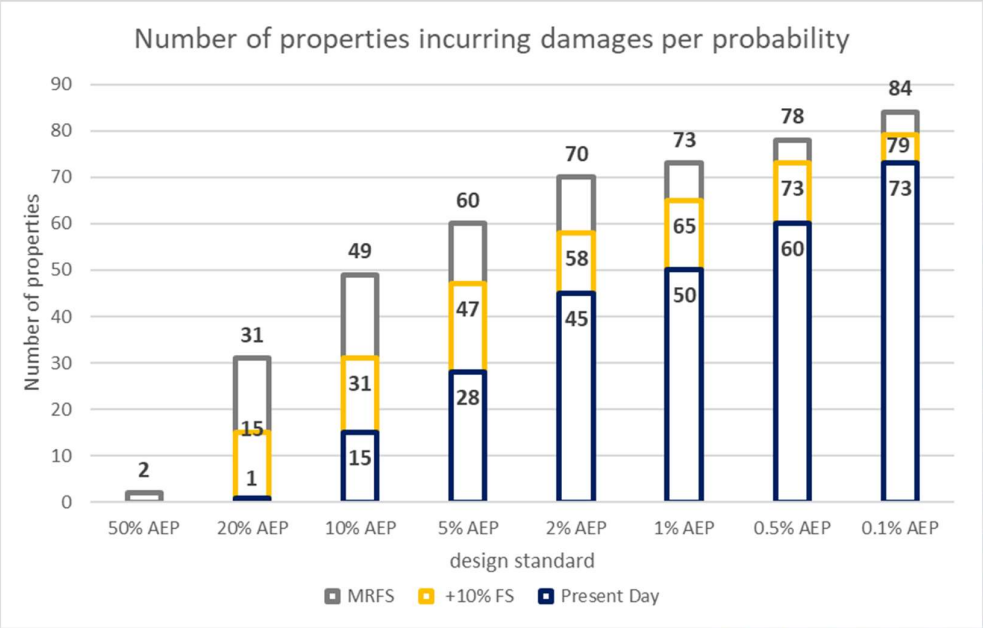


Figure 8-4: Number of properties at risk per probability in the baseline, for the present day, +10% climate change and the MRFS climate change scenarios.

8.2 Option Costs

8.2.1 Methodology

When building up cost estimates for a scheme of this scale, 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 are the elements that were considered when developing cost estimates for the project:

- Construction costs (including environmental mitigation measures)
- Design and site supervision costs
- Site investigation and survey costs
- Land purchase and compensation costs
- Maintenance costs
- Allowance for optimism bias
- Allowance for art

The following costs were excluded:

- Value Added Tax

8.2.2 Construction Costing Method

Base costs for construction elements of the scheme were obtained from the following sources:

- Estimates and tendered rates from similar civil engineering contracts.
- Published cost databases, including the NRA unit cost database and the draft OPW unit cost database.

The following assumptions have been made when compiling the construction cost estimates:

- Normal working week for construction personnel and plant
- No exceptional adverse weather.
- Construction contracts with values of between €15m and €20m and durations of 18 to 24 months.
- Significant costs of traffic management within space restrictions.
- Allowance of 12% for known unmeasured items such as local drainage, services etc.

Environmental and archaeological monitoring will be required during the construction of the works. It is also likely that some environmental mitigation and improvement works will be necessary.

An allowance has been made for design and site supervision costs, reflecting the current best estimate of the likely duration of the construction contracts and required size of site supervision teams for the construction phase only.

8.2.3 Specialist Survey Costs incurred to the end of Stage 1

Specialist surveys, including site investigation, topographic survey and various environmental surveys (bat surveys, bird surveys, aquatic surveys, alluvial woodland surveys etc.) and monitoring assessments have been carried out for the scheme. These are included under design and supervision costs, discussed below.

8.2.4 Design and Supervision Costs

Design and Supervision includes all design fees and all third party survey and assessment costs incurred to date. An allowance for expected future surveys and estimated design and site supervision costs for Stages 3-5, reflecting the current best estimate of the likely duration of the construction contracts and required size of site supervision teams for the construction phase only, has also been included.

8.2.5 Maintenance Works

Limerick City & County Council organise and mount a significant sand bagging and pumping operation when extreme flows are forecast to be released down the Old River Shannon. Such an operation was implemented for the floods in 2009, 2015 and 2020. Based on past events, it is expected that this operation would be required every 5 years (reducing to every 4 -years after year 20).

The operational costs which are incurred in the baseline for flood event response have been based on records from Limerick City & County Council for the 2009 event. Over the appraisal period they are included as a benefit because they are a cost avoided as a result of the scheme. This is balanced on the cost side by the whole life costs of maintaining and operating the scheme. The response cost per flood event based on the 2009 flood event report, is €180,300. This is assumed to occur every five years and has been discounted to reach a Net Present Value of event operational costs of €934,420 (costs avoided).

Although the costs of the event operation are less for Option 2 than for Options 1 and 3, this is not reflected in the NPV values as the 0.25% O&M provision is greater based on the larger capital investment. No provision has been made in Options 1 and 3 for any maintenance that may be required to the existing Mall wall if it remains in place.

8.2.6 Project Contingency/Optimism Bias

There can be a tendency for budget cost estimates for flood defence schemes to be overly optimistic i.e. underestimating the cost of the works. In a project of this nature where access for labour, plant and materials will be challenging, including a robust contingency in the cost estimate is essential. A contingency/optimism bias of 20% of the construction cost has been included in the whole project cost.

8.2.7 Allowance for Art

The "per cent for art" scheme is compulsory for all major public works contracts. For this size of project (investment band €5,000,000 to €20,000,000), the required allowance for art is 1% of the capital cost up to a maximum of €125,000. Details of the capital cost estimates are included in Table 8-1.

8.2.8 Scheme Costs

Table 8-1 summarises the total cost of all three scheme options and the works included.

Table 8-1: Summary of Option Costs

Item	%	Option 1	Option 2	Option 3
Capital Costs		€9,049,688	€9,949,446	€8,524,097
Construction		€7,344,103	€8,177,545	€6,917,175
Measured		€4,710,657	€5,245,244	€4,436,175
Unmeasured	12%	€565,279	€629,429	€532,341
Preliminaries	16%	€844,150	€939,948	€794,963
Optimism Bias	20%	€1,224,017	€1,362,924	€1,152,696
Land Purchase		€48,431	€48,431	€48,431
Art		€73,441	€81,775	€69,162
Enabling Costs		€1,583,713	€1,641,694	€1,490,330
Design and Construction Supervision		€1,205,953	€1,301,799	€1,156,741
Investigations and Surveys		€319,008	€299,008	€299,008
Environmental & Arch. Monitoring		€58,753	€40,888	€34,581
Operation and Maintenance (50 year) (PV)		€720,784	€722,400	€680,681
Whole Life Cost (PV Costs)		€9,770,472	€10,671,846	€9,204,778

8.3 Benefit Cost Analysis

Benefit cost analysis examines the ratio between the total damages and the total scheme cost for the 1% AEP design event (the SoP event). A benefit cost ratio (BCR) of one, indicates that the scheme's costs and damages are equal, values above one indicates a cost beneficial scheme and less than one a non-cost beneficial scheme.

The total damages for the Castleconnell defended area for the 1% AEP event are €7,309,649. The total scheme costs and associated BCRs are shown in the table below.

Table 8-2: Cost Benefit Ratios

	PV Costs	PVd (capped)	BCR
Option 1	€9,770,472	€7,309,649	0.75
Option 2	€10,671,846	€7,309,649	0.68
Option 3	€9,204,778	€7,309,649	0.79

As all BCRs are below 1.0 it means that the proposed scheme will cost more to build than the total damages incurred during the SoP event.

The CFRAM Study included Castleconnell as an Area for Further Assessment (AFA), it should be noted that the construction costs calculated as part of the scheme are significantly higher than those calculated as part of the CFRAM Study. This is due to several factors including inflation, significant increase in the cost of labour and materials, updated hydraulic modelling and flood extents as well as the CFRAMS assumption that IPP would be sufficient protection for the northern properties. With a higher flood level across the whole village the height and extent of defences are now considerably larger.

The BCR however does not account for intangible benefits such as improvement to ecology and landscape which is important when considering aspects like maintaining access along the Mall Road, increasing the footprint of the SAC by c. 1m along the Mall Road and enhancing the woodland at Coolbane Woods. Given the need of the scheme to protect the at-risk areas and the intangible benefits associated with it, it is recommended that the scheme will progress despite having a BCR of less than 1.

9 Multi-Criteria Analysis of Shortlisted Options

Multi-Criteria Analysis (MCA) is a tool to compare proposed scheme options against one another using a set of flood risk management objectives. The following objectives are considered in the MCA:

- Technical
- Economic
- Social
- Environmental

Each of these objectives include subcategories for further assessment. Each objective has also been weighted both globally and locally to reflect the importance of each. These weightings are in accordance with the OPW Technical Methodology Note (TMN) – Option Appraisal and the Multi-Criteria Analysis (MCA) Framework.

9.1 Technical Objective

The technical objective of the MCA relates to the overall success of the scheme in protecting receptors from flood risk. There are three sub-objectives under the technical objective listed in Table 9-1, which also highlights the weightings applied to each objective. Details how the proposed scheme meets the objectives is provided in Table 9-2.

Table 9-1: Technical Weightings

Technical Sub-objective		Local Weighting	Comments
1A	Ensure flood risk management options are operationally robust.	5	Constant (no change permitted)
1B	Minimise health and safety risks associated with the construction and maintenance of flood risk management options.	5	
1C	Ensure flood risk management options are adaptable to future flood risk and the potential impacts of climate change.	5	

Table 9-2: Technical Scores

Technical Sub-objective	Score Option 1	Score Option 2	Score Option 3	Comments
1A	100	200	0	The proposed scheme relies on fixed elements such as raised defences and flood relief culverts which will be designed to a sufficient standard such that they do not fail during an SoP event. While all options are reliant on interventions in the form of demountable barriers. Option 1 proposes 5 nr. demountable barriers, Option 2 proposes 4 nr. demountable barriers and Option 3 proposes 6 nr demountable barriers.
1B	150	200	150	Construction of the scheme will be carried out by competent, qualified contractors with full detailed design and construction details to be considered. Particular risks, as defined under the Safety, Health and Welfare at Work (Construction) Regulations, associated with all three options include: 1) Falling from a height/burial within excavations under earthfalls. 2) Work exposing persons to the risk of drowning – both during construction and maintenance as works are adjacent to a watercourse. Options 1 and 3 have been further reduced to reflect the risk of collapse of the Mall wall during a flood event. However, it should be noted that Option 2 will reduce the need for placement of sandbags during flood events, thus eliminating risk.
1C	300	300	300	All options score the same as all defences will be constructed to permit an extension in height without exceeding heights of 1.5m-1.5m in public areas (Note: heights in some private properties exceed 2m). All options will require the construction of a new flood wall to protect 3 nr. properties in the MRFS that are not currently at risk in the 1% baseline design scenario.

9.2 Economic Objective

The economic objective of the MCA considers the total benefits the scheme provides to the area. There are four sub-objectives.

Table 9-3: Economic Weightings

Economic Sub-objective		Local Weighting	Comments
2A	Minimise economic risk	2.110	AAD for the scheme = €158,270
2B	Minimise risk to transport infrastructure	5	Based on calculated assessment of the probability of flooding to different road classifications.
2C	Minimise risk to utility infrastructure	5	Based on calculated assessment of the probability of flooding of utility infrastructure (ESB substation, 2 nr. pumping stations, gas main)
2D	Minimise risk to agriculture	0	The scheme does not propose any protection to agricultural zoned lands.

Table 9-4: Economic Scores

Economic Sub-objective	Score Option 1	Score Option 2	Score Option 3	Comments
2A	2.8	2.8	2.8	Residual annual average damages with option in place is €482 for all three options. (Excludes infrastructure, indirect and intangible damages which are included in the CBA) >12hrs warning period available for flood forecasting system.
2B	171.2	189.8	171.2	Option 2 scores higher than Options 1 and 3 as it provides protection to the Mall Road (Section A).
2C	180.4	203.4	180.4	Option 2 scores higher than Options 1 and 3 as it provides protection to the gas main under the Mall Road (Section A).
2D	0	0	0	The scheme does not propose any protection to agricultural zoned lands.

9.3 Social Objectives

The social objective of the MCA examines the impact the scheme has in relation to the local community and the visual changes to the area that the scheme will have. There are four sub-objectives under this heading.

Table 9-5: Social Weightings

Social Sub-objective		Local Weighting	Comments
3A (i)	Minimise risk to human health and life of residents	0.4374	Based on calculated assessment of the probability of flooding to all properties in the scheme area.
3A (ii)	Minimise risk to high vulnerability properties	0	No high vulnerability properties in scheme area.
3B (i)	Minimise risk to infrastructure and amenity	0.725	Based on calculated assessment of the probability of flooding of infrastructure and amenity (Community Centre, Post Office, Health Centre, Educational Facility, Credit Union and Art Studio)
3B (ii)	Minimise risk to local employment	2.07	Based on calculated assessment of the probability of flooding of buildings that provide employment (Pharmacy, Food Business, Educational Facility, Pubs, Health Centre, B&B, Community Centre, Shops, Post Office and Credit Union)

Table 9-6: Social Scores

Social Sub-objective	Score Option 1	Score Option 2	Score Option 3	Comments
3A (i)	53.1	53.1	53.1	All options score the same as the same level of protection is provided to all properties.
3A (ii)	0	0	0	
3B (i)	25.9	25.9	25.9	
3B (ii)	72	72	72	

9.4 Environmental objective

The environmental objective includes the most sub-objectives. The scheme should be as environmentally neutral or beneficial as possible given the works undertaken and the final configuration.

Table 9-7: Environmental Weightings

Environmental Sub-objective		Local Weighting	Comments
4A	Provide no impediment to the achievement of water body objectives and, if possible, contribute to the achievement of water body objectives	5	Constant (no change permitted)
4B	Avoid detrimental effects to, and where possible enhance Natura 2000 network, protected species and their key habitats, recognising relevant landscape features and steppingstones.	5	Maximum weighting based on the presence of Natura 2000 sites and priority Annex 1 habitats.
4C	Avoid damage to or loss of, and where possible enhance nature conservation sites and protected species or other known species of conservation concern.	5	Maximum weighting based on the presence of Special Area of Conservation.
4D	Maintain existing and where possible create new fisheries habitats including the maintenance or improvement of conditions that allow upstream migration for fish species.	4	Waterbody supports substantial salmonid fisheries and is of national value for fishing/ang Ling
4E	Protect, and where possible enhance visual amenity, landscape protection zones and views into/from designated scenic areas within the river corridor.	1	Castleconnell is within the Shannon ICZM landscape character area. The County Development Plan does not specify landscape sensitivities or values for each LCA. No designated views or specified landscape sensitivity or value in the area, but certain local views of the Shannon or of heritage sites are important.
4F (i)	Avoid damage to or loss of features of architectural value and their setting.	3	No National Monuments (state owned or vested in the care of local authorities) in study area. PRFA Methodology (OPW, 2011) - Architectural structures listed as either low (houses, bridge, gates/railings), moderate (church, public house, gate lodge, school), or high (country house)

4F (ii)	Avoid damages to or loss of features of archaeological value and their setting.	2	PRFA Methodology (OPW, 2011) lists the features present in Castleconnell as either low (Architectural Feature, Burial Ground, Castle - Anglo-Norman masonry, cross-inscribed stone, graveyard, metalworking site, souterrain) or Moderate (Church)

Table 9-8: Environmental Scores

Env. Sub-objective	Score Option 1	Score Option 2	Score Option 3	Comments
4A	-320	160	0	Option 1 scores lower due to the permanent negative impact from the works to the causeway and the cut-off embankment structure across Cloon Stream. Option 2 scores higher than Option 3 due to the re-naturalisation of the 1m strip adjacent to the Mall wall (Section A) and installation of interceptors along Mall Road
4B	-250	-50	-50	Option 1 scores lower due to the impact from the works to the causeway and the cut-off embankment structure across Cloon Stream, which are in the SAC. Any potential impacts from Options 2 and 3 will be localised and will be limited to the construction period. All three Options will benefit from acquisition and enhancement of lands to the south (East and Southeast of Coolbane Woods) which is expected to develop into alluvial woodland to compensate for the loss/felling of immature birch woodland associated with the Coolbane Woods embankment.
4C	-125	-50	-50	A Heronry located at Island house, which will be impacted by disturbance, so avoidance (timing) mitigation required to reduce impacts to breeding birds. There will be loss/felling of Immature birch woodland beside Coolbane Wood entrance for construction of embankment, compensation via the enhancement of adjacent woodland which is expected to develop into alluvial woodland as a result of enhancement works.

				Option 1 scores lower due to the impact from the works to the causeway and the cut-off embankment structure across Cloon Stream, which will result in permanent loss in habitat or residual impact on habitat.
4D	-208	-156	-156	Option 1 scores lower due to the culverts through the proposed embankment across Cloon Stream and penstocks on Island House causeway culverts.
4E	-32	-40	-32	Physical defences will be designed with minimal visual and landscape impact in mind. This will be achieved through the re-utilisation of existing materials where possible and the inclusion of glass panels in select flood walls to maintain key views of the river from the most affected properties. Option 2 scores lower due to the impact of the flood wall along the Mall Road, on landscape views. All three Options will benefit from the undergrounding of overhead services along the Mall Road. The benefits associated with Option 2 will be greater due to the inclusion of the northern section of Mall wall.
4F (i)	-24	-12	-12	Option 1 scores lower due to the proposed works to the Island House causeway, which is a protected structure.
4F (ii)	-16	-16	-16	Works requiring excavations will require archaeological assessment prior to commencement. Mitigation measures will likely be proposed as a result of this assessment, such as an archaeological watching brief while works are carried out.

9.5 MCA Outcomes and Conclusions

The MCA is a useful tool to guide the decision-making process and to review the performance of the scheme with regard to each of the sub-categories discussed above.

Criteria Scores: The MCA produces a weighted score for each objective and the sum of these within each of the criteria classifications is the Criteria Score, as summarised in Table 9-9.

- **MCA Benefit Score:** The sum of the scores for the economic, social and environmental criteria. It excludes the technical criteria score. This score represents the net benefits of the option.

- **Option Selection MCA Score:** The sum of the scores for all four of the criteria. This score compliments the MCA Benefit Score with the Technical Criteria Score, and hence includes all of the aspects that should be taken into account in considering the preferred option for a given location.

Table 9-9: Summary of MCA Scores

Criteria	Option 1	Option 2	Option 3
Technical	550	700	450
Economic	354	396	354
Social	151	151	151
Environmental	-975	-164	-316
MCA Benefit Score	-470	383	189
Options Selection Score	80	1083	639

When the MCA Benefit Score and Options Selection Score are considered, the highest scoring option is Option 2. For this reason, Option 2 has been identified as the preferred option. This is discussed further in Section 10.

10 Selection of Preferred Option

10.1 Introduction

Three emerging options have been considered to provide the appropriate level of flood relief to Castleconnell considering the specific local constraints and an understanding of how the flow in the Shannon is impacted by Parteen Weir and the operation of the turbines and spillway at Ardnacrusha.

There are common elements to all three options, and these include the proposed works in:

- The northern section – the area to the north of Mall House
- The southern section – the area to the south of Maher's pub

The differences in the options occur in the central section and are discussed in this section.

All three options include local protection to Mall House and Dunkineely House but this takes slightly different forms in Option 2.

At the entrance to Island House, option 1 proposes significant works to the existing causeway. To prevent flood waters passing the causeway and entering the town, the option proposes to replace the existing causeway with a higher structure and the provision of penstocks to close off the openings that extend through the causeway in periods of flood. The structure would then be acting as a flood defence structure. Barriers to this option include the fact that the causeway is listed on the Record of Protected Structures and is located within the area of the SAC. Both these facts would make it challenging to implement the changes and progress this option.

Option 1 proposes no protection to the Mall Road and proposes a demountable barrier crossing the Mall Road near the junction with Scanlon Park. There would also be local raising of the road level at this junction and an earth embankment constructed along the north side of Scanlon Park to tie into higher ground.

Option 1 would result in the Mall Road being closed to all traffic during flood events.

To prevent flood flows entering the town via the south side of Island House, option 1 proposes that an earth embankment is constructed extending from the car park of Maher's pub and into the higher ground towards Island House. Culverts would be provided through this embankment to allow flow through Cloon Stream under normal flow conditions however, penstocks or non-return valves would be installed on these to prevent backing up of flows during flood events. This has the advantage of meaning there is no need to construct a flood wall along The Mall between the entrance to Island House to Maher's pub but does mean the proposed embankment is constructed within the SAC.

Option 3 removes the need to significantly amend the causeway to Island House and the need for the embankment extending within the SAC from Maher's pub towards Island House. It does this through the provision of a flood wall along The Mall from the entrance to Island House and the car park at Maher's pub. This has the advantage of limiting the impact on both the SAC and the listed structure.

Option 3 still relies on the provision of localised raising of the road at the entrance to Island House, a demountable barrier across the entrance, an embankment extending parallel to Scanlon Park and a demountable barrier crossing the Mall Road. It also means that, as with Options 1, the Mall Road would be closed to all traffic during a flood event.

Option 2 has been developed to prevent the flood water from entering the Mall Road through the construction of a new flood wall to replace the Mall Wall from the entrance to Island House to Mall House. The presence of the SAC and in particular the alluvial woodland has been considered and to mitigate this, the wall will be constructed outside the boundary of the SAC. This option results in a slight reduction in the width available for the highway and footpath along this length of The Elvers.

In order to secure the flood defence at the access to Island House, it is proposed that the road level be raised slightly, and a demountable barrier be located at the entrance to the causeway.

As with Option 3, this option means that access to Island House will not be able to be maintained during significant flood events. An offset flood wall will also be required from the entrance to Island House to Maher's Pub car park to provide protection from Cloon Stream.

When considering the benefit cost of the options, it should be noted that the benefit cost ratio (BCR) is not greater than one for any of the three options. Option 3 provides the highest BCR, and the additional cost of the new Mall Wall results in Option 2 having the lowest BCR of the three options.

10.2 Emerging Preferred Option

Despite having the lowest BCR, Option 2 has been established as the preferred option as it has a number of advantages when compared with Options 1 and 3. These include:

- Having the lowest overall potential environmental impacts of all the options: it minimises the impact on the SAC and the protected structure at the causeway.
- Minimising the reliance on demountable barriers on public roads.
- Ensuring the Mall Road will remain open during a flood event - maintaining good access for the public and emergency vehicles.
- Options 1 and 3 do not consider the Mall wall to act as a flood defence asset. There may be a risk that flood flows could destabilise the structure resulting in localised failure. Failure of the Mall wall could result in areas of The Mall Road being at increased risk of erosion, affecting access and services along the highway for significant periods post flood event.

