Project

Ballyhale Flood Relief Scheme, Ballyhale, Co. Kilkenny

Report Title

Cost Benefit Analysis Report

Clients

OPW

Kilkenny County Council

INFRASTRUCTURE

DBFL CONSULTING ENGINEERS

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APPENDICES

1 Introduction

1.1 Project Background

DBFL Consulting Engineers have been appointed by Kilkenny County Council (KCC) to advance and implement a flood relief scheme for Ballyhale.

The objective of this project is the identification, design, and submission (for planning consent) of a Flood Relief Scheme, that is technically, socially, environmentally, and economically acceptable, to alleviate the risk of flooding to the Community of Ballyhale. Kilkenny County Council is the