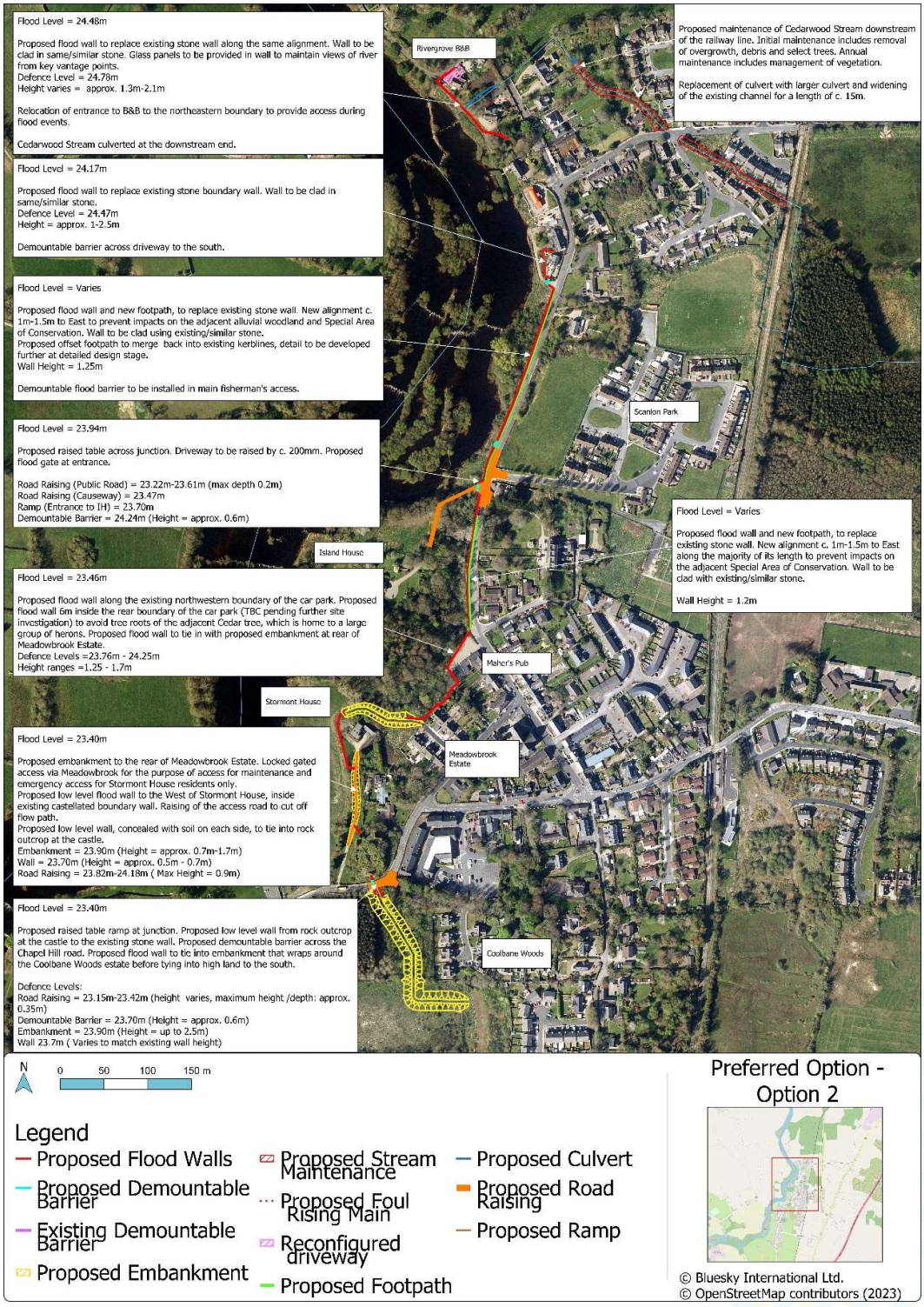


Figure 10-1: Identified Preferred Option

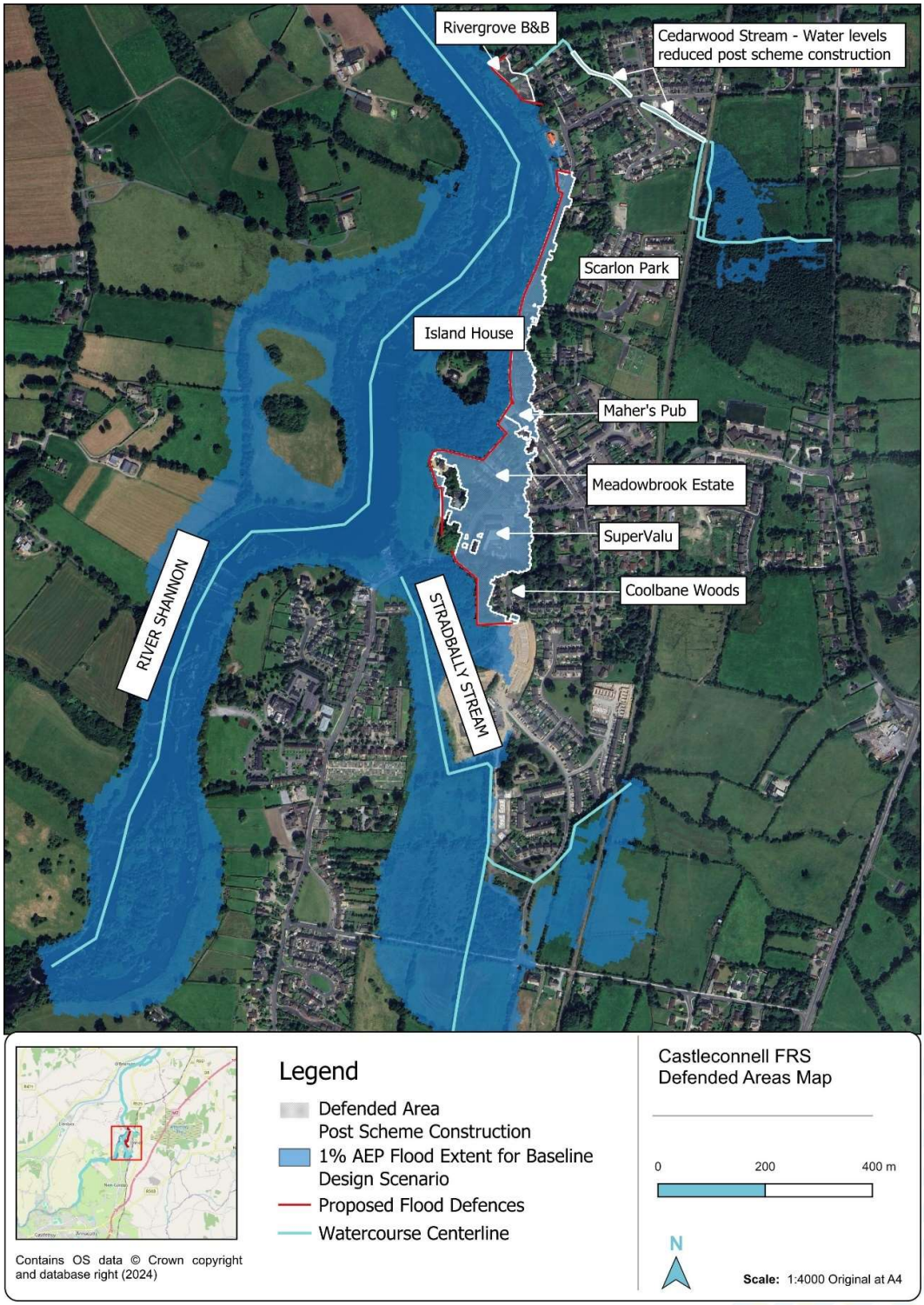


Figure 10-2: Defended Areas Post Scheme Construction (Option 2)

10.3 Climate Change Adaption for Option 2 in the MRFS

The present-day scheme option was run with the MRFS flows to establish any changes or additional areas at risk in the future event with the scheme in place. Typically, MRFS levels are c. 0.5m higher than the current baseline design scenario flood levels. Results of this are shown in Figure 10-3. A grid resolution of 4m has been used which may make some properties to be at a greater risk than they actually are. All existing floor levels and surrounding ground levels have been checked against predicted flood levels).

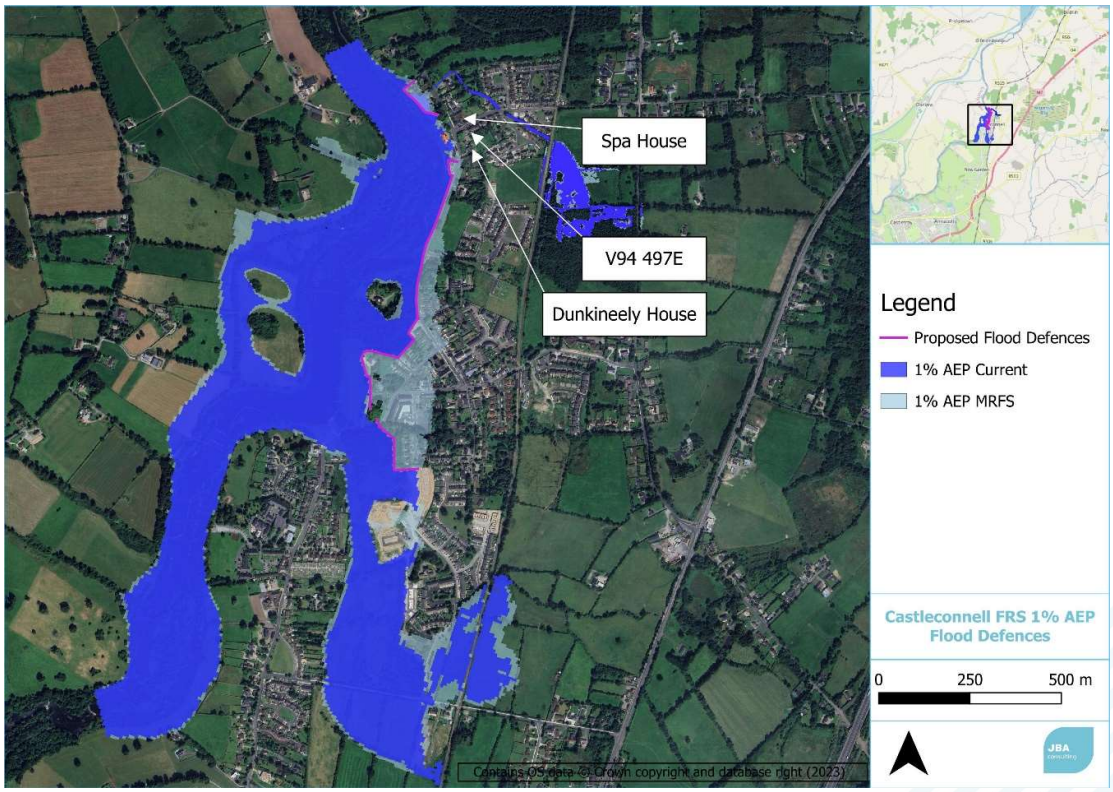


Figure 10-3: Baseline Design Event and MRFS Flood Extents with defences in place

This mapping shows that most defences overtop in the MRFS and highlights the following additional areas which are currently at risk in the MRFS without a scheme in place, which are not at risk in the current baseline design scenario:

- Spa House;
- House at Cloon and Commons, V94 497E (Between Spa House and Dunkineely House);
- Dunkineely House.

10.4 Adaptation Pathway Decision Tree Analysis

Adaptation Pathway Decision tree analysis involves visually outlining and considering the potential adaptations required to allow the present-day scheme to defend against the future climate change scenarios. It is a powerful tool to examine what can be done at present day and in the future to adapt the scheme.

Figure 10-4 presents the climate change decision tree for Option 2.

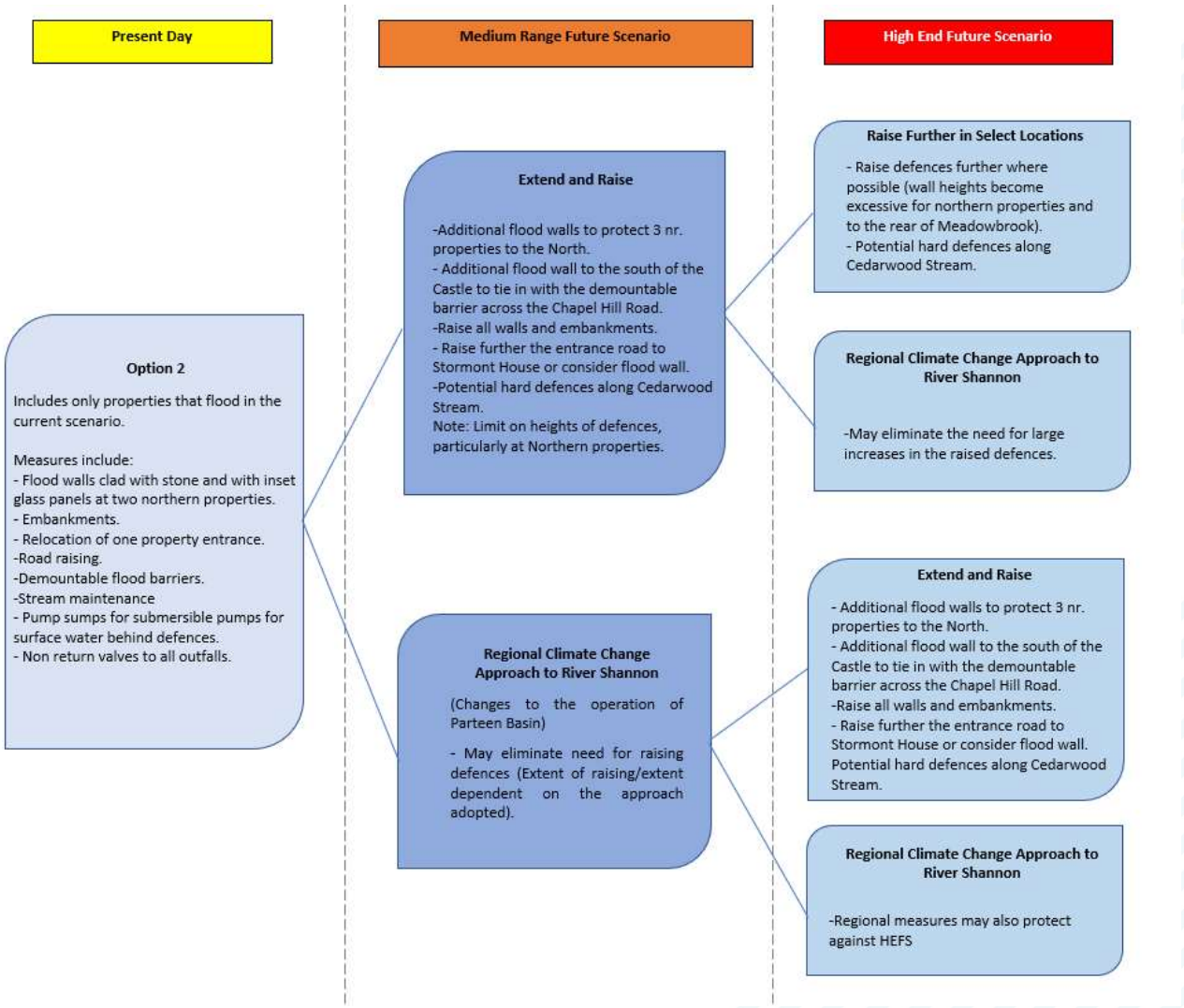


Figure 10-4: Decision Tree

10.5 Benefit Cost Ratio for Potential MRFS Scheme

As discussed in Section 7.3, the regional climate change approaches have not been analysed as they are outside the control of the project. Therefore, without further analysis it is not possible to estimate an approximate benefit cost ratio for these pathways.

Although increasing wall and embankment heights by c. 0.5m may not be considered acceptable in many areas, the costs and benefits associated with this increase in addition to providing flood defence walls to the additional three properties at risk are included below.

This shows that the cost of the adaptions is marginally greater than the additional damages incurred between the current baseline design scenario the MRFS baseline design event. The benefit cost ratio of the MRFS scheme as a whole (current scheme + future adaptions) is 0.76 which means that the proposed scheme will cost more to build than the total damages incurred up to the MRFS 1% AEP baseline design event.

As discussed in 8.3, given the need of the scheme to protect the at-risk areas and the intangible benefits associated with it, it is recommended that the scheme will progress.

Table 10-1: Scheme costs, benefits and benefit cost ratio for MRFS Scheme

Item	Option 2 Present Day Costs	Adaptions Only	Total MRFS Scheme (Adaptions + Current Day Scheme)
Capital Costs	€9,949,446	€2,901,872	€12,851,318
Construction	€8,177,545	€2,541,850	€10,719,395
Measured	€5,245,244	€1,630,394	€6,875,639
Unmeasured	€629,429	€195,647	€825,077
Preliminaries	€939,948	€292,167	€1,232,114
Optimism Bias	€1,362,924	€423,642	€1,786,566
Land Purchase	€48,431	-	€48,431
Art	€81,775	-	€81,775
Enabling Costs	€1,641,694	€360,022	€2,001,716
Design and Construction Supervision	€1,301,799	€292,313	€1,594,111
Investigations and Surveys	€299,008	€55,000	€354,008
Environmental & Arch. Monitoring	€40,888	€12,709	€53,597
Operation and Maintenance (50 year) (PV)	€722,400	€344,066	€1,066,466
Whole Life Cost (PV Costs)	€10,671,846	€3,245,938	€13,917,784
PVd, Baseline + 10% (MRFS), capped	€7,309,649	€3,114,731	€10,424,380
Benefit Cost Ratio	0.68	0.96	0.75

11 Conclusion

The extent and severity of the flood risk in the study area was established and defined through a detailed hydrology study, hydraulic modelling, flood mapping, largely undertaken through the Shannon CFRAM Study, but reviewed and updated under this project.

The aim of the Castleconnell FRS is to produce a scheme that will protect at risk properties up to the 1% AEP event.

The Options Report follows on from the establishment of the baseline and existing scenario work to establish flood risk in the area and examines what could be put in place to provide the protection required. It considers all the constraints in the area, key flood risk mechanisms and receptors.

An initial high-level consideration of flood risk management methods was first carried out with viable methods used to develop measures that could be built within the existing system. The flood risk management methods identified as potentially being appropriate were containment and conveyance.

Several measures were then tested and their impact on the overall flood risk to see which were viable. The overall benefit, buildability, environmental impact and complexity of each measure was taken into consideration when screened. From these measures, three scheme options were developed and Option 2 was identified as the preferred option. Climate change adaptability was also considered when developing the final option in the form of decision tree analysis and the incorporation of climate change adaptability features into the present-day scheme.

The outcome of this optioneering work is the development of Option 2, which is discussed in detail in Section 6.2 and shown in Figure 10-1.

This combination of measures was found to be the one with the greatest local support. Adaptations to the scheme to combat the impacts of climate change were also identified and a scheme was developed to demonstrate that the proposed scheme can be adapted when required, to provide protection against the MRFS.

The scheme option was then assessed from an environmental, cost and buildability perspective. Environmental considerations influenced the alignment and construction methodology for some defences, particularly in Options 2 and 3. Option 1 scored the poorest environmentally due to the significant impacts associated with the construction of defences in the SAC. Public feedback and discussions greatly influenced the development of options, with the feedback being overall positive and a particular interest in maintaining access to the Mall Road in flood events.

The estimated whole life project cost of the preferred scheme for the current scenario is €10,671,846 with a benefit cost ratio of 0.68.

The estimated whole life project cost of the preferred scheme for the MRFS is €13,917,784 with a benefit cost ratio of 0.75. The estimated cost of the adaptions alone is €3,245,938 with a benefit cost ratio of 0.96.

It is therefore proposed to progress the present-day Option 2 from planning through to construction. Adaption of this scheme to cater for the MRFS should be considered before the current standard of protection is exceeded due to climate change.

Appendices

A. Public Participation Day Summary Reports

A.1 June/July 2020 – Initial PPD

Castleconnell Flood Relief Scheme

Public Consultation Summary Report

June 2020

OPW Oifig na nOibreacha Poiblí Office of Public Works

Tionscadal Éireann Project Ireland 2040

Comhairle Cathrach & Contae Luimnigh
Limerick City & County Council

JBA Project Manager

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Revision History

Revision Ref / Date Issued	Amendments	Issued to
S2-P01/ 30th June 2020		Steering Group via SharePoint
S2-P02/13th July 2020	Section 3.1 updated	Steering Group via SharePoint
S2-P03/24th August 2023	Names redacted for GDPR purposes	Steering Group via SharePoint

Contract

This report relates to the Castleconnell Flood Relief Scheme commissioned by Limerick City and County Council, on behalf of the Office of Public Works. Declan White and Leanne Leonard of JBA Consulting carried out this work.

Prepared by ..... Leanne Leonard BEng (Hons) MIEI
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Purpose

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Contents

List of Figures

1 Background to the Study

1.1 Purpose of the Public Consultation Event

The purpose of the public consultation event was to seek initial views from the public and other interested parties in relation to the key issues that the study should address, the options to manage the flood risk in Castleconnell, including the CFRAM scheme option, to highlight points of local importance that might constrain the design and/or viability of any potential flood alleviation measures and to collate information on any flood events that have occurred.

Effective communication with the locals in Castleconnell is vital given the frequency and magnitude of flooding in the village since 2009. Lack of engagement with residents could increase the risk of rejection of the scheme, or elements of the scheme, and lack of identification of key stakeholders could result in delays.

At this early stage of the project it is important that the project team has the opportunity to listen to the views of those who will be living and working near the scheme, and others who may also have an interest in the long term plans, as well as start to build a relationship with members of the local community.

1.2 Target Audience

Any and all interested parties, including political stakeholders. However, the focus of the event is the local residents and business holders. This includes those who have and have not flooded in the past.

2 Event Format

Given the Covid-19 pandemic and associated restrictions it was not possible to hold a public consultation day within the village as previously planned. As of 18th May, Ireland entered Phase 1 of the Roadmap for Reopening Society and Business. Such restrictions under Phase 1 include:

- Travel of greater than 5km from home is permitted only for essential services. Non-essential travel should be avoided;
- Indoor gatherings are not permitted;
- Outdoor gatherings are limited to a maximum of 4 people. Social distancing must be adhered to and the gathering must be within 5km of each person's home.

To comply with the Government restrictions and guidelines above, the format of the public consultation event was altered to ensure that all contact was via brochure and flyer drops and electronic means.

2.1 Means of Promotion and Communication

2.1.1 Brochure and Questionnaire drop

110nr brochures and questionnaires were distributed to select residents and businesses on Tuesday 2nd June 2020 and as outlined in Appendix A.

This brochure outlined the stages of the project along with an overview of the works completed to date, flood risk management options under consideration and possible solutions together with the CFRAMS scheme option as proposed.

2.1.2 Poster campaign

300 nr. flyers and posters were distributed to local businesses including:

- Shannon Stores,
- SuperValu,
- Green Cross Pharmacy,
- Sloan's Pharmacy,
- McDermott's Butchers,
- Castleconnell Post Office,
- Castleconnell/Ahane Credit Union.

The flyers directed residents to the brochure and questionnaire on the Limerick City and County Council website.

Those who wished to receive a hard copy of the brochure pack were directed to the JBA office.

2.1.3 Local Authority website

The brochure and questionnaire were uploaded to the Limerick City and County Council 'Castleconnell Flood Relief Scheme' web page and at the following link.

https://www.limerick.ie/council/services/water-and-drainage/flooding-related-schemes-and-assistance/castleconnell-flood

The questionnaire was made available in both PDF and word format.

2.1.4 Community groups and public organisations

A soft copy of the brochure and questionnaire were emailed to the following stakeholders:

- [**Name removed**] of the Castleconnell Fisheries Association who also circulated to the Ahane Castleconnell Montpellier (ACM) Development Activity Group;
- [**Name removed**] of the Love Castleconnell Group who circulated to Tidy Towns;
- [**Name removed**] of ESB;
- [**Name removed**] of Inland Fisheries Ireland;
- [**Name removed**] of National Parks & Wildlife Service;

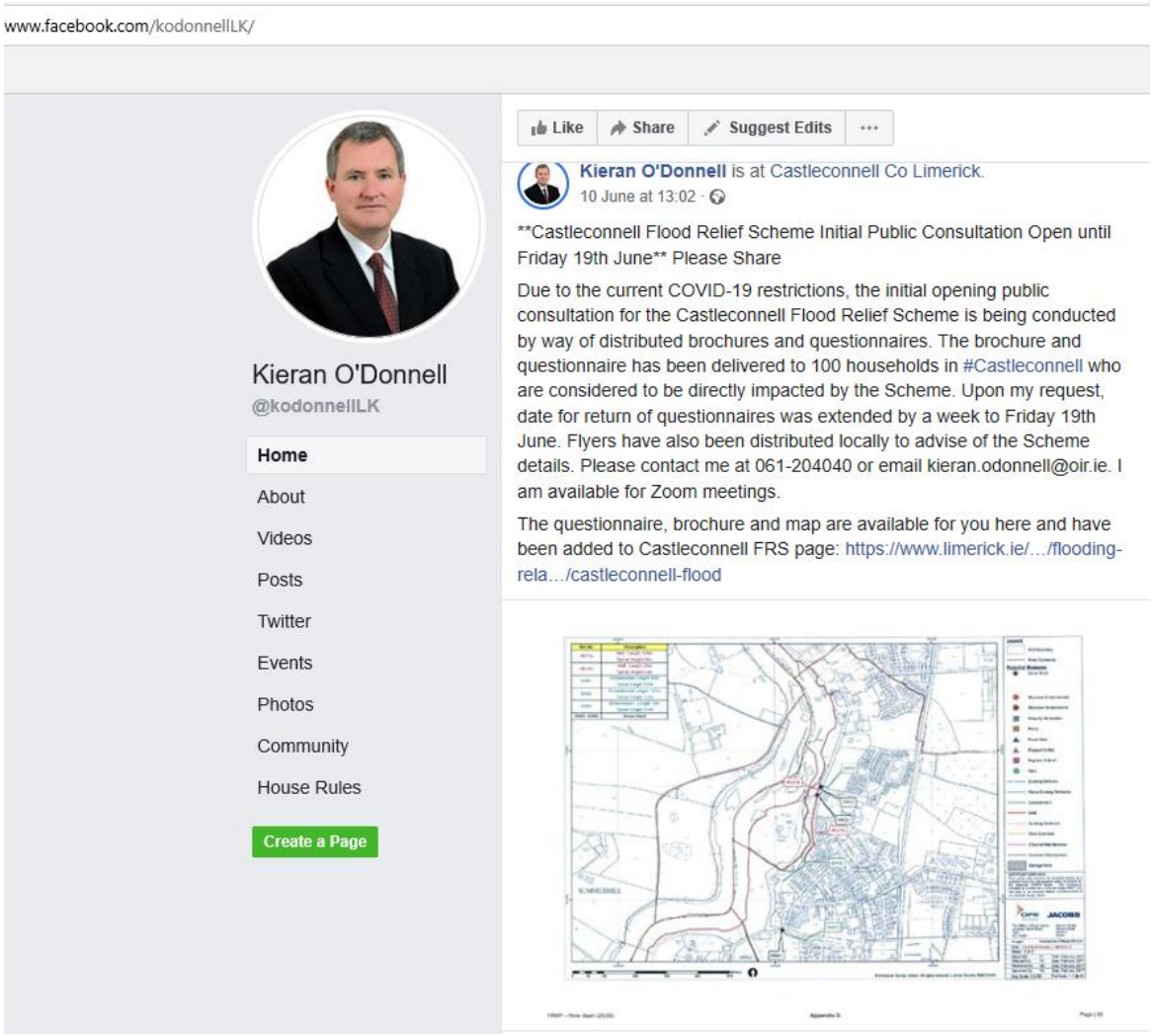
- Limerick & District Anglers Association;
- Mulcair Anglers;
- Ecofact;
- [**Name removed**], resident of Scanlon Park, who circulated to other Scanlon Park residents via a Facebook group.

2.1.5 Kieran O'Donnell TD

Local Fine Gael councillor Kieran O'Donnell was consulted as to the content of the brochure and questionnaire prior to distribution. This resulted in extending the planned period for returns to Friday 19th June.

Mr. O'Donnell also shared a soft copy of the documents on his public Facebook page and as shown in **Error! Reference source not found.**.

Figure 2-1: Extract from Kieran O'Donnell TD Facebook page



2.1.6 Other

A small number of questionnaires submitted have reported being made aware of the public consultation event via word of mouth.

3 Feedback Received

3.1 Questionnaire Analysis

There were 30 nr questionnaires returned as well as three email submissions. Out of these, eight were from residents or organisations outside of the leaflet drop area. The responses to the submissions are summarised hereunder.

3.1.1 Which area of Castleconnell do you have a particular interest in?

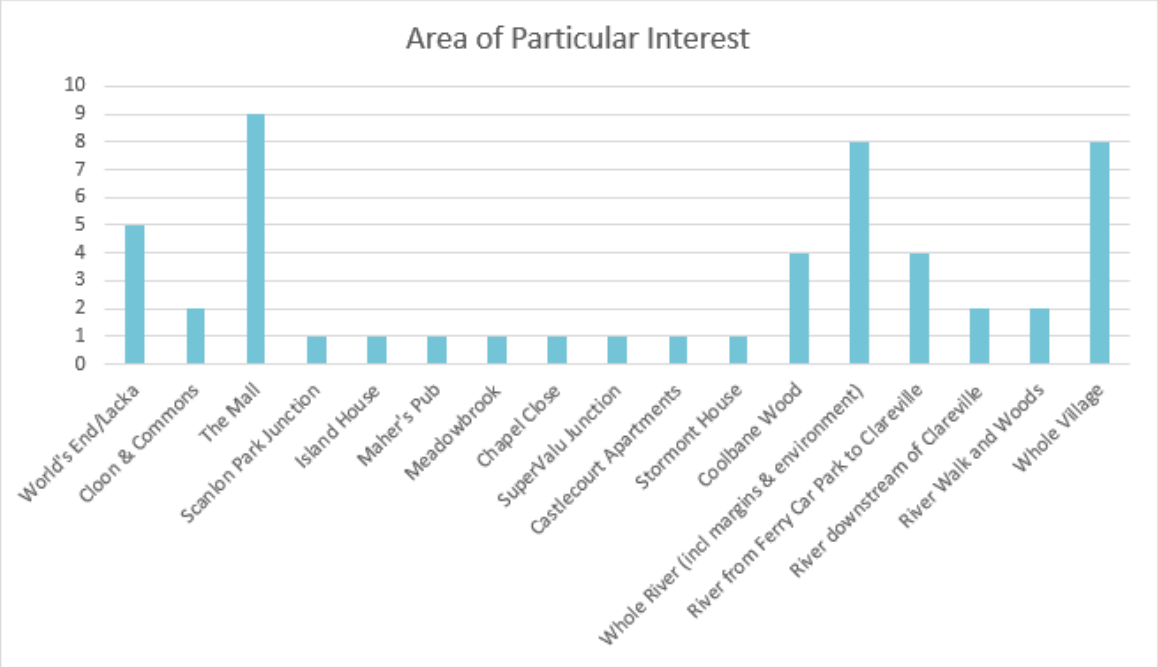
Twenty-six respondents were residents of Castleconnell, albeit some were from outside the area of the leaflet drop.

Seven respondents were from local kayaking/canoeing clubs that regularly use the River Shannon in Castleconnell. The area of interest for the majority of these clubs was generally the river itself from World's End to Clareville Water Treatment Works.

The Castleconnell Fisheries Association response stated that the whole river including its margins and environment were of particular interest.

It should be noted that more than one answer was provided to this question in most returned questionnaires and therefore the total number of votes exceeds the number of respondents.

Figure 3-1: Respondent's area of particular interest



3.1.2 Is there anything specific you would like us to take into account when designing the flood relief scheme?

There were a range of views relating to important elements of the design. Relevant feedback as extracted from the questionnaires is as listed hereunder and in no particular order.

- We've lived at [**House name removed**] for more than 50 years. There's only been a problem once when due apparently to the ESB's failure to allow for flooding, we were unable to get in and out of our gate due to the flood. The house was not affected but our neighbours across the road had a major problem due to sewage flooding.
- Chapel Close Resident:
  - Flooding of my neighbour's home in the village.
- Coolbane Wood Resident:
  - Each year the wooded field immediately south of the public road and behind our houses is flooded.

  - When flooding gets high it affects our sewerage system – but so far has not caused a break down.
  - The flooding has been dealt with in recent years by a pump on the road.
- Relocate the proposed embankment EM02 to run along the stream boundary to the west/north west of the lands owned by the Gubbins family to allow future development to the west of Meadowbrook. Please clarify why EM02 embankment is proposed to end where shown rather than running to River Shannon.
- The river height and flow when the works are complete.
  - Will the water level be stable or will it still be affected by water released from the Parteen Weir by the ESB?
  - Will any works carried out affect the strength of the flow at the area known as World's End?
  - Will the water course change direction in any specific way?
- Meadowbrook Resident:
  - Meadowbrook has suffered flooding from the drain near the bottom wall. Will these measures stop the water from coming out of this manhole.
  - Water level management in Lough Derg is a big concern. The consensus in the village is that competing interests are affecting decisions. Please investigate this thoroughly.
  - New proposals for building in Castlerock could push more water our way. Review our full submission to the OPW.
- Prior to designing the flood relief scheme, [**Name removed**] would ask that consideration is given for the current use of the river features for the sport of kayaking, when proposing changes in the channel and removing or installing/repositioning existing features under the heading of channel diversion and channel cleaning.

  [**Name removed**] propose, if possible, is to assist and identify the position of existing key relevant features and where possible to assist and improve these features in conjunction with other kayaking clubs and Canoeing Ireland, with the overall aim of flood prevention and maximising this natural resource. This can be effectively achieved by strategically redistributing and structurally placing the extracted material from the river cleaning process and by utilising areas of backwater. The recent flooding has increased the ongoing bank erosion at the Ferry Bridge carpark and we suggest an alternative to standard bank rebuilding be implemented, and an appropriate water access point be considered in the design. When construction access & egress points have been established, we would ask that the Designer to consider utilising the construction access and egress space by developing community amenities at these positions and by providing additional parking. [**Name removed**] would ask that where possible any instream works be used as an opportunity to optimise the potential for all river users.
- Mall Road Resident:
  - Our home is the property most at risk of flooding in the first instance during a flooding event. The house flooded in 2009 and was saved only in 2015/2016 and more recently 2020 by county council pumps and sandbags. Flood events cause us extreme stress, anxiety and trauma. Our quality of life plummets for 2/3 months each year.
- I have read through your brochure on the above and found it very comprehensive and informative especially to any on new to the area.
  - I have lived in Castleconnell since 1940 and have seen how the river has been completely neglected since the Shannon Scheme was constructed and which now controls the flow of water to a major extent.
  - I have recorded the water levels during the big flood of 2009 and the low water level during dry season conditions and found the flow is reduced during a flood. The rock outcrop and the overgrowth at the start of the rapids at Hermitage is causing a difference in water levels before and after the constriction of 1.2m. There is also a constriction at the foot bridge and both of these plus the complete overgrown state of the river are causing a backup of water which increases flooding at Castleconnell village.

  - Owing to the neglect of the Board of Works and controlled water flow by the ESB the river because of the reduced flow has become overgrown and silted up and this has added to the flood situation that we are now dealing with in Castleconnell, Clonlara, Corbally and Limerick City.
  - Another major cause of flooding is the policy of the ESB to retain water to generate electricity at peak times and this demand is getting greater. They continue to retain water and keep Lough Derg at the highest level, allowed by law, so that when there is a period of prolonged heavy rain the water gets to a dangerous level and has to be released without complete control.
  - The ESB power station at Ardnacrusha has caused untold environmental damage to the river, particularly in the Castleconnell area.
  - If the trees and the overgrown sections were cleared the flow of the river would be restored and relieve the flooding situation.
- The streams and islands upstream of the village along from Island House to the Mall are of major importance as spawning and nursery streams for salmon, lamprey (marine) and trout, as well as a huge variety of birds. [**Name removed**] have been maintaining the streams for 13 years approx. which has resulted in a great improvement in seriously depleted salmon and lamprey stock. Spawning streams also present at Lackaleen (across river from Ferry). Some man-made rock weirs have caused slowing of river flow, resulting in siltation, excess vegetation and raising of water level during both normal and flood flows. This is an intricate man-influenced system and we look forward to ongoing detailed consultation. We would stress that dredging in any form is not an option.
- As a family we chose to make Castleconnell our home because of the amazing location that the River Shannon provides for Kayaking activities. We also regularly swim in the river and enjoy walks along the bank.
  - Our family are all involved in Kayaking and we are founder members of the Junior section of the Limerick Kayaking Club helping to make this fantastic sport accessible to children and adults in the Castleconnell area and beyond. We are actively involved in river clean ups and measures to protect the river.
  - The River Shannon at Castleconnell is an amazing natural resource and any measures designed to protect the village from flooding should take into account all the user groups for whom the river is such an important amenity.
  - We would like the scheme to consider and consult with Kayaking groups before carrying out any instream works in the river that could affect the quality of the whitewater paddling experience. This would include any changes to river flows, moving boulders, inserting any objects etc.
  - If funds allow for bankside works the car park at the end of New Garden Road (Clareville) beside the river should be upgraded to provide a better experience for all river users.
- Science based solutions are best as opposed to engineering ones:
  - Dredging would be a disaster and cause collateral damage.
  - Weirs upstream of footbridge could be removed.
  - Look at land use along river – too much drainage of wet lands.
  - Allow more moderate flooding at times of the year to curb excessive vegetation and growth or increase statutory flow from 10cumecs.
  - Gouig Bog is being excavated at industrial levels – must exacerbate flooding.
  - Re-wilding and re-wetting are long term and cheap solutions.
  - Planning – disastrous planning decisions re housing/development.
- I would hate to see anything happen to the very distinctive riverfront walls. These are a definite part of the character of Castleconnell. A concrete wall in that location anywhere would be very obtrusive.
  - The slip on the Mall (sometimes known as Broderick's slip): I use this slip to launch my river boats, cedar canoe and traditional Castleconnell Cot. My family have launched our boats there for at least four generations, so I would not like to see that slip further modified, or access impeded.
  - I would not like to see the trout and salmon streams affected.

- Subject to protection of wildlife habitats and in particular the salmon pools, we favour some removal of obstacles to the free flow of the river upstream and perhaps downstream of Island House (IH). In particular, the trees etc. obstructing the free flow of the river under the bridge from Cloon Island to the smaller island (the little island) should be removed and an ongoing program of river maintenance implemented. We are opposed to the elimination of the little island and/or access to it and the concrete structures on either side of the bridge to the little island including in particular those associated with the eel fishery – they are of historical significance and should be preserved.
- The River Shannon at Castleconnell is one of the premier sites in Ireland for Kayak and Canoe skills training. It is unique in that it is the only river location in Ireland that holds a minimum water flow providing whitewater throughout the summer. Kayakers are probably the single biggest user group of the river outside of recreational walkers. The river is used regularly by Kilfinane OETC as well as a number of clubs with whom we have close contact – Limerick Kayak Senior and Junior Clubs, Limerick Kayaking Academy, Bruff Scouts, Shannon Paddlers, UL Kayak Club, Canoeing Ireland and many visiting groups. Kayaking is a sport for life and the age range of user groups in Castleconnell range from 7 years up to adults in retirement.
    - [**Name removed**] would request that the importance of the river as a kayaking amenity be considered and consultation be carried out with the kayaking community before any instream works take place.
    - It is important to highlight that instream works could negatively impact on river features for kayaking however with planned consultation works could take place that both alleviate flood risk and protect or improve river features for paddle sports. Kayak instructors and experienced paddlers will have an intimate knowledge of the river and high-level understanding of river flows and choke points which are causing flooding, combined with an ingrained respect for the river and environment.
    - [**Name removed**] staff have been involved with Limerick County Council and the Water and Communities Office to carry out works at egress point at Clareville, look at access points and issues and proposals for bio-security measures. We consider the river to ae an extremely important natural amenity for walkers, kayakers, rowers, open water swimmers and anglers as well as being a very important natural habitat.
    - We would ask that consideration is given to improving access and egress points and parking particularly at the Ferry Car park and Clareville waterworks.
- The present Mall wall does not have the capacity to protect the village in a secure way. In my view the present wall should be preserved if possible and a reinforced concrete wall capable of dealing with the high water levels and beyond – as was experienced in 2015 – should be constructed behind it. I think it's vital to secure the Mall road and thus the village also from extreme flood as it seems the present proposals could not cope with a flood as high or higher than 2015.
- We can find nothing in the preliminary report to show mitigation measures on the Mall road wall. This is unfathomable considering the lengths Limerick City & Co Council go to each flood to try support this 'bearing all the load' wall and keep the raging waters out. The new flood wall in the proposal document only goes from Mahers Pub to Island House. In 2015 for example, floods had the water level near the top of the wall all along the Mall. Pumps were going night and day for weeks to keep out the water. 2 tonne sandbags a meter apart, both then and most recently in early 2020, stood against the Mall wall as support against the strength of the water. If this wall collapses there will be huge damage throughout the village. There are also at present gaps (including a driveway) in this wall. They have been filled with sandbags in past to attempt to bridge the breach.
    - We propose that the only solution is a floodwall of reinforced concrete be built behind this historic stone wall and that the stone wall height is increased somewhat to mask it.
    - If water levels of the future reach the water levels of the past (and there is no reason why they wouldn't)- without massive pump support this stone wall as it stands bearing the weight of high flood waters, is like a pressure valve waiting to burst.
    - Towards the end of the Mall properties on the edge of the water, many/most of which have required pumps in each backyard to try keep out the water, so as to prevent their homes being destroyed.

- A reinforced concrete flood wall along the Mall from Island House continuing round the properties until the curved red roof house appears vital. Further properties continuing along riverbank are in fragile locations. Extended floodwall/embankments, as surveys deem fit are proposed by us.
- The Mall stone wall, left without such serious mitigation of a flood wall is a liability to the safety of the entire village, and its own longevity. The reinforced concrete floodwall can be masked by the historic stone wall on the Mall, raised by another 30-50cm of stone cap.
- Regarding vegetation on the Mall: 30 years ago there was a clear view of the river and the little islands where birds nest, all along the Mall road. This is now 75% eliminated by massive growth of random tree/vegetation on Mall bank. This should be thinned/cleared according to ecological/structural/scenic requirement. 'New' trees have grown very near wall, thus undermining its structure. Our property 'looks' directly 'onto the river'. But over the years this random uncontrolled growth has obliterated the view we and the public walking the Mall used enjoy of the river. Now we all look on trees from most angles, not water! I also note bird life on the river is far less abundant. In the 1980's I counted, as a teenager, 40 swans from my desk. Now from the same desk – is no view of river and when walking the length of river 3-4 pairs of swans at present at max.

- Lacka Resident:
  - Our house is situated on the river, as such, most of the flood barriers etc. would not be suitable in terms of mitigation for us. Therefore, in our view, the most important thing would be some sort of drainage system/pump system/divert to avoid the river flood/build-up altogether.
- I would like to know what is planned in the Lacka area of Castleconnell as we are on the river and would be disappointed if a wall was being built which would block our beautiful views.
- River access and egress for kayaks and canoes at [Ferry Bridge carpark, the cul-de-sac at Clareville Water Treatment plant and Worrels End].
  - Ensuring that these point the river banks are protected from bank erosion.
  - That water levels do not drop below the current summer levels.
  - That any modification proposed are canoe and kayaking friendly and do not create any danger zones for kayakers and canoeist that navigate these sections of the river.
  - The [Ferry Bridge carpark to the cul-de-sac at Clareville Water Treatment plant and the Worrles End to the Ferry Bridge Carpark] sections of the river are regularly navigated by local kayaking clubs, Limerick Kayaking Academy, Limerick Kayak Club, Limerick Kayaking Junior Club, University of Limerick Kayak Club and the outdoor education centres.
  - Kayaking clubs and ODEC from all around the country also use these section of the river all year round.
  - The section from The Ferry Bridge to Clareville water treatment is the most important kayaking and canoe section of the river in the county for training and coaching. White water races are regularly run on this section of the river. If the flood relief could improve and enhance the river for kayaking that would be a bonus the kayaking community country wide.
- There will be an opportunity of enhancing the walks along the Shannon from Castleconnell to O'Briensbridge. This would build on Castleconnell reputation of been a sporting village that would encourage more walking, running and cycling if the looped walks were provided as part of the flood relief scheme. In addition, looped walks would inspire tourism to Castleconnell.
  - Castleconnell is a village that seems to be losing its connection to the River Shannon. In the 1900's, this area was a world famous salmon fishery that had uniquely large salmon – which according to Arthur Went Fisheries – Dept. Biologist at the time, declined at the same time as the introduction of Ardnacrusha HE PowerStation. However, the Shannon here now is a private ESB fishery and Salmon stocks are now so vulnerable that the fishery is closed for them as part of their conservation. Angling is becoming exclusive and scarce at the moment.

- However, it is vitally important that the Shannon habitats are protected. The riparian areas, and instream islands around Castleconnell have habitat vegetation communities that are undermanaged and are consequently changing from reed and large sedge swamps to riparian woodland and becoming a woodland climax community. I would like to see routine maintenance of the riparian areas of the Shannon happening on a yearly basis after the works have been completed in the interests of biodiversity and fisheries.
- The slipway at the World's End is in need of repair, and it is too steep and tight to turn. The Castleconnell boat club is becoming a world famous rowing club and it needs a slipway, and floating pontoons to make Nationwide rowing events easier on the rowers and volunteers involved. The Castleconnell Club House floods out every year and costs a lot in terms of volunteer's money and time to make it fit for purpose again. A flood wall around these premises would help also.

- This section of river [from the ferry bridge car park to Clareville WTW] is used by [**Name removed**] throughout the year but in particular from April through to September for the training and development of our junior members ranging in ages from 7-18. The River Shannon provides a great amenity for this important development for our young members with its natural features to support the skills needed in kayaking.

  The majority of these members are living locally in the surrounding areas of Castleconnell and are very aware of the difficulties of flooding and the dangers to its residents. Members would like their input in the event that the course of the river or features may change as these changes may possess a danger to Kayakers in the future.

  Instructors from [**Namer removed**] regularly remind our young members of the importance of the River Shannon. This takes into consideration Litter, Biodiversity and the importance of wildlife on the Shannon.

  The fact that Clareville water works provides water to households and commercial premises in the Limerick area is most important in our approach to the sustainability of the River Shannon. Maintaining a high level of water quality is very important.
- [**Name removed**] has a very active club and member base in Castleconnell and the wider Limerick area. The clubs and organisations regularly using the river include Limerick Kayak Club, Limerick Academy Kayaking, University of Limerick Kayak Club, Shannon Paddlers, Kilfinane Outdoor Education Centre and UL activity centre. These clubs provide kayaking opportunities for residents of Castleconnell and the wider area to access paddlesports and have a particularly active base of local children paddling. The River Shannon is an extremely important amenity for our clubs and members in the Limerick area and further afield. The size of the Shannon makes it one of the very few rivers in the country where whitewater paddling can take place all year round allowing for skills and safety training even in the summer. We would request that [**Name removed**] and its members organisations above are consulted in advance of any specific instream measures taking place that could alter or change the character and volume of river flows and whitewater features such as rapids and drops, particularly in the stretch between the ferry car park and Clareville. We would request that consideration is given to the high level of use for the sport of kayaking and that the Shannon at Castleconnell is the only river in the region suitable for moving water paddling for much of the year. In addressing the issue of flood relief, it may be possible that instream works could be used to optimise river features for kayaking and canoeing activities and this should be considered for all works. In all cases instream works should take into account the safety of Kayakers and Canoeists and not pose a hazard to them. [**Name removed**] is aware that its member clubs are part of the local community and actively engage to provide opportunities for sport and competition, carry out river clean ups and charity events and have engaged with Limerick County Council and the Local Authority Waters Programme to address access/ egress concerns, environmental and biosecurity issues. Access and egress points for paddle sports would benefit from any improvements that may be possible within the scope of this scheme such as launch points, universal access and parking.
- I am writing as a matter of urgency regarding the proposed plans to manage the risk associated with our location. We have been living here for the last 13 years and in the past, we have been severely affected by the floods. Our home is on the bank of the river and has suffered water penetration many times due to the lack of adequate protective barriers.

I would urgently request flood preventative measures to protect [**House name removed**]. I would like to request individual property protection to ensure the architectural interest is protected, conserved and maintained, as part of Limerick's cultural heritage.

  - I would also request flood walls, dredging and channel cleaning to the river area to the front of the boundary wall. There is a small island inlet in front conserving natural habitat and existing ecosystem.
  - Lastly, I would request the stream which flows through our property be assessed. This has been problematic with floods as it retains water during flooding.
  - I am appealing to please consider us for some form of relief to protect a building which is our family home and furthermore, a building of significant architectural interest.

- Protection for houses in Coolbane Wood from flooding.
- This section of river is used by a lot of different groups of kayakers from around limerick, ourselves [**Name removed**] Senior and junior sections, Limerick Acadamy and scouts kayaking, Bruff Scouts, UL kayak club, Shannon paddlers, Kilfinane OETC just to name a few along with visiting kayakers from other parts of the country. It is a river that can be paddled all year round without any extra rainfall which makes it an extremely important resource for peoples health, fitness and wellbeing.

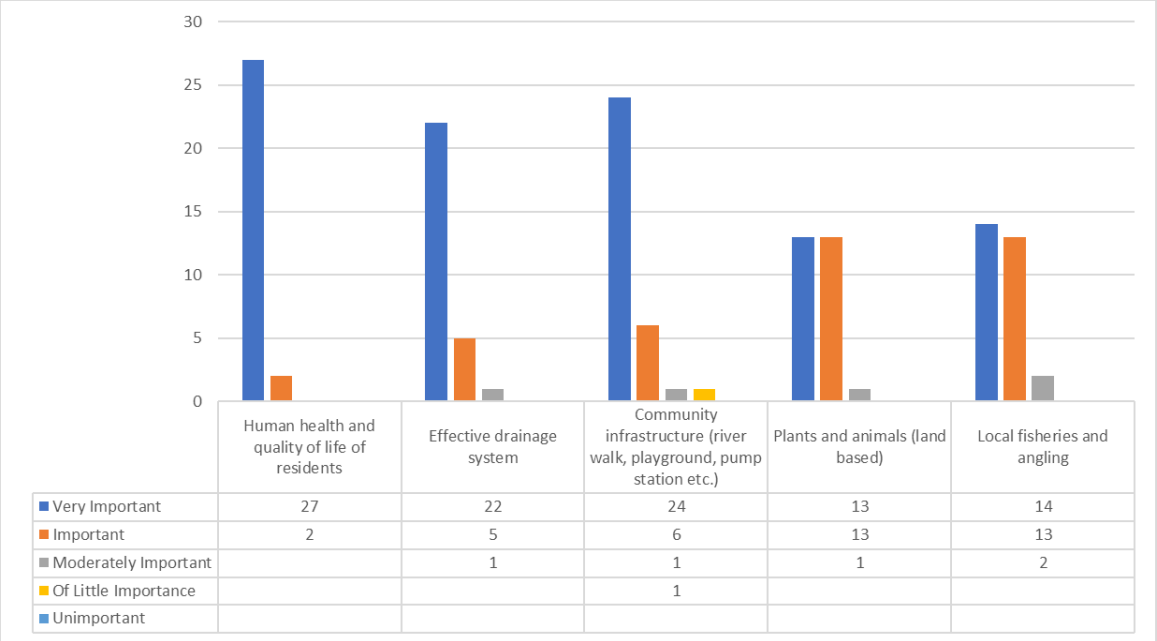
  The features that are present in the river and along its course make for a great practice grounds for young and old, for all abilities. Changes to the river could effect these features and how the water flows work in certain areas. Taking this into account any works that may be done in the river could be used to optimise and improve the potential for all river users.

  We would also have concerns over access that may be blocked due to flood defences and debris that may be left in the river or just exposed hazards such as re-bar which can be found protruding on many rivers.

3.1.3 In your opinion, how important are the following in the development of a Flood Relief Scheme?

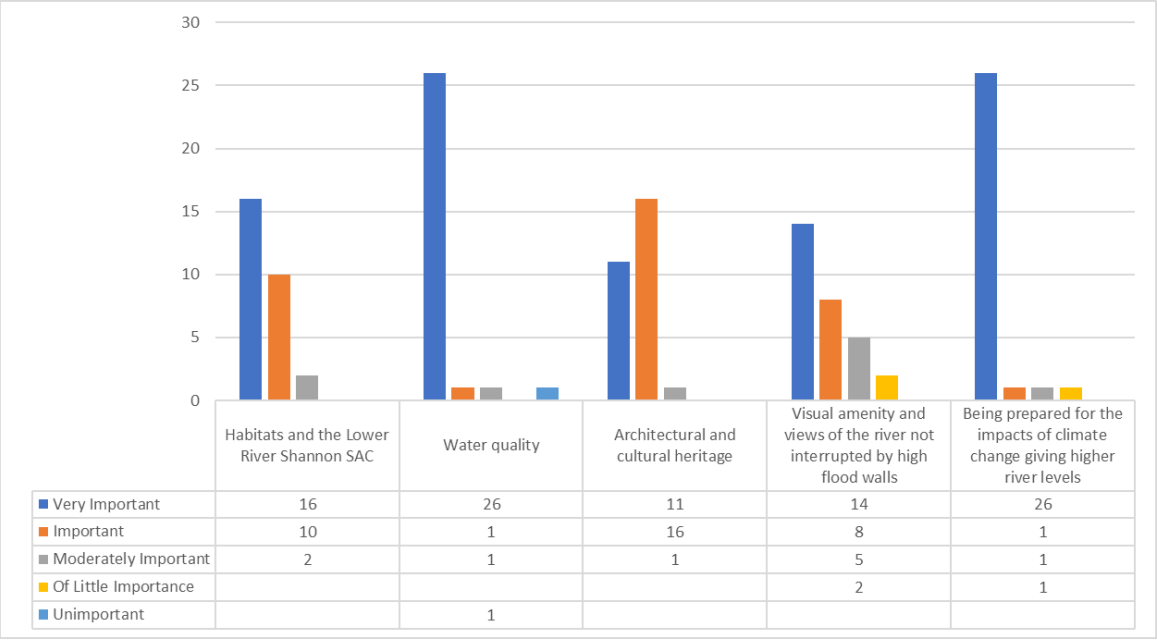
The responses for each of the options given in the questionnaire are presented in the Figures below.

Figure 3-2: Respondent's priorities in the development of a Flood Relief Scheme (Q3, Points 1-5)



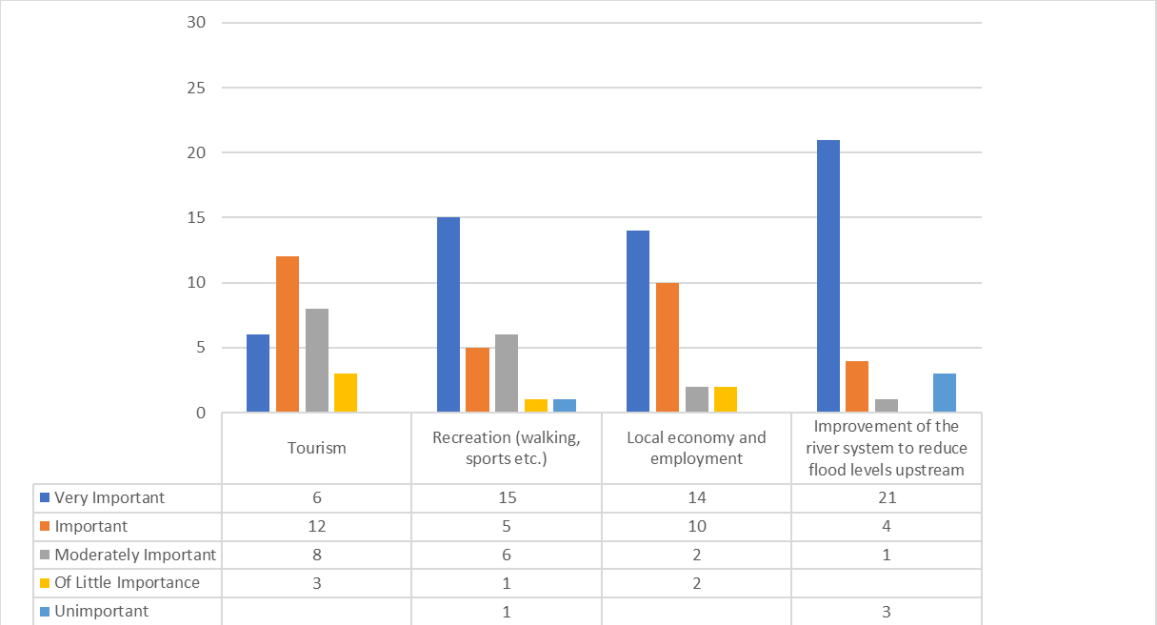
	Human health and quality of life of residents	Effective drainage system	Community infrastructure (river walk, playground, pump station etc.)	Plants and animals (land based)	Local fisheries and angling
Very Important	27	22	24	13	14
Important	2	5	6	13	13
Moderately Important		1	1	1	2
Of Little Importance			1		
Unimportant					

Figure 3-3: Respondent's priorities in the development of a Flood Relief Scheme (Q3, Points 6-10)



	Habitats and the Lower River Shannon SAC	Water quality	Architectural and cultural heritage	Visual amenity and views of the river not interrupted by high flood walls	Being prepared for the impacts of climate change giving higher river levels
Very Important	16	26	11	14	26
Important	10	1	16	8	1
Moderately Important	2	1	1	5	1
Of Little Importance				2	1
Unimportant		1			

Figure 3-4: Respondent's priorities in the development of a Flood Relief Scheme (Q3, Points 11-14)



	Tourism	Recreation (walking, sports etc.)	Local economy and employment	Improvement of the river system to reduce flood levels upstream
Very Important	6	15	14	21
Important	12	5	10	4
Moderately Important	8	6	2	1
Of Little Importance	3	1	2	
Unimportant		1		3

3.1.4 Please indicate which best describes you

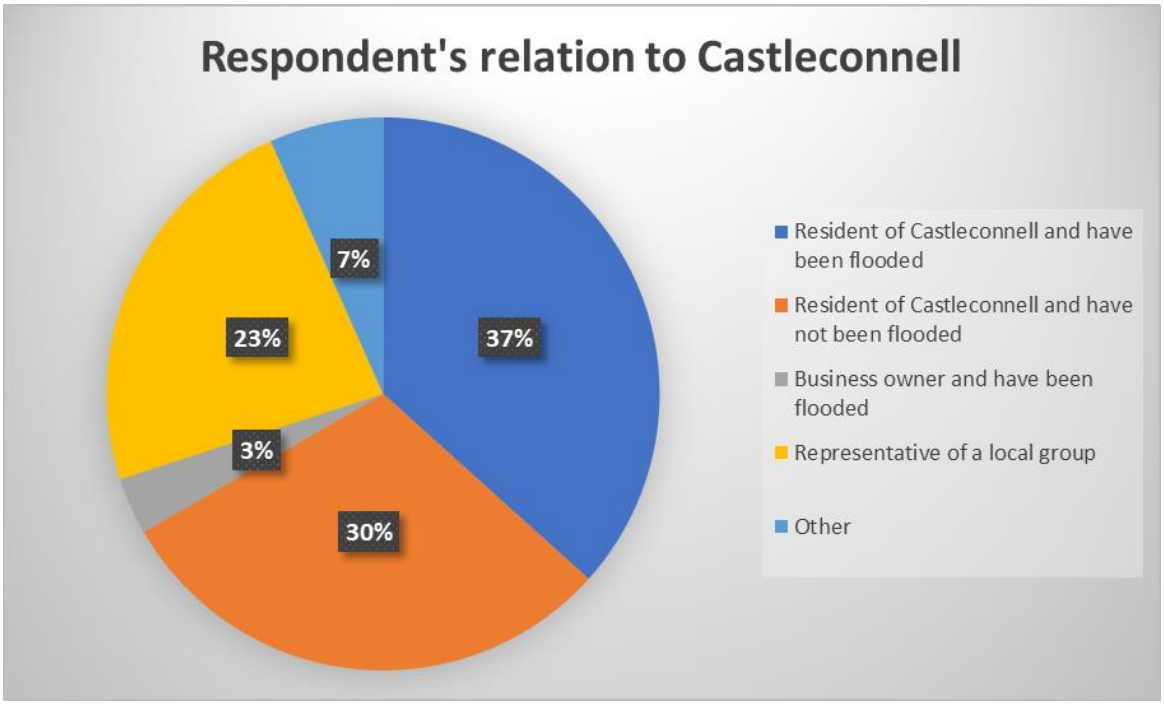
Figure 3-5 illustrates the respondent's relation to Castleconnell. Of those who flooded, all but one were reported to be in 2009.

Other floods were experienced in 2010, 2015, 2016 and 2020. One resident stated that their property has flooded on more than six occasions. While 38% (11 nr.) residents reported flooding, not all experienced internal property flooding.

Some residents reported driveways and gardens flooding with flood waters coming within 'millimetres' of some houses.

Many residents that had not been flooded reported that their houses were sandbagged in recent flood events.

Figure 3-5: Respondent's relation to Castleconnell



3.1.5 Please record your experiences of flooding and any comments regarding the proposed scheme.

There were a range of experiences of flooding and comments regarding the proposed scheme. Rather than try to group responses, relevant information is listed hereunder and in no particular order.

- The last flooding we had to have sandbags outside our front door for a number of weeks and we were very worried what would happen if we did get flooded. We only moved here in Nov 19.
- Proposed scheme will probably become more important in time, but effective control of Lough Derg water levels by the ESB, particularly during the winter months is essential. Lough Derg should be considered as a giant floodplain and controlled accordingly. We are also extremely concerned to discover that for house insurance purposes we are now considered to be on a floodplain and have been refused a quote on that basis. Will this scheme change that?
- The water came into the car park of the credit union which is directly in front of my home although a little lower than my home. The fear of going to bed not knowing how it was going to be in the morning.
- Coolbane Wood Resident:
    - 2009 worst year. Flooding stopped just short of our house, which was sandbagged and boarded. Public road and drive flooded – access only through garden of friends reached through lane beside Guerin's Pub. Flooding has occurred a few times since, but not so bad as in 2009. Road access blocked from Castle Oaks side but possible from school/station side. Field at rear of our houses becomes a lake most years.
- The Boat Club in Castleconnell has been flooded on a number of previous occasions: 1995, 1999, 2009, 2016 and 2020.
    - Much damage has been done to the entire Clubhouse which is now undergoing a total refurbishment at considerable expense because of the most recent flooding.
    - Our Club athletes, including our high performance international rowers, have lost months of valuable training time both in the Club gym and on the river: the floods have rendered the Clubhouse unusable and the slipway inaccessible. This will seriously impact on their respective performances at the Olympics, World Championships, European competitions and the National Championships.
    - With over 150 registered members, from twelve-year-old juniors to 70+ year- old senior masters, our Castleconnell Club has the largest number of registered rowers of any club with Rowing Ireland, the National Governing body for Rowing in Ireland (North and South).
- Meadowbrook Resident:
    - My family were out of our home for 4 months during 2009/10.
        - Temporary pumps outside the front door have prevented damage to the house in 2015 and 2019/20.
        - No insurance cover for flooding and people buying a house in Meadowbrook need cash as a result.
        - Affecting the value of houses also.
        - Not good for our mental health situation.
        - Our end boundary wall needs replacing/reinforcing.
- [**Name removed**] are currently in the preplanning stage after preliminary securing a site from Limerick County Council for a new Kayaking development in proximity to the River Shannon in [**Address removed**].
    - The new development will bolster the well-established sport of Kayaking on the River Shannon, specifically in Castleconnell and will form part of the overall development of the Sport of Kayaking in the Munster region. This will provide the sport to all members of the community with various sport disciplines, such as Canoe Polo, Freestyle, Paddle Surf, Marathon Racing, Canoeing Sprint Racing (Olympic Sport) Canoe Slalom (Olympic sport) Canadian Canoeing.
    - [**Name removed**] ask, that when considering the design of the flood relief scheme, that you consider other impacts arising from the great natural resource such as the

benefit to the community by living in proximity to the River Shannon. The longstanding fears of flooding could somehow be put in balance through natural wellbeing and by wellness both on and near the water, also the proven benefits of living near water through recreation and sport.

  - This flood relief scheme is a perfect opportunity to address the fundamental issue of protecting property and people's homes but also an opportunity to enhance their lives.

- The Mall Resident:
  - We have on two occasions during flooding events emptied our house of all the downstairs furniture and put it into storage for a number of weeks. The stress of this cannot be quantified. Prior to 2009 there was no history of flooding recorded at this property. As a result of that we are unable to get flood insurance which in turn deprives us of my peace of mind.
- House at Hermitage Lane – Water came to 25mm of floor level.
- Mall field is zoned in flood area and this is not the case.
- Meadowbrook Resident:
  - In November 2009 my house was flooded. Even though we were given sand bags it did not stop the water from coming in. My sitting room, hall and kitchen went under. I had to evacuate for six weeks. However, I got through it with help from fiends, family and council. Hope everything goes well for the developing of the scheme.
- The current flood control regime operated by ESB whereby the "old river" channel is used only as a spillway means that the Castleconnell River rarely floods, but when it does it is often a large flood of short duration. This has the effect of allowing vegetation (trees) to grow along/across the weirs, and into the sides of streams, so that when a really large flood comes, the channel is too constricted. Some weirs and unintended tree growth on weirs and within flood margins of formerly high-flow velocity streams has had the effect of slowing normal flow as well as flood flow, thus increasing flood levels. Rectifying these matters would obviate the need for expensive engineering interventions. A minor maintenance budget would be required.
- We have experienced a number of flood events in Castleconnell over the past number of years. In the winter 2019/20 excellent work was carried out by Limerick County Council, the Army and other local bodies to protect the village, homes and businesses.
  - However our experience is that the timing of water releases from Parteen Weir into the natural course of the river is generally very late into a flood event and that pre-emptive measures to allow water to run off well in advance of heavy rains would be a much more effective strategy. This may in fact prevent any flooding in the village or the need to take emergency action such as barriers and pumping.
  - This would also provide a more natural flow of water for the river which should naturally rise and fall with rains instead of being kept at an artificially low level throughout the winter. This would surely be a better environmental approach and help to keep the river channels clear.
- Buildings on flood plains in village include Meadowbrook, SuperValu, Coolbane Wood, Tonville, Houses on Mall. Personally remember back as far as mid 1970's – regular flooding in these areas.
  - Huge areas of wetlands in the area have been drained intensively, no compensatory measures to help hold water back during wet periods.
  - River banks and islands are all unrecognisable from 30/40 years ago.
  - ESB have abdicated responsibility for the fishery, thus there is no proper input from them i.e. they used have full time fishery officer/manager – obliged under S8 1935 Fishery Act.
- Flooding affects us in [**House name removed**] in 2 ways.
  - One is that when the roadway, half way between Mahers Pub and Island House gate floods, we have to allow pedestrians and even vehicles through our garden, which gets them around the flood until it gets too high at Cloon Well, and at that point we are marooned ourselves.

- In the past (not in last 2 major floods) if groundwater is impounded by the Mall, and especially Island House wall, the water table rises and the cellars of Tontines Houses are liable to flood. This would obviously be exacerbated if a concrete wall was inserted between us and the river. We have not had a cellar flood in many decades, and then it may have been caused by new sewerage pipes.

- [**House name removed**] is not prone to flooding but part of the surrounding c.9 acres is. Some of this is a flood plain and is woodland and does not need to be protected from flooding. However, part of our field and driveway have been severely flooded in the past, such that access to [**House name removed**] became impossible and we had to be evacuated twice. In the most recent flood, LC&CC maintained access to [**House name removed**] by a combination of pumping and erection of temporary flood defences. We understand that the proposed flood protection measures are designed to protect both us and the village from future flooding. To that end, we favour [**illegible**] the concept of constructing a wall (subject to agreement on its style being consistent with the "battlements" on the bridge over the stream and agreement on its height) along the [**Name removed**] alongside the field but remain unconvinced that it should extend beyond this point. If desired, we would have no objection in principle to a wall being built from where the stream re-enters the Shannon as far as the rear of Maher's Pub.

  We note that mention is not made of the wall along the Mall as far as Mall House and believe that consideration should be given to strengthening it.

- The natural river channel of the Shannon at Castleconnell has become very overgrown with trees and small islands building up. In some sections there is forest where there would naturally have been open river.
  - This could be alleviated by raising the outflow from Parteen weir to the river above the minimum level of 10 cumecs for periods of the winter. This would mimic a more natural river flow and help reduce vegetation build up as well as reducing water levels upstream.
  - At present the natural river is maintained at a low level all year round and only raised during flood events, when it is raised quickly and lowered quickly afterwards. This would not be the natural pattern for a river of this size and gradient.
  - It would appear that earlier and more gradual release of water in winter to lower the levels of Lough Derg in advance of forecasted rain would significantly decrease the flood risk to Castleconnell, Limerick City and upriver towns.
  - A clear main channel for the river with strong glows in addition to flood channels that remain clear of vegetation should be the first line of defence against flooding in Castleconell.
  - [**Name removed**] would request that the proposed scheme consider the importance of the River Shannon as not only an important habitat but an extremely important resource for education and recreation for many kayaking and other water user groups. In designing the flood relief scheme to protect Castleconnell and other areas there is an opportunity to enhance this fantastic natural resource.

- In 2009 the Mall road flooded to such an extent no car could pass it. We parked our vehicles elsewhere and waded through and walked up our driveway in wellington boots on foot. Our house is the highest along the road, thus we did not ourselves flood. Neighbours were in serious danger.

- The proposed scheme has nothing in the publicly provided document to as of yet suggest comprehensive, thorough, or even cursory attention is intending on being paid to the mall road wall and it's untenable/essential role in protection of the village in holding back the waters come severe flood as has been seen before and shall be seen more or less again. We need structure that is reliable, not luck, nor as a singular solution - sandbags, split, every single one of them by fun pranksters who thought to tear sand bags apart some years back in a recent flood all along the Mall.

- Lacka Resident:
  - Our house is positioned on the river but is built high up, therefore the garden becomes completely flooded but luckily has not entered the house. However, it has come extremely close twice in recent years (within millimetres).
  - We require a new manhole outside our front house gate, to stop the flood water coming down our drive and damaging house foundations.

- Lacka Resident:
    - In 2009/10 the garden was completely flooded but fortunately did not come into the house. The water was higher than the road so the river was flowing in to the garden as well as completely covering the Mall bordering the river.
    - In 2015/16 and 2019/20 we were spared the worst of the flooding by the pump which was supplied by the council, and which contained the flood waters to the front garden.
- At normal water level kayakers grade this section of the river as class 2/3. During high flooding it class 4/5 and should only be kayaked who are of L4 + standard. (There is 5 skills level of trained kayaker). The main problem we experience is the raw sewage that get into the river system. I personally witnessed sewage flowing into the Ferry Bridge Carpark during one flood it would seem that the local sewage system could not cope. There is also a very strong smell of farm effluent from the river water that I presume is from slurry tanks that have been breech by the flood waters.
- Four massive floods in last 11 years. First flood was in 2009, prevented traffic going to village via 'the elvers' road.
    - Subsequent floods have been well managed and pumps have been deployed which kept elvers road open.
    - The flooding affected the Castleconnell community as it made us feel vulnerable, worried, helpless and were empathetic to other households more severely affected and cut off. All insurances for our homes were affected by flooding – even though we were not directly affected by the floods.
    - Routine sensitive pruning of riparian woodland zone and maintenance of riparian zone of river will also assist in flood management for this area.
- As we are all very much aware of climate change and its effect especially with higher rainfall which can be seen as the main cause of Flooding. Preventative measures may help in the prevention of major flooding to the Castleconnell area and down river. This includes the monitoring of rain forecast along with the safe increase of discharge from the Parteen Weir as necessary.
    - The regular increased discharge may help decrease cultivation and restrictions which can be a cause of the build-up of debris on the river as this can be seen clearly in low waters.
    - We do feel more regular release of water to mimic the more natural flows of a river could greatly help the river and its flooding issues as well creating a more natural river environment for all river plants and animals.
- [**Name removed**] would support the view of our members that increasing the outflow from Parteen Weir to the natural river at intervals throughout the year when water levels allow would help to keep river channels clear and prevent build-up of vegetation, thus reducing choke points during times of flood. This would also improve the kayaking experience and reduce water levels upstream when needed. We would again highlight the importance of the Shannon at Castleconnell for the sport and recreation of Canoeing. There is potential to not only maintain the quality of this fantastic amenity but also to improve it and develop a world class amenity. We would request that [**Name removed**] and our member organisations are consulted at all appropriate stages of the project and particularly in relation to any instream works or works at access and egress points
- Our Georgian home sits on the banks of the River Shannon. A low, stone boundary wall is all that separates our home from the river. We have experienced two flooding's since we moved here thirteen years ago.
    - As you can see from provided photos, our boundary wall from the Shannon offers minimal security against the risk of flooding. In 2016, our conservatory flooded. The water also surrounded the front and sides of building. These flooding's have caused great stress and anxiety, disrupting our lives and livelihood. This caused damage to the property, dealing with the flood and leading with the consequences of water damage and aftermath and clean up.
    - I would please request the flood relief scheme to include protective measures to preserve and conserve this country house, our family home. This is now an annual

worry and stress as climate change continues to impact our environment and frequent flooding is increasingly inevitable.

- Regarding the proposed scheme, I would plead that we be considered for individual property protection and flood wall barrier.

- In 2009 it came very close but has been well managed in recent times since then reducing the impact of flooding in the last number of years.
- Flooding is something that naturally occurs on all rivers on a regular basis. Flooding on the river Shannon should be the same but because the amount of water is controlled, the water level for much of the year remains the same at a fairly low level with very little change. Due to these lower levels a lot of the year round, vegetation and trees have free rain to grow up and block channels and narrow the river. When waters are released to increase the flow these obstructions can then cause an issue with pushing the river up and out thus causing flooding. This vegetation also collects more debris that flows down stream forming mini islands that also contributes to flooding. If these trees and vegetation that can be situated in the river where to be removed it would also increase flows helping to decrease the flooding.
- We do feel more regular releases of water to mimic the more natural flows of a river could greatly help the river and its flooding issues as well creating a more natural river environment for all river plants and animals.

4 Summary

While a wide range of suggestions for specific items to be taken into account when designing the Flood Relief Scheme, and reasons as to why flooding has become such a large problem in Castleconnell in recent years were submitted, some items featured in more than one submission. These have been outlined below.

4.1 ESB management of Lough Derg and outflow from Parteen Weir

Many respondents are of the opinion that mismanagement of water levels at Lough Derg increases the flood risk to Castleconnell. It is believed that ESB retain the water level at Lough Derg at the maximum levels allowed by law and when a prolonged period of rain occurs, large discharges from Parteen Weir result in flooding downstream. Effective control of Lough Derg water levels by ESB, particularly during winter months, is essential.

4.2 Statutory minimum flow in the 'Old Shannon'

A large number of returned questionnaires quoted excessive vegetation growth and siltation as a factor that influences flood levels in the village. Many believe that this is due to the reduced flow of just 10 cumecs for much of the year. Some suggested that the river has been neglected since the Shannon Scheme was constructed while others proposed a regime that allows more moderate flooding at times of the year to curb excessive vegetation growth.

4.3 Removal of instream features

Many respondents believe that instream features such as man-made rock weirs, rock outcrops and overgrowth have caused slowing of the river, resulting in further siltation and excess vegetation growth, in turn raising water levels during flood events.

4.4 The Mall wall

Many residents expressed their concern that the Mall road was not included in the scheme proposal included in the brochure pack. Most feel that it is vital to protect the Mall road in full as well as the properties to the north of it.

It was made clear that many are also concerned over the structural stability of the Mall wall and noted that large sandbags have been placed in front of the wall in recent flood events 'to support it'.

Most respondents suggested construction of a reinforced concrete wall behind the existing Mall wall, and raising of the existing stone wall to mask it. It was made clear that the existing stone wall is of cultural and architectural significance to the residents who wish to retain it.

4.5 Other suggestions

- Some respondents expressed that they would not be in favour of dredging the river;
- Most kayaking/canoeing groups requested that they are considered in the solution and consulted before any instream works take place. They further suggested that flood relief measures could be used to optimise river features for kayaking and canoeing;
- An on-going programme of river maintenance was suggested;
- Improvement of both the foul and storm drainage systems was suggested as flooding of manholes has been problematic in previous flood events;
- Protection of salmon and trout spawns and Shannon habitats;
- Individual Property Protection was requested where the Flood Relief Scheme will not protect certain properties;
- Excess drainage of wetlands was stated as having contributed to the flooding problems in Castleconnell by one respondent.

Appendices

A Brochure Drop Area

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A2. 21st September 2022 – Emerging Preferred Options PPD

Castleconnell Flood Relief Scheme

Emerging Options Public Participation Day

Summary Report

November 2022

OPW Oifig na nOibreacha Poiblí Office of Public Works

Tionscadal Éireann Project Ireland 2040

Comhairle Cathrach & Contae Luimnigh
Limerick City & County Council

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Revision History

Revision Ref/Date	Amendments	Issued to
S3-P01/ 9th November 2022	First Issue	Steering Group via SharePoint
S3-P02/23rd August 2023	Names redacted for GDPR reasons	Steering Group via SharePoint
S4-P03 / 15th November 2023	Amendments to S5.2	Steering Group via SharePoint
S4-P04 / 2nd July 2024	Removal of S5.2	Steering Group via SharePoint

Contract

This report relates to the Castleconnell Flood Relief Scheme commissioned by Limerick City and County Council, on behalf of the Office of Public Works. Leanne Leonard and Richard Buck of JBA Consulting carried out this work.

Prepared by ..... Leanne Leonard BEng (Hons) MIEI

Engineer

Reviewed by ..... Richard Buck BEng CEng MICE

Director

Purpose

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Contents

1 Introduction

1.1 Purpose of the Public Participation Day

Effective communication with the locals in Castleconnell is vital given the frequency and magnitude of flooding in the village since 2009. Lack of engagement with residents could increase the risk of rejection of the scheme, or elements of the scheme, and lack of identification of key stakeholders could result in delays.

This is a key stage in the project to give those who will be living and working near the scheme the opportunity to share their views and opinions on the emerging options, any potential constraints to their implementation and any suggestions for changes.

1.2 Event Details

	The purpose of the Public Participation Event was to present: • the work carried out to date in developing flood maps • the surveys carried out to date • the measures that have been considered • how the measures have been grouped into options • the measures that have been discounted • the options which we would like to progress The main aim was to seek feedback from the public and other interested parties in relation to the emerging scheme options.
Venue	Castle Oaks House Hotel, Castleconnell, Co. Limerick V94 EH94
Date and Time	Wednesday 21st September 2022 12:00 – Set up by project team 14:30 – Presentation to Elected Representatives 16:00 – Open to the public 17:00 – Presentation to public 19:00 – Presentation to public 20:00 – Close
Target Audience	Any and all interested parties, including statutory stakeholders.
Event Format	The PPD was held as an in-person event to maximise public engagement. A pre-briefing was provided to invited elected members which was attended by just 1 nr. representative. Registration (host role) and one-to-one or small group discussions. Drop-in format, which included presentations by the project team at 5pm and 7pm.

	Posters displayed on display stands. Attendees were encouraged to fill out and return questionnaires on the day, although most opted not take them home.

2 Promoting the Event

2.1 Overview

Promotion of any event is key to its success on the day. A variety of means of promoting/advertising were used to increase awareness of the day and aim to maximise attendance.

This event built upon connections made at the Early Engagement event, through site visits and contacts made over the course of the project.

2.2 Means of promotion

Direct contact	All stakeholders, clubs and groups included in Appendix A.1 were emailed directly to notify them of the event. All respondents that provided contact details in the June 2020 PPD Questionnaire, were emailed directly to notify them of the event. Locals who had been in contact with the Steering Group up to the event were also emailed directly. Word of mouth was useful as the community is relatively small. This helped spread the message between people who had seen leaflets / posters and those who had not.
Postal drop	The company All Homes were contracted to distribute newsletters to a predefined catchment area (refer Appendix A.2) which included 975 nr. houses, 14 nr. apartments and 56 nr. commercial units within Castleconnell. The All Homes Completion Report is included in Appendix B.
Local Authority Mechanisms	A webpage for the PPD was set up on the Limerick City & County Council public consultation portal. Details of the event were published ahead of the PPD and all information presented on the day was uploaded following the event. (https://mypoint.limerick.ie/en/consultation/castleconnell-flood-relief-scheme-options-public-participation-day) A public notice was also published on the LCCC website (https://www.limerick.ie/council/newsroom/public-notices/public-notice-castleconnell-flood-relief-scheme)
Media Campaign	A press release was issued to the Limerick Leader and the Irish Examiner in the form of a public notice. Articles were also posted on the following websites: • Limerick Leader (https://www.limerickleader.ie/news/home/914880/open-day-on-limerick-village-s-flood-relief-scheme.html) • Limerick Post

	(https://www.limerickpost.ie/2022/09/18/castleconnell-residents-urged-to-attend-flood-relief-scheme-update/) • Nenagh Guardian (https://www.nenaghguardian.ie/2022/09/19/meeting-on-mid-west-flood-relief-scheme/) •
Social Media	The PPD was advertised on the below social media pages: • OPW Facebook Page • OPW Instagram Page • Limerick Leader Facebook Page • Kieran O'Donnell Facebook Page - Shared by Castleconnell Tidy Towns, Mike Murphy TD and 4 others (anonymous)
Poster Campaign	Posters were distributed to: • Tom Maher's Pub • Shannon Stores • Shannon House Restaurant • SuperValu Castleconnell • Green Cross Pharmacy • Daybreak Daly's Cross • Bradshaw's Bar • McDermott's Butchers Remaining businesses in the village were not open at the time of distribution.

Attendees reported hearing about the event from a range of sources including newspapers, word of mouth and newsletters through the door.

3 On the day

3.1 Project Team Representation

There were 9 nr. representatives from the Steering Group on the day (3 nr. from Limerick City & County Council, 2 nr. from OPW, 3 nr. from JBA Consulting and 1 nr. from JB Barry & Partners).

3.2 Supporting Material

The following materials were available on the day:

- GDPR compliant sign in book.
- 60 nr. printed questionnaires – On arrival each attendee was encouraged to fill in a questionnaire and return it before leaving. All questionnaires were distributed on the night.
- A series of posters were displayed which covered the following topics:
  - Welcome Poster
  - Project Introduction
  - Water & Aquatic Ecology
  - Water Quality
  - Bats
  - Birds
  - Habitats
  - Archaeology & Cultural Heritage
  - Ecological Constraints
  - Conveyance Measures Considered
  - Flood Extent Map
  - Option 1 Overview
  - Option 2 Overview
  - Option 3 Overview
  - Rivergrove B&B – All Options
  - Grange House – All Options
  - Mall House – Options 1 & 3
  - Mall House – Option 2
  - The Mall Road Section A – Options 1 & 3
  - The Mall Road Section A – Option 2
  - The Mall Road Section B – Option 1
  - The Mall Road Section B – Option 2
  - The Mall Road Section B – Option 3
  - Meadowbrook & Stormont House – All Options
  - Coolbane Woods Junction – All Options
  - Diversion Routes for Road Closures
  - Opportunities to Take Part

3.3 Attendance

63 nr. attendees were recorded on the sign in sheet with several more in attendance who did not sign in.

7 nr. questionnaires were returned on the night, 3 nr. were returned via post and 2nr. via email.

Both presentations were well attended with the 5pm slot being more popular.

Figure 3-1: Attendance at 5pm presentation

Figure 3-2: Attendance at 7pm presentation

3.4 Summary notes from discussions and queries raised on the day

- Cultural heritage is of utmost importance and the scheme should respect this. Attendees were pleased to hear that it is intended that the stone from the existing walls can be used to clad the new flood walls so that the final look and feel will be similar to the existing scenario.
- Some attendees queried what the defences would look like and noted that examples would help them visualise the proposed scheme, particularly examples within Ireland that they could view in person.

- One attendee raised a query during the first presentation to the public, which expanded to a lengthy discussion lasting c. 30-45mins. The individual in question advised that he has been keeping ESB records for many years and has done modelling and reporting on Parteen Basin. They expressed their opinions regarding the operation of Parteen Basin, particularly in relation to the maximum and minimum water levels in the basin. The Steering Group advised that they have worked with ESB but that the individual's observations would be reviewed in due course. Contact details were taken and a follow up meeting will take place.
- It was queried whether the scheme is at risk if ESB do not co-operate as the scheme will depend on a set abstraction to Ardnacrusha. The Steering Group responded that an assessment into the flow through Ardnacrusha had been undertaken, which takes into account past instances where turbines have been unavailable.
- It was suggested that ESB are primarily responsible for the flooding of Castleconnell due to mismanagement of Parteen Basin and that the scheme would be pointless if ESb do not co-operate. It was then queried whether ESB would fund the scheme to which the Steering Group responded that OPW would be funding the scheme. The individual then suggested that means that the taxpayer will ultimately be paying for it.
- It was suggested that Ardnacrusha Power Station is now centrally controlled from Poulaphouca, which could be leading to problems around day-to-day operations, such as relying on sensors instead of personnel.
- It was noted that the flooding in Meadowbrook was through drains and queried how this will be prevented. The Steering Group responded that non-return valves would be fitted to all outfalls and sump pumps would be utilised for surface water in select locations.
- A resident of Meadowbrook Estate noted that they felt that the existing wall helped to ease flooding in previous events and noted their concern with providing a gated opening. The Steering Group explained that the northern section of the wall would be replaced and the proposed gateway would be situated behind a proposed embankment preventing a flow path to the village. It was further explained that this gate would be for maintenance of the embankment and for emergency access to the residents of Stormont House during a flood event only.
- It was suggested that the laneway from the soccer pitch to the Mall Road acts as a flow path during heavy rain, which may be a concern during a flood event if it cannot discharge to the River Shanon.
- There was a misunderstanding surrounding the proposals for Rivergrove B&B where one local was concerned about flooding of the property through the existing entrance. It was explained that it is proposed to relocate the driveway above the flood level and to provide a flood wall at the location of he existing entrance.
- The Steering Group were questioned about the certainty that all three options presented would work. It was explained that all three are technically viable but that some uncertainty remains around the demountable barriers.
- The appearance of the proposed embankments was queried to which the Steering Group explained that they would be grassed and periodically cut and inspected to visually assess their condition.
- One attendee queried the cost difference between the Option 3 and Option 1, noting that a significant amount of money would be spent in Option 1 to provide access for just one family. It was suggested that Option 2 would provide access for many more families, for a similar cost.

- One attendee asked to make three points:
  - He felt that the ESB issue regarding management of Parteen Basin should be investigated as part of the scheme.
  - He thanked the project team for the high standard of information presented and noted his appreciation.
  - He accepted that the cost benefit is a challenge but implored Limerick City & County Council to preserve the heritage and beauty of the village by balancing function with aesthetics. He requested that any proposed works should not have the same appearance as the pointing carried out by Limerick City & County Council to the Mall Road last year. LCCC accepted that the pointing job was not in-keeping with the existing wall and promised that a specialist would be appointed as part of the scheme.
- One attendee wished to note that while the environment is important, it should not be put ahead of protecting humans.
- It was queried whether the flood maps produced as part of the scheme would replace the CFRAMS mapping. The Steering Group advised that once published, the scheme mapping would supersede the CFRAMS mapping in the scheme area.
- A homeowner queried whether the scheme would allow them to receive flood insurance. It was explained that this would most likely be on a case-by-case basis and that the OPW are in ongoing discussions with insurance companies regarding this.

4 Feedback Received

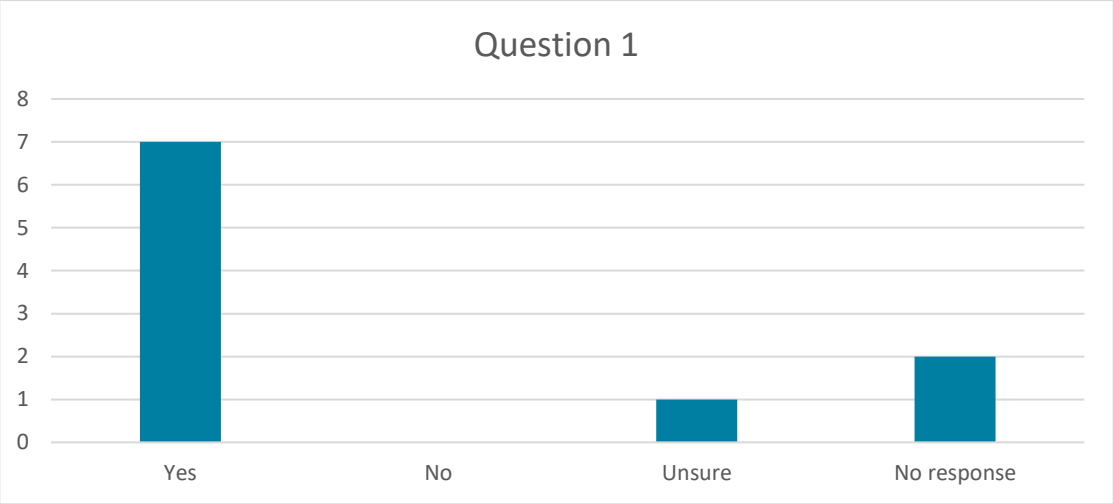
4.1 Questionnaire Analysis

Questionnaires were requested to be returned by 19th October, allowing four weeks for the public to complete them. There were 12 nr. questionnaires returned in total, although 60 nr. were distributed on the day and they were also made available on the project website following the event.

The responses to the various questions are summarised below.

4.2 Question 1

Do the flood maps represent the scale of flooding you have experienced? Please also review the Cedarwood and Stradbally Streams.



The following comments were also received:

- The Cedarwood suffered a flood 25 years ago and flooded an internal roadway. Such flooding has not been experienced since.
- Pictures of the 2009 floods between Coolbane/Castlerock and Stradbally North would be of particular interest to me and the Stradbally North Residents Association.
- Never saw the Cedarwood Stream as an issue. The Stradbally Stream can raise backing up to Belmont Road and causing high water around [Coolbane] Woods.
- Too difficult to follow the graphics.
- ESB [Parteen] Weir and amount of water let off flooding Annacotty and Mountshannon Rd.

4.3 Question 2

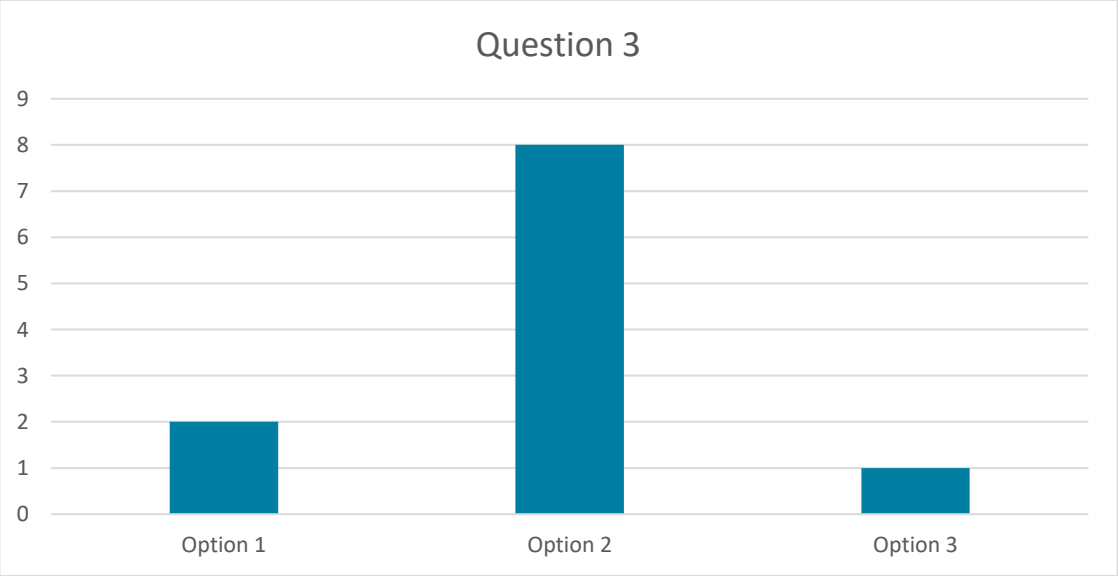
Are there any additional measures that you think should have been considered? (Please provide reasons for your answer)

- Flood defences should have been in place a number of years ago! ESB carry a good share of responsibility for safety of homeowners.
- Serious discussions needed with ESB re actions they take or should take when flood threats emerge!
- ESB level Killaloe.

- I don't see any mention of mitigation of present in-river obstructions, which may not solve the entire flooding problem but must be of benefit. Bear in mind that the present channel used to accommodate almost twice the flow under flood conditions. Specifically we are talking about removing a small number of mostly Sycamore trees on man-made structures and lowering 2 or possibly 3 stone weirs.
- I'm sure that you have consulted with the ESB, particularly at Parteen Weir, who are responsible for regulating flow of water downstream. ESB needs to 'up their game' dramatically when fulfilling their statutory obligations in this area.
- Raising car park and road from bottom Chapel Hill to village supermarket. Commuter village from/to Limerick so car access/ambulance/fire vital.
- More discussion with ESB about their role in easing the flood problems.
- Some consideration to the O'Briens Bridge Road. Connection between Montpelier and Castleconnell blocked under the railway bridge.
- Yes raised land on site 0.3A (where creche to be built) – see figures 3.6 & 3.7 on FRA document on Planning Permission file No 19518 (Castlerock). See Sect 2.1 FRA Doc – "Ground levels appear to have been raised in recent past by infill". The site area here was raised by infill by more than 6 feet. This will impact on flood waters coming up carpark stream to this area. Have you taken this into account and if so what provisions are planned to prevent flooding of Stradbally North due to this raised ground on development (Castlerock) Torca site?
- In 1927 the Germans laid the headrace embankment. It was dressed in concrete plate. In 100 years - No maintenance. In 2022 the embankment will be covered in grass – mowed and regularly maintained in its virgin state at what cost.

4.4 Question 3

Which option would you select as your preferred option? (Please provide reasons for your answer)



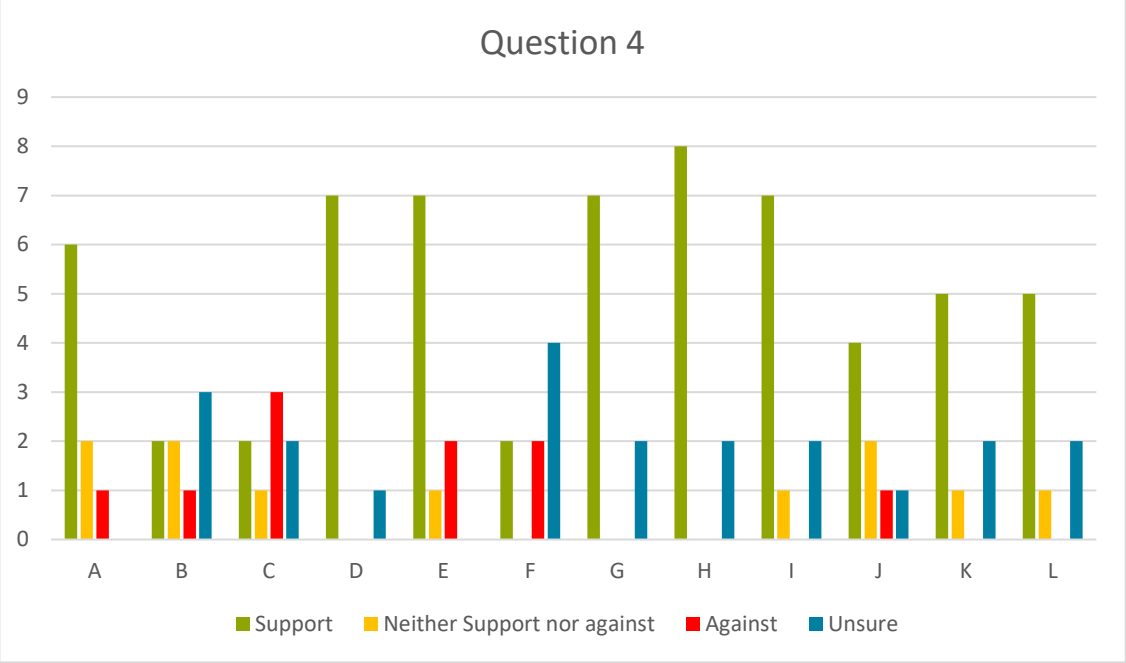
- Existing wall along Mall is not sufficient to hold out flood water. Option 2 offers best defence for village from Rivergrove B7B to ferry car park. It is critical that ESB input on their flood management at Parteen Weir be sought and included in your plan. Will this happen?

- The Mall Road offers an important access/exit for the village.
- Moving entrance at B&B very good.
- **[Name removed]** "Rose Cottage", **[Mall]** House totally enclosed – Thank you.
- Victorian flood wall breached "water poured in". Unoccupied for two years – Sold on.
- Effective future flood protection of property and road access in/out of village 24/7.
- [**Illegible**] need for emergency measures & costs to be stood up/stood down every year.
- Remove insurance "Blight" policy on house.
- Village is zoned for housing & development – difficult to get house insurance with repeat flooding.
- Completely against Option 2.
- Option 3 seems to represent the best balance between effectiveness, cost and [**illegible**] and impact on local [**illegible**] and environment.
- Not fully sure on this one. Personally whichever measures offer Meadowbrook the optimum and most long term solution would be preferable. We like the idea of isolating Cloon Stream.
- Secures protection for my home (Option 2).
- Options 2 or 3 preferred – low impact to Island House site.
- We do not support Option 1 because of impact to Island House site, i.e. the raising of the causeway and the intrusion of the cut-off structure into woods.

The response to Question 3 indicates a strong desire for the selection of Option 2 as the preferred option.

4.5 Question 4

We have shown you the emerging options for providing flood relief to Castleconnell. Please use the boxes below to indicate your opinion on the various elements of the options. Please add any options you believe should be considered in the blank rows at the bottom of the table. (Please tick appropriate boxes) (See attached maps for reference locations)



Map Ref.	Proposed Defences	Comments Received
A	**New set-back flood wall along Mall Road**	Feel best that it is done at this time. No need for it, and the existing wall is vital part of CC.
B	**Traffic diversion system to close access at the Scanlon Park junction.**	93 homes affected. Relies on emergency services and budget re costs every year. Surely very temporary if necessary.
C	**Replacement of the Island House causeway.**	Not sure how necessary this measure is. Vital part of heritage & no need. Impact to Island House site.
D	**Demountable barrier across the Island House entrance.**	As long as it doesn't drive water towards the village. Not necessary unless road is breached. Will need warning to leave site.
E	**New set back flood wall between Island House and Maher's Pub.**	If deemed necessary Totally unnecessary. Absolutely vital part of heritage.

F	**Embankment across Cloon Stream.**	"Across"? Impact to Island House site.
G	**New flood wall in the Maher's Pub car park.**	
H	**Flood wall from Maher's Pub to Meadowbrook Estate.**	To keep water from the rear of those properties.
I	**Embankment from Meadowbrook Estate to Stormont House.**	Not sure if Stormont floods. Allow the land to flood.
J	**Traffic diversion system to close access at the Chapel Hill Road.**	Would be acceptable during a flood event. Relies on emergency services being available. V. occasionally necessary. Or could raise part of road?
K	**Embankment to the rear of Coolbane Woods.**	Can some sort of non return valve be fitted to Stradbally Stream.
L	**Maintenance & improvement of conveyance on Cedarwood Stream.**	The current stream is ruined by development including the culvert 2 house development. Stream is wildlife habitat.

The responses to Question 4 showed strong support for the set-back flood wall along the Mall Road, demountable barrier across Island House, set-back flood wall between Island House and Maher's Pub, flood wall in Maher's Pub car park, flood wall from Maher's Pub to Meadowbrook Estate, Embankment from Meadowbrook Estate to Stormont House, embankment to the rear of Coolbane Woods and maintenance of the Cedarwood Stream.

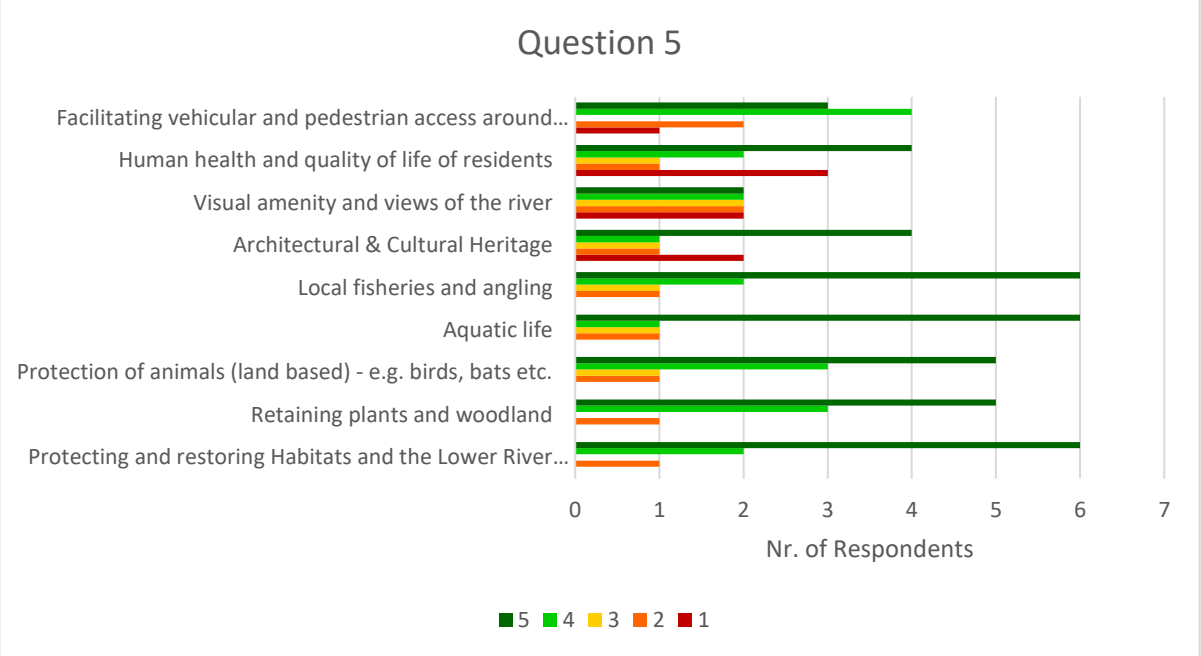
Of those that responded, the majority were against replacement of the Island House causeway and unsure about the proposed downstream cut-off embankment across Cloon Stream.

Respondents were also unsure about the traffic diversion at the Scanlon Park junction.

All of the above closely aligns with Option 2 and reinforces the desire from the public for protection of the Mall Road.

4.6 Question 5

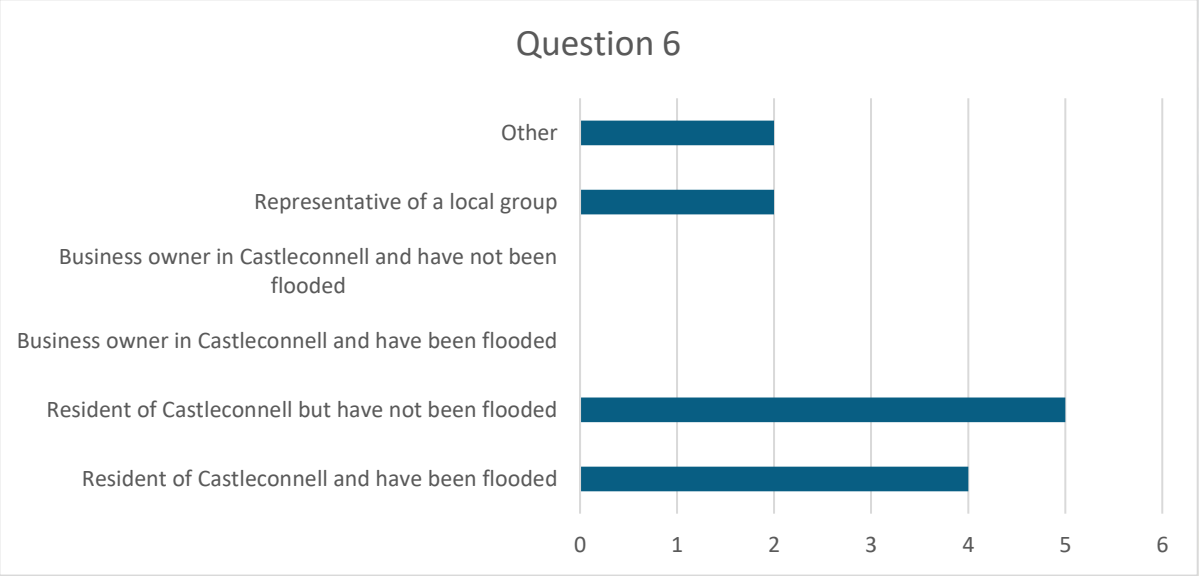
In the assessment of the options rank 1-5 the weight you would give to each of these issues.



The strongest weightings were given to Local fisheries and angling, aquatic life, protection of animals (land based), retaining plants and woodland and protecting and restoring habitats and the lower River Shannon SAC. This would suggest that the locals are concerned about the environment and the effect the scheme may have on it.

4.7 Question 6

Please indicate which best describes you. (Select as many as apply)



Representatives from the following Local Groups responded to the questionnaire:

- Stradbally North Residents Association
- Castleconnell River Association
- Castleconnell River Association (Formerly Castleconnell Fishery Association)

4.8 Question 7

How did you hear about today's event?

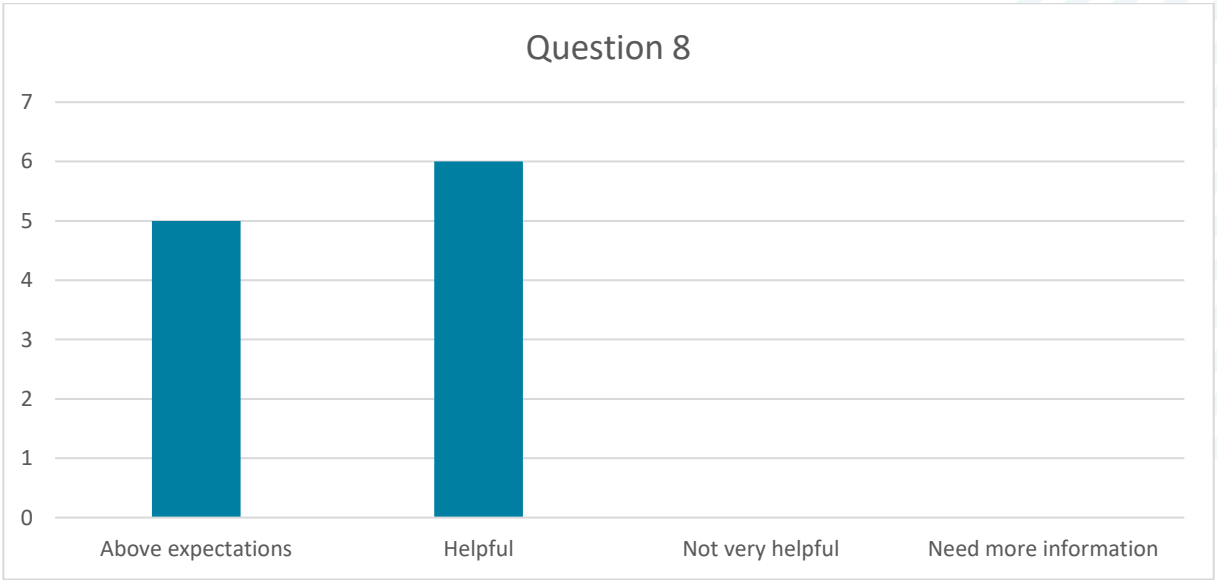
Respondents noted the following means of hearing about the PPD:

- Newsletter
- Word of mouth/Newsletter passed on by neighbour
- Limerick Leader
- Notice in village post office
- Direct invitation by either email or phone call
- Radio (Note: Radio advertising not organised by Steering Group)

Some attendees reported not receiving a newsletter. All Homes were queried on this and provided their completion report which shows that all properties within the catchment area received a newsletter.

4.9 Question 8

How useful have you found this event in understanding the project and how you can feed into the process?



In addition to the questionnaire, many attendees praised the project team on the night for the level of detail presented.

4.10 Question 9

If there is anything else you would like to add, please use the space below.

- Congratulations on the meeting. Thanks to Chariman & lady speaker. Brilliant mapping and floor layout. (Response provided to Q1 but more suited to Q9)
- Session needed to be managed better as some people were allowed to dominate/take-over the presentation. Suggest using a moderator/event manager in future.
- A good start but critical to get finished as soon as possible.
- We need a political process/campaign to have proper flow control from ESB. If this could be achieved it would reduce the cost and complexity of Castleconnell Flood Protection. Cost to ESB almost nil.
- Approx 6 areas of interest. Expanded view appreciated. I misunderstood area of B&B. I now see you're moving entrance, very good.
- I, as others, walk daily to the Worlds End. At the time of last major flood drivers in SUV drove regularly causing heavy water to swirl and drown the footwear of walkers.
- You have done a very thorough job in presenting the options. Thank you.
- Further to response to Q2 (regarding in-river obstructions), bear in mind the existence of multi-agency Shannon Connectivity Project, currently at draft report stage, especially from point of view of cross-river weirs and flow regime, which may eventually affect tree growth.
- Where will all flood water go after Castleconnell Flood Relief done in Clonlara Castleconnell?
- As earlier, **[name removed]** was very animated and clear that his monitoring & findings should be seriously considered. Thank you for pursuing this and please continue with all speed.
- Protection measures for homeowners to be put in place as quickly as possible, especially for elderly people. Hopefully offering peace of mind and reduced anxiety during winter months.

5 Summary of PPD

5.1 Practical Arrangements

When attendees entered the room they were greeted, asked to sign in and encouraged to take, fill-out and return a questionnaire before leaving (Refer Figure 5-1). Two large display stands were hired from a company called Creo. Because lighting was poor at the rear of the room, it was decided to use the larger stand only and to attach posters to both sides. This allowed attendees to move around the stand to examine the posters and brought them into the presentation area (Refer Figure 5-1 and Figure 5-3).

The slideshow for the presentation was shown on a television as there was no projector in the room (Refer Figure 5-2). However, the slides could be seen clearly from the back row of the audience.

The venue size was appropriate and the facilities available were suitable. For all of the reasons above in addition to the proximity of the venue to the scheme, it would be preferred for future Public Participation Days.

The event was widely advertised, with the mail drop and word of mouth appearing to be the most successful means of advertising.

Figure 5-1: Sign-in area upon entry with display stand behind

Figure 5-2: Presentation area

Figure 5-3: View facing the other side of the display stand.

6 Register of Issues and Actions

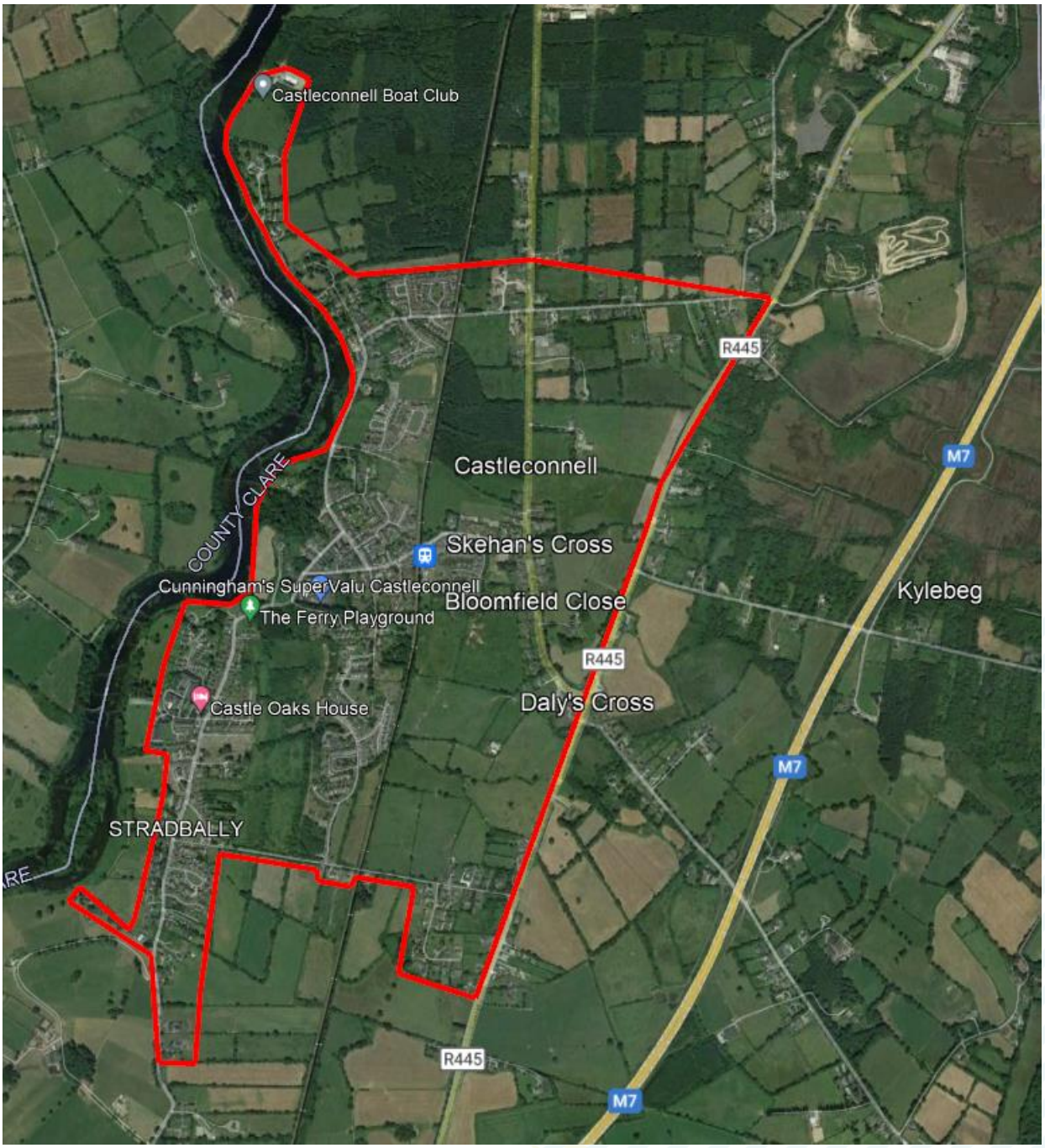
Action	Action By	Completed
Give consideration to removing a small number of mostly Sycamore trees on man made structures and lowering 2-3 stone weirs.	OPW	
Arrange a meeting between the Steering Group and the individual that raised the concerns regarding operation of Parteen Basin.	LCCC	

A Appendix A –Direct Notification

A.1 Stakeholders notified about the PPD

- ESB - Declan Quille (Operations Manager at Ardnacrusha)
- Councillors Metropolitan District
- Road Design Office - Greenway Project
- Darragh Corcoran - LCCC Area Engineer
- Statutory Consultees:
  - NPWS (DAU)
  - IFI
  - An Taisce
  - Environmental Protection Agency
  - National Monument Service (DAU)
- ACM Community Development Society/Castleconnell Development Association
- Castleconnell Boat Club
- Love Castleconnell Group
- National Governing Body of Sport Canoeing Ireland
- Kilfinane Outdoor Education and Training Centre
- Limerick Kayak Club
- Limerick Kayaking Academy
- Limerick Kayak Club Juniors
- Castleconnell River Association (Formerly Castleconnell Fisheries Association)

A.2 Catchment area of properties that received a newsletter

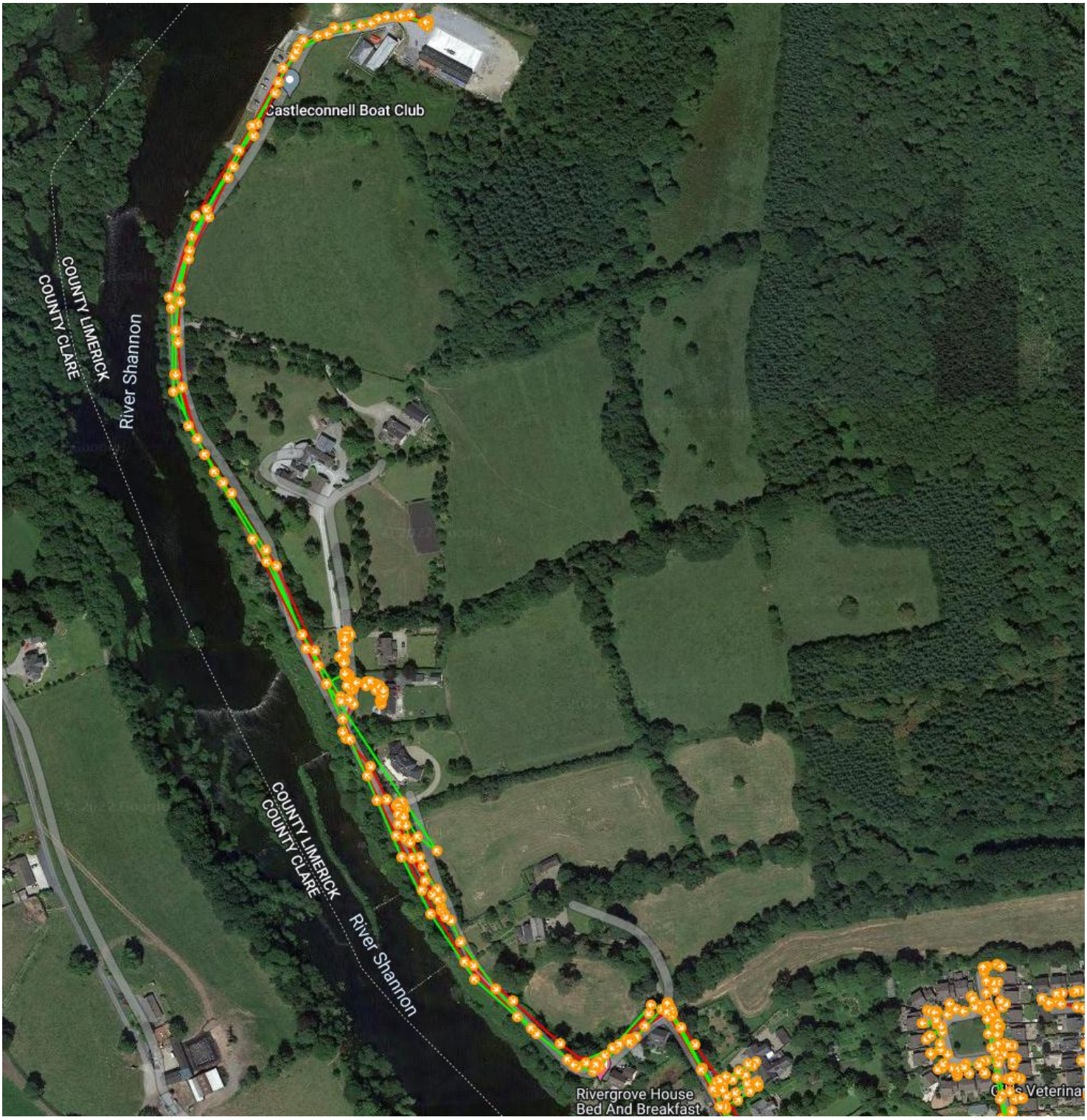


B Appendix B – All Homes Order Completion Report

Order Completion Report

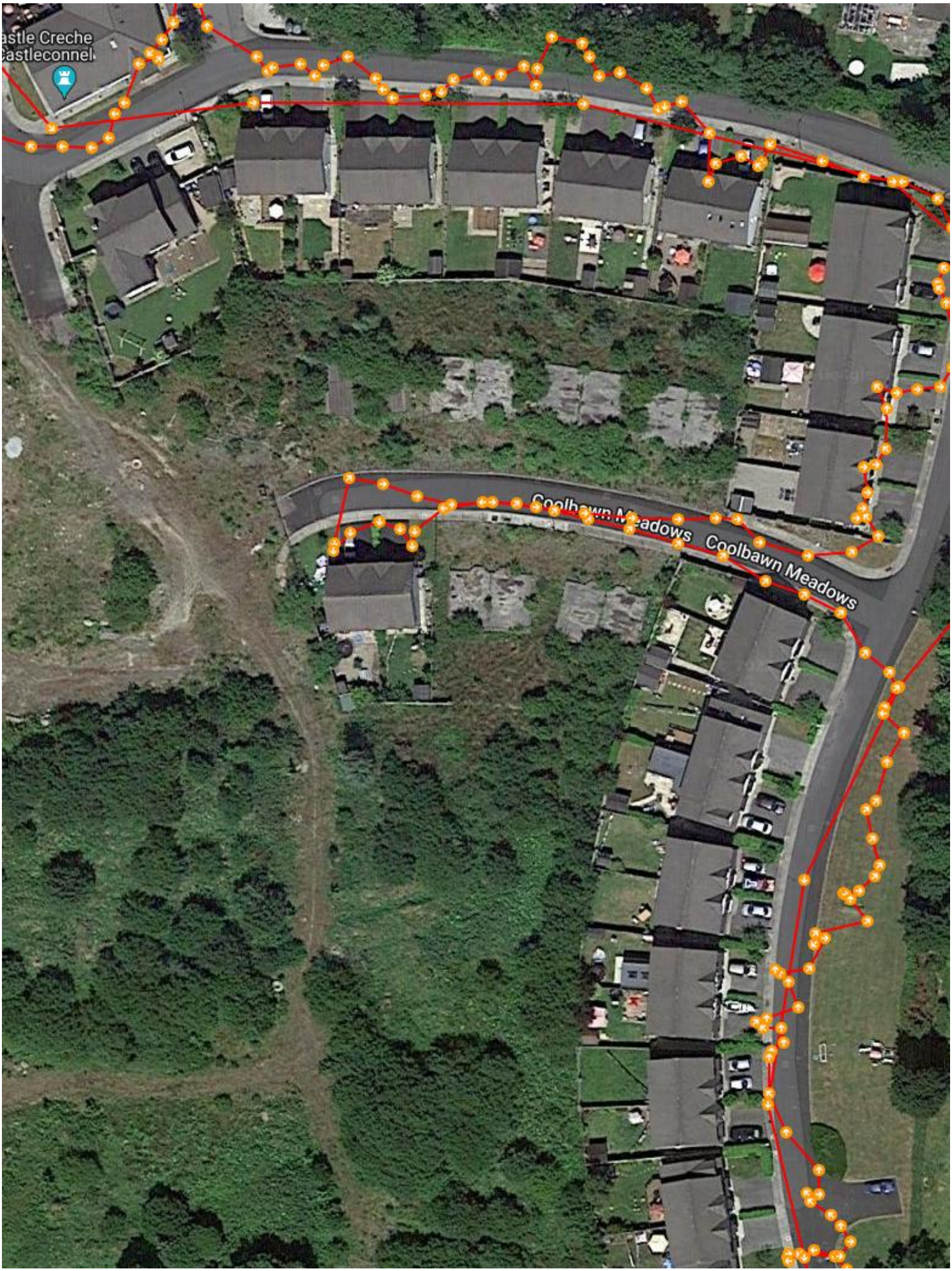
Order No.:	**010290**	Map Number:	**Castleconnell**
Map Status:	**Paid**	Map Name:	**Castleconnell**

Maps Leaflet Distribution Tracking Report




Cill Lonáin, Derreen, Castleconnell, Co...
The Commons
The Commons
Beechfield House
Single
Multiple


Castleconnell
Station Rd
Maple Grove
Station House Parking
Five Star Kebab & Pizza
Pizza Takeout • $
Maple Grove
DMAC Ceilings
& Partitions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Coolbawn Meadows


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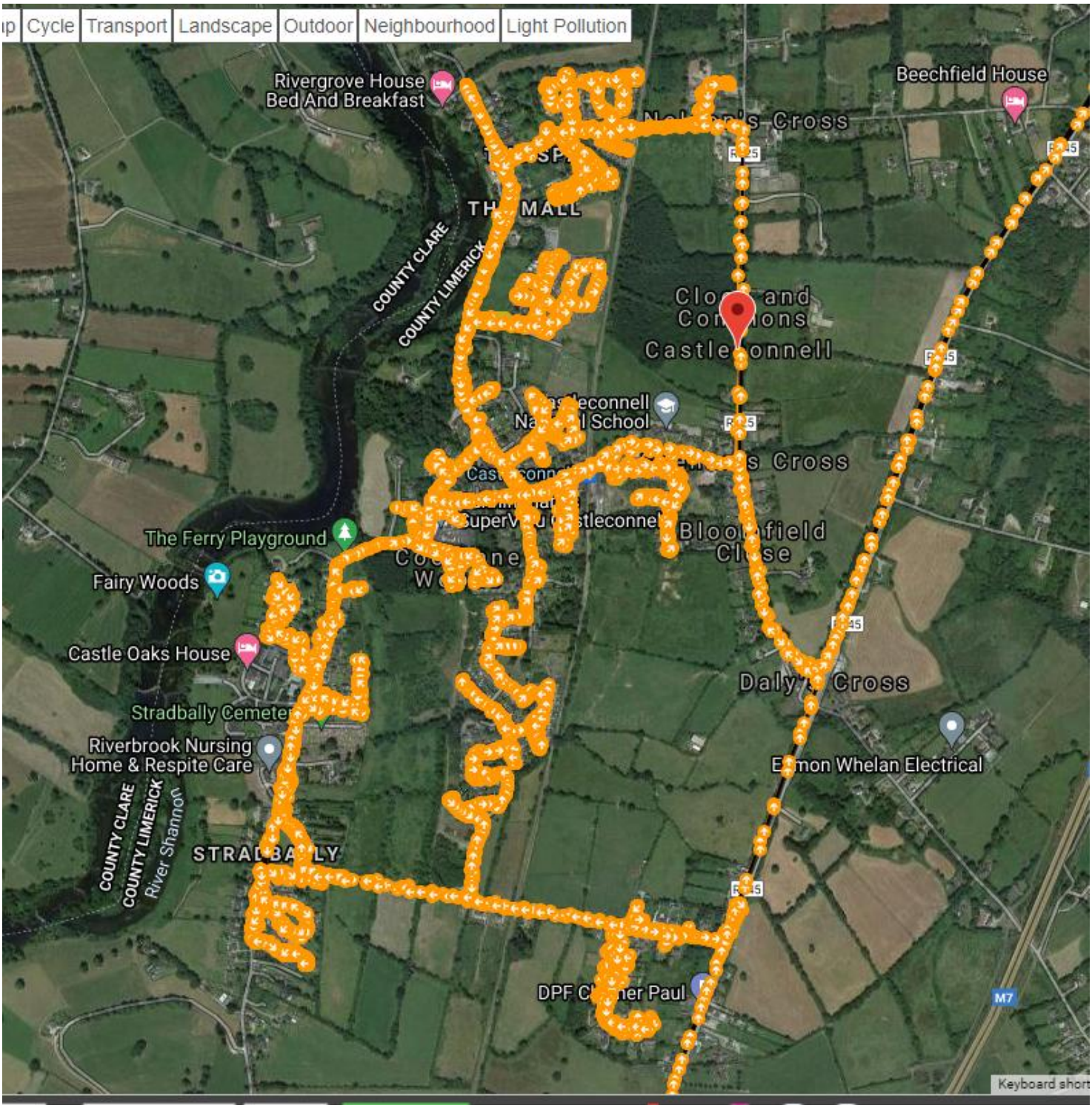
Cycle
Transport
Landscape
Outdoor
Neighbourhood
Light Pollution
Rivergrove House
Bed And Breakfast
Beechfield House
Cross
THE MALL
COUNTY CLARE
COUNTY LIMERICK
Castleconnell
Castleconnell
National School
Cross
The Ferry Playground
Fairy Woods
Bloomfield
Close
Castle Oaks House
Daly's Cross
Stradbally Cemetery
Riverbrook Nursing
Home & Respite Care
Eamon Whelan Electrical
COUNTY CLARE
COUNTY LIMERICK
River Shannon
STRADBALLY
DPF Cleaner Paul
M7
Keyboard short

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Cork
Castlebar

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A3. 6th September 2023 – Preferred Option PPD

Castleconnell Flood Relief Scheme

Preferred Option Public Participation Day – 6 September 2023

Summary Report

July 2024

OPW
Oifig na nOibreacha Poiblí
Office of Public Works

Tionscadal Éireann
Project Ireland
2040

Comhairle Cathrach & Contae Luimnigh
Limerick City & County Council

JBA Project Manager

Richard Buck
24 Grove Island
Corbally
Limerick

JBB Project Manager

Willem Snyman

Revision History

Revision Ref/Date	Amendments	Issued to
S3-P01/ 15th November 2023	First Issue	Steering Group via SharePoint
S3-P02 / 12th July 2024	S3.15 Removed	Steering Group via SharePoint

Contract

This report relates to the Castleconnell Flood Relief Scheme commissioned by Limerick City and County Council, on behalf of the Office of Public Works. Ken Mealiff and Leanne Leonard of JBA Consulting carried out this work.

Prepared by ..... Ken Mealiff BEng (Ord)

Technician

..... Leanne Leonard BEng (Hons) MIEI

Senior Engineer

Reviewed by ..... Richard Buck BEng CEng MICE

Director

Purpose

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JBA & JBB is aiming to reduce its per capita carbon emissions.

Contents

1 Introduction

1.1 Purpose of the Public Participation Day

Effective communication with the locals in Castleconnell is vital given the frequency and magnitude of flooding in the village since 2009. Lack of engagement with residents could increase the risk of rejection of the scheme, or elements of the scheme, and lack of identification of key stakeholders could result in delays.

This is a key stage in the project to give those who will be living and working near the scheme the opportunity to share their views and opinions on the preferred option, any potential constraints to its implementation and any suggestions for changes.

1.2 Details of Previous Events

A "socially-distanced" Public Consultation Event was held in June 2020. To comply with Government restrictions and guidelines, the format of the event was altered to ensure that all contact was via the distribution of brochures, flyers and questionnaires. 110nr brochures and questionnaires were distributed to select residents and businesses on 2nd June 2020. Electronic copies were made available on the Limerick City & County Council website. Further electronic copies were issued to select individuals and organisations that requested copies. The brochure outlined the stages of the project along with an overview of the works completed to date, the CFRAMS scheme option as proposed and a questionnaire. This questionnaire asked the recipients to share any information regarding past flooding in the village, their own personal areas of interest in the village and their views on the importance of various aspects (e.g., Water quality, architectural & cultural heritage, visual amenity and views of the river etc.).

A second Public Participation Day was held on 21st September 2022 in the Castle Oaks House Hotel in Castleconnell. The event was broken into two separate presentations with time before each for the attendees to browse the posters displayed in the room. The event was well attended with 63 nr. attendees recorded on the night. Questionnaires were distributed to all attendees on the night, who were encouraged to fill it out and return it at the event. Contact details were printed on the questionnaire for those who wished to take it home to complete. All information presented at the PPD was subsequently uploaded to the LCCC MyPoint website.

Following the creation of the website all materials from the previous PPDs were uploaded to the project website www.castleconnellfrs.ie.

1.3 Event Details

Purpose	The purpose of the Public Participation Day event was to present: • the development and identification of the preferred scheme option; • the finer detail of the proposed defences; • any constraints that have influenced the design and alignment of the proposed scheme; • how the defences may be adapted for climate change and its impact on flows and flood levels.
Venue	Castle Oaks House Hotel, Castleconnell, Co. Limerick V94 EH94
Date and Time	Wednesday 6th September 2023

	09:00 – Set up by project team 14:30 – Open to Elected Representatives 15:00 – Presentation to Elected Representatives 16:00 – Open to the public (Video presentation at regular intervals, approx. once per hour, throughout the event.) 20:00 – Close
Target Audience	Any and all interested parties, including statutory stakeholders.
Event Format	The PPD was held as an in-person event to maximise public engagement. A pre-briefing was provided to invited elected members which was attended by 2 nr. representatives. Registration (host role) and one-to-one / small group discussions. Drop-in format, which included a pre-recorded video presentation by the project team at c. hourly intervals. Posters displayed on stands. Attendees were encouraged to fill out and return questionnaires on the day, although several opted to take them home.

2 Promoting the Event

2.1 Overview

Promotion of any event is key to its success on the day. A variety of means of promoting/advertising were used to increase awareness of the day and aim to maximise attendance.

This event built upon connections made at the the previous public consultation and participation events, through site visits, previous PPD events and contacts made over the course of the project.

2.2 Means of promotion

Direct contact	All stakeholders, clubs and groups included in Appendix A.1 were emailed directly to notify them of the event. All respondents that provided contact details in the June 2020 and September 2022 PPD Questionnaires, were emailed directly to notify them of the event. Locals who had been in contact with the Steering Group up to the event were also emailed directly. Word of mouth was useful as the community is relatively small. This helped spread the message between people who had seen leaflets / posters and those who had not.

Postal drop	Newsletters were distributed by JBA staff to a predefined catchment area (refer Appendix A.2) which included 975 nr. houses, 14 nr. apartments and 56 nr. commercial units within Castleconnell, in the week prior to the PPD.
Project website	Details of the event, along with the latest newsletter, were uploaded to the project website. Materials presented at previous PPD events and published reports were also made available on the website.
Media Campaign	A press release was issued to the Limerick Leader and the Irish Examiner in the form of a public notice. Articles were also posted on the following website: • Limerick Leader (https://www.limerickleader.ie/news/home/1289770/public-feedback-sought-on-flood-relief-scheme-in-limerick.html)
Social Media	The PPD was advertised on the following social media pages: • OPW Facebook Page • Limerick Leader Facebook Page • Cllr Seán Hartigan Facebook Page • Condor Publishers Ltd Facebook Page
Poster Campaign	Posters were distributed to businesses within the catchment area shown in Appendix A.2.

3 On the day

3.1 Project Team Representation

There were 9 nr. representatives from the Steering Group available on the day (3 nr. from Limerick City & County Council, 1 nr. from OPW, 4 nr. from JBA Consulting and 1 nr. from JB Barry & Partners).

3.2 Practical Arrangements

When attendees entered the room, they were greeted, asked to sign in and encouraged to take, fill-out and return a questionnaire before leaving. Posters were displayed on stands in the centre of the room leading attendees to a television with seating to watch the 15 minute pre-recorded presentation. The presentation was shown on a television at approximately hourly intervals.

The venue size was appropriate and the facilities available were suitable.

The event was widely advertised, with the mail drop appearing to be the most successful means of advertising.

Figure 3-1: Display stand and presentation area

Figure 3-2: Attendees viewing display stands

Figure 3-3: Attendees viewing posters and presentation

3.3 Supporting Material

The following materials were available on the day:

- GDPR compliant sign in book.
- 60 nr. printed questionnaires – On arrival each attendee was encouraged to fill in a questionnaire and return it before leaving.
- A series of posters were displayed which covered the following topics:
  - Introduction
  - Preferred Option
  - Flood Extents

- Diversion Routes
- Ecology
- Rivergrove B&B and Grange House Layout Plan
- Rivergrove B&B and Grange House Elevations and Long Sections
- Mall House Layout Plan
- Mall House Elevations and Long Sections
- Sections Sheet 1
- Mall Road North Layout Plan
- Mall Road North Elevations and Long Sections
- Island House Causeway Sections
- Sections Sheet 2
- Mall Road South Layout Plan
- Mall Road South Elevations and Long Sections
- Maher's Pub and Meadowbrook Estate Layout Plan
- Maher's Pub and Meadowbrook Estate Long Sections
- Stormont House Layout Plan
- Meadowbrook Estate and Stormont House Elevations and Long Sections
- Coolbane Woods Layout Plan
- Coolbane Woods Elevations and Long Sections
- Stormont House and Coolbane Woods Junction Roadworks Longsections
- Sections Sheet 3
- Cedarwood Stream Layout Plan

3.4 Attendance

43 nr. attendees were recorded on the sign in sheet with several more in attendance who did not sign in.

8 nr. questionnaires were returned on the night, 1 nr. was returned via post and 2 nr. via email.

3.5 Summary notes from discussions and queries raised on the day

- Many residents voiced concern over the perceived effect on flood levels of the Castlerock development currently under construction. Many believed that the development is within the floodplain and displacing flood water. The Steering Group explained that the development is proposed on the elevated lands to the east of the floodplain and that surface water from the development will be attenuated with a controlled discharge rate to the receiving watercourse/drains. This means that the proposed development will not increase flood risk to surrounding properties or impact the flood extent within the Stradbally Stream floodplain. Furthermore, a Site-Specific Flood Risk Assessment was submitted as part of the planning submission which found that the proposed development will not increase flood risk elsewhere.
- Some residents queried the proposed works to the Cedarwood and noted their disappointment in the current houses under construction adjacent to the stream at the Cloon and Commons Road. Some were concerned that the raising of the wall adjacent to the stream may increase flood risk. It was explained that the effect of this wall had been tested within the hydraulic model and that it does not have any impact on the 1% baseline design scenario, and results in an increase of just 2mm in the 0.1% event.

- Some residents recalled issues with foul sewers during past flood events and requested that this be addressed as part of the scheme.
- Some residents queried the responsibility of ESB wrt the FRS and whether the operation of Parteen Basin will change. Some noted that the flows in the river fluctuate despite ESB declaring that they are discharging the statutory minimum 10 cumecs down the Old River Shannon. The Steering Group explained that the operation of Ardnacrusha and Parteen Basin are outside the control of the scheme. Notwithstanding this, there has been ongoing consultation with ESB to ensure that the assumptions regarding flows used in the design are reasonable. Furthermore, ESB are on the list of stakeholders for the project and have been invited to all public participation events.

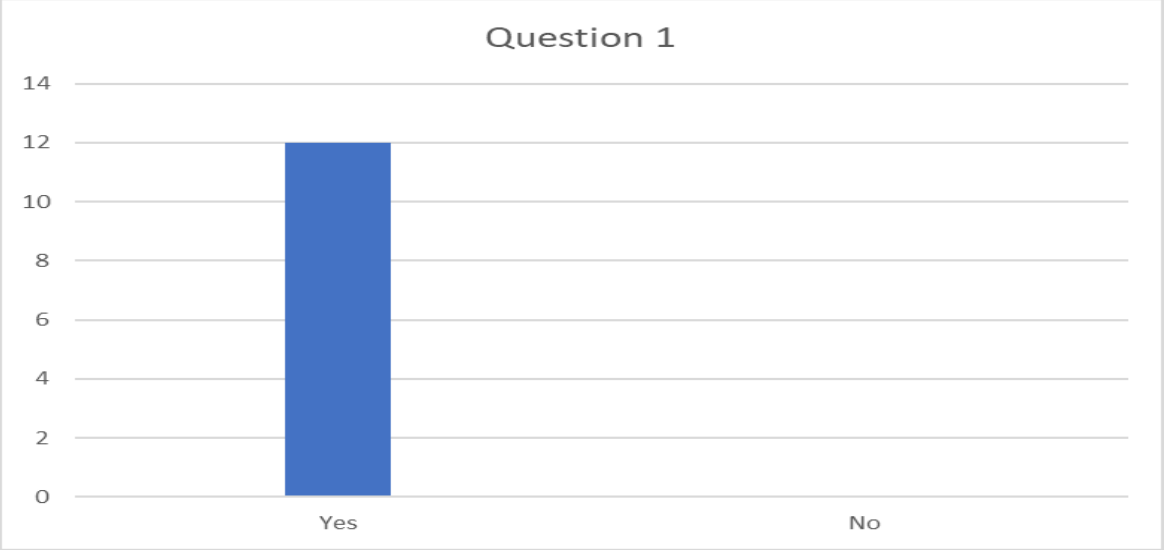
3.6 Questionnaire Analysis

Questionnaires were requested to be returned by 20th September, allowing two weeks for the public to complete them. There were 12 nr. questionnaires returned in total.

The responses to the various questions are summarised below.

3.7 Question 1

Can you clearly comprehend the chosen preferred option and its potential effects on you?



The following comments were also received:

- *"As I explained to Darragh Ryan [LCCC] on Wednesday, we in Stradbally North have serious issues about increased flood risk via Ferry car park-Stradbally Stream back to lower end of our estate."*
- *"From the presentation yes. Maps a bit confusing".*
- *"The before and after pictures on the video also helped."*
- *"I fully comprehend the option, but I cannot understand how the FRS can be so neglectful and so uninterested in increasing flood defences further downstream of the train tracks (Cedarwood Stream), by not doing so it is leaving our family farm in ruins."*

3.8 Question 2

What thoughts or considerations would you like to share regarding the construction of the selected option?

- *"Increasing the defence downstream, it would allow for the North and South culvert under the train tracks to be increased in size without affecting areas downstream and*

saving our farmland from being forced into flood zone classification. Man made factors is causing the cause here not natural factors."

- *"Difficult to say at this stage but a look at the final solution for the wall in Meadowbrook would be very welcome."*
- *"As far as I can see the flood defences finish at the house behind the castle. Nothing at Ferry car park. Our area and land between Stradbally and Castlerock is always flooded when river rises (See photo on your newsletter No 3) In my previous submission (last year), I detailed how [Illegible] have raised the ground level on their side of Stradbally Stream."*
- *"Management of water levels should be integrated with the plan. The river level of 10 cumecs all year is low to maintain open channels leading to excessive growth, which increases the flood risk."*
- *"Has to be sensitive in the interest of the SAC."*
- *"Looks good. Very good consultation."*
- *"Access to Scanlon Park if the wall is to be moved out should be highlighted as it is difficult enough."*
- *"I am concerned that no firm guarantee is given to face the Mall wall with existing stone. Caveat words like [Illegible] and "where possible" do not communicate commitment but rather a way to wriggle out. I personally commit all my energy to ensure that the integrity of the existing Mall stone wall heritage is maintained. It is a key part of the Castleconnell Development Plan. "*
- *"Access to embankment for construction behind Meadowbrook could be behind the south side of Meadowbrook house to avoid disruption to residents."*
- *"The ecology expert explained how the wildlife would be protected but have concerns how the work process will have an impact."*
- *"Protection of visual amenity is important to the community and local businesses/tourism and activity groups."*
- *"Increasing the defence downstream it would allow for the north and south culvert under the train tracks to be increased in size without affecting areas downstream and saving our farmland from being forced into flood zone classification. Man made factors is causing the cause here not natural factors."*
- *"It would be most important to replace the stone facing on all the walls to be replaced around my house."*

3.9 Question 3

Do you have any thoughts or feedback regarding the operation and maintenance of the chosen option that you would like to share with us?

- *"Still a small concern with the drain opposite No 6 Meadowbrook. This was very problematic over the years."*
- *"Your proposal does not deal with this increased flood risk to the lower end of Stradbally North estate as far as we can see. I also think the second weir to the north of the footbridge which was put there by the ESB (30 years ago?) should be removed. It serves no purpose other than needlessly raising river levels."*
- *"Management of water levels should be integrated with the plan. The river level of 10 cumecs all year is low to maintain open channels leading to excessive growth, which increases the flood risk."*
- *"Line of sight re Scanlon Park junction is a concern. With narrower road, consideration should be given to improving line of sight on right hand side by taking a small section of that corner."*
- *"No!"*

- *"Is there option to allow walkers to access the embankment areas? This could be interesting area to visit."*
- *"Concern about the "locked" exit at the end of Meadowbrook will become overused!*
- *No comment."*
- *"Speed and urgent construction to go ahead ASAP!!"*

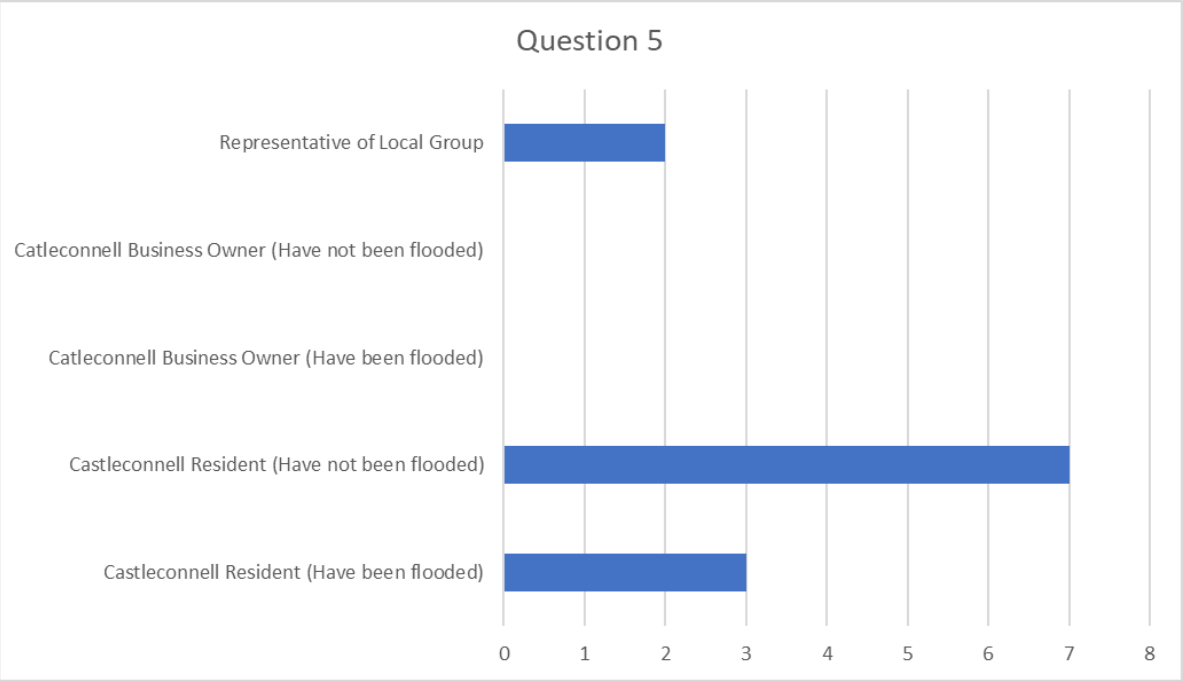
3.10 Question 4

Do you feel there are any aspects or challenges that are not comprehensively addressed by this chosen option?

- *"Difficult to say at this stage but not really".*
- *"Yes. Implementing proportionate flows to release more water, allowing more natural flow levels."*
- *"Future housing development option within Castleconnell must be aligned with County Development Plan to include SuDS and rainwater harvesting and solar options in the [Illegible] of climate change and not adding to the water flooding locally."*
- *"The ESB should have been at the meeting. At the previous meeting, the JBA team were asked / challenged to produce historical figures of the ESB's management of river flows. Did you do that? If so what are the results? If you didn't do it, why not?"*
- *"Access to embankment behind Meadowbrook, as described on page 1."*
- *"There have not been comprehensive efforts made to address our issue of flooding. We intend to fight this with determination until the right outcome prevails."*
- *"Have the issues / facts of possible and probable objections been discussed and how will objectors be dealt with."*

3.11 Question 5

Please indicate which best describes you (Select as many as apply)



- 2 no. attendees stated they were residents that had been flooded in 2009.
- 1 no. attendee stated that he was flooded in 2009/2010 and that the pumps kept water out in 2015 and 2020.

Representatives from the following Local Groups responded to the questionnaire:

- Limerick Kayak Club
- Castleconnell Action Network

3.12 Question 6

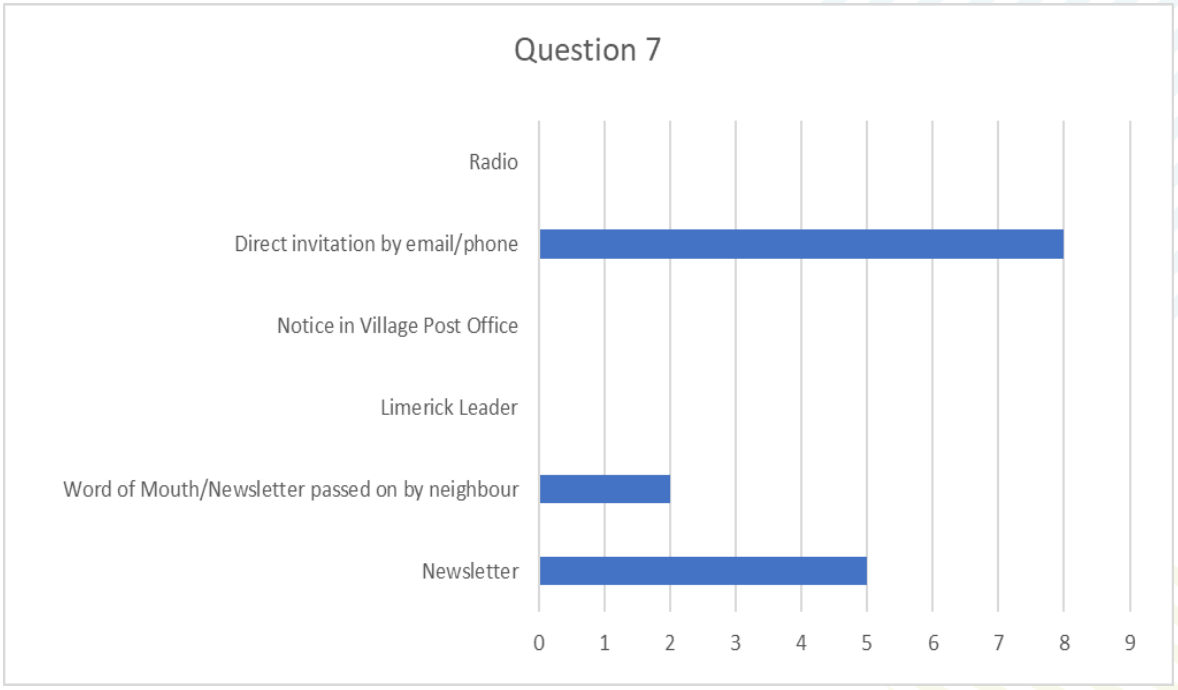
Please use the space below to add any other comments regarding the preferred option.

- *"Please implement ASAP. Maybe some security concerns and aesthetics re new wall and gate in Meadowbrook?"*
- *"Is there a Strategic Environmental Assessment aligned with this scheme (SEA). The project is likely to have some influences on the P+P in the Shannon catchment."*
- *"It is very [non-transparent] and disingenuous to not have a public Q&A after the presentation. Is "divide and conquer" your approach. Very very unprofessional of you not to allow the public share our concerns with each other."*
- *"I just moved to Meadowbrook last December. The pictures of the floods in 2009 were worrying. I'm assured now that steps are in place for prevention."*
- *"The Castleconnell FRS Public Participation Day (PPD) fell far short of what could be considered as a "public engagement or stakeholder engagement" event. No in-person presentation was delivered by the FRS team on the night. No Q&A was permitted after the prerecorded presentation ended. The project team have not permitted the public to review and evaluate the proposed works adequately. The Hydrology and Hydraulics reports which are the basis for all proposed flood mitigation measures, were only published on the project website six (6) days before the FRS PPD. This is an unacceptable timeline to allow the public review and evaluate the reports. The Project Lifecycle Stage 1 Scheme Development and Design completion date will have to be extended to permit adequate time to review and evaluate these reports. The project design team could not confirm what (if any) stakeholder engagement had occurred with Irish Rail or other statutory bodies for the Castleconnell FRS. No information is available on the project webpage on records or details of communication with statutory bodies for the Castleconnell FRS."*
- *"Between Nov 2023 and 2025 when construction is due to commence, will the properties at risk be protected during flood events. Is there a comprehensive plan in place?"*

3.13 Question 7

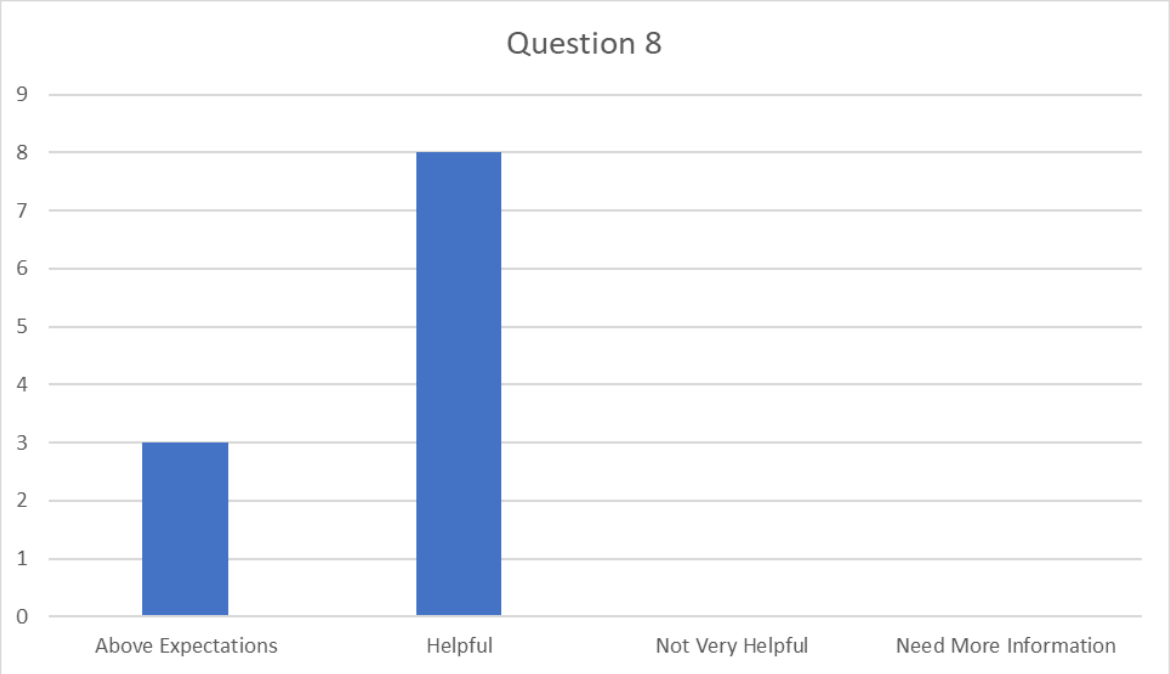
How did you hear about today's event?

Respondents noted the following means of hearing about the PPD:



3.14 Question 8

How useful have you found this event in understanding the project and how you can feed into the process?



4 Register of Issues and Actions

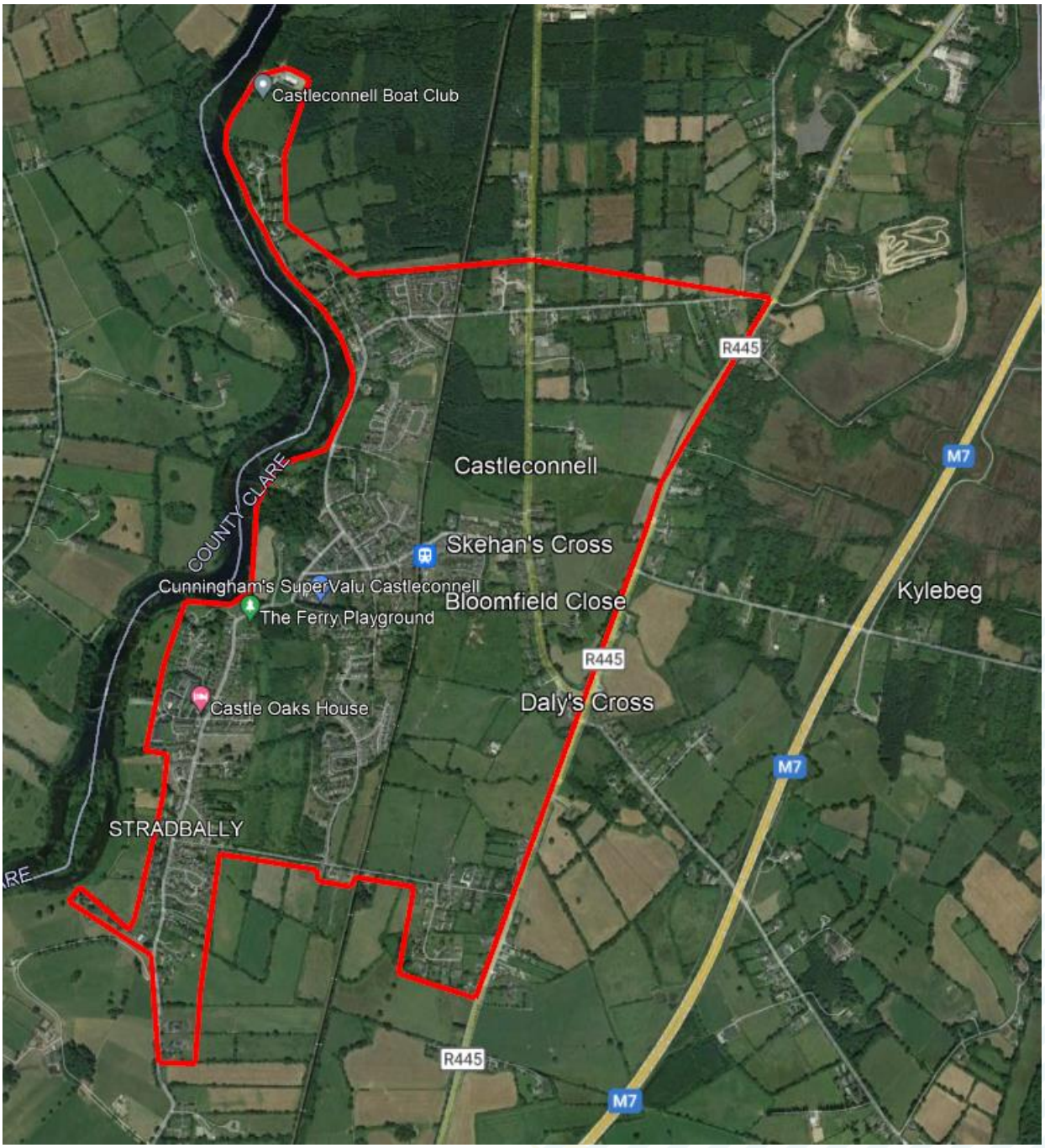
Action	Action By	Completed
Respond to queries raised by certain attendees on the day.	JBA/LCCC	
Publish photomontages when available.	JBA	

A Appendix A –Direct Notification

A.1 Stakeholders notified about the PPD

- Department of Housing, Local Government and Heritage
- Stradbally North Residents Association
- Irish Water – Spatial Planning Sector
- ESB - Declan Quille (Operations Manager at Ardnacrusha)
- Councillors Metropolitan District
- Road Design Office - Greenway Project
- Darragh Corcoran - LCCC Area Engineer
- Statutory Consultees:
  - NPWS (DAU)
  - IFI
  - An Taisce
  - Environmental Protection Agency
  - National Monument Service (DAU)
- ACM Community Development Society/Castleconnell Development Association
- Castleconnell Boat Club
- Love Castleconnell Group
- National Governing Body of Sport Canoeing Ireland
- Kilfinane Outdoor Education and Training Centre
- Limerick Kayak Club
- Limerick Kayaking Academy
- Limerick Kayak Club Juniors
- Canoeing Ireland
- Castleconnell River Association (Formerly Castleconnell Fisheries Association)
- All residents that have provided contact details

A.2 Catchment area of properties that received a newsletter



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B. Multi Criteria Analysis Summary

CFRAM Multi Critieria Analysis Tool

Project name:	Limerick City and County Council - Castleconnell FRS	**Prepared by:**	LL
Project Ref:	2019s0927	**Checked by:**	RB

Description of Option					Option 1	Option 2	Option 3
					1	2	3
4. Technical	a	Ensure flood risk management options are operationally robust	i)	Ensure flood risk management options are operationally robust	100	200.0	0.0
	b	Minimise health and safety risks associated with the construction, operation and maintenance of flood risk management options	i)	Minimise health and safety risks associated with the construction, operation and maintenance of flood risk management options	150	200.0	150.0
	c	Ensure flood risk management options are adaptable to future flood risk and the potential impacts of climate change	i)	Ensure flood risk management options are adaptable to future flood risk and the potential impacts of climate change	300	300.0	300.0
TECHNICAL SCORE					**550**	**700.0**	**450.0**
2. Economic	a	Minimise economic risk	i)	Minimise economic risk	2.8	2.8	2.8
	b	Minimise risk to transport infrastructure	i)	Minimise risk to transport infrastructure	171.2	189.8	171.2
	c	Minimise risk to utility infrastructure	i)	Minimise risk to utility infrastructure	180.4	203.4	180.4
	d	Minimise risk to agriculture	i)	Minimise risk to agriculture	0	0.0	0.0
ECONOMIC SCORE					**354.4**	**396.0**	**354.4**
1. Social	a	Minimise risk to human health and life	i)	Minimise risk to human health and life of residents	53.1	53.1	53.1
			ii)	Minimise risk to high vulnerability properties	0.0	0.0	0.0
	b	Minimise risk to community	i)	Minimise risk to social infrastructure and amenity	25.9	25.9	25.9
			ii)	Minimise risk to local employment	72.0	72.0	72.0
SOCIAL SCORE					**151.0**	**151.0**	**151.0**
3. Environmental	a	Support the objectives of the WFD	i)	Prevent deterioration in status, and if possible contribute to the achievement of good ecological status / potential of water-bodies	-320	160.0	0.0
	b	Support the objectives of the Habitats and Birds Directive	i)	Avoid damage to, and where possible enhance, Natura 2000 sites	-250	-50.0	-50.0
	c	Avoid damage to, and where possible enhance, the flora and fauna of the catchment	i)	Avoid damage to, and where possible enhance, legally protected sites / habitats and other sites / habitats of nature conservation importance	-125	-50.0	-50.0
	d	Protect, and where possible enhance, fisheries resource within the catchment	i)	Maintain existing, and where possible create new, fisheries habitat including the maintenance or improvement of conditions that allow upstream migration for fish species	-208	-156.0	-156.0
	e	Protect, and where possible enhance, landscape character and visual amenity within the river corridor	i)	Protect, and where possible enhance, visual amenity, landscape protection zones and views into / from designated scenic areas within the river corridor	-32	-40.0	-32.0
	f	Avoid damage to or loss of features, institutions and collections of cultural heritage importance and their setting	i)	Avoid damage to or loss of features, institutions and collections of architectural value and their setting	-24	-12.0	-12.0
			ii)	Avoid damage to or loss of features, institutions and collections of archaeological value and their setting	-16	-16.0	-16.0

ENVIRONMENTAL SCORE	-975	-164.0	-316.0
OPTION SELECTION SCORE	80	1083	639
MCA BENEFIT SCORE	-470	383	189
COST	€9,770,472	€10,671,846	€9,204,778
Damages	€7,309,649	€7,309,649	€7,309,649
Economic BCR	0.75	0.68	0.79
MCA BCR (benefits per 1000 Euro)	-0.04807	0.036	0.021
	Option 1	Option 2	Option 3

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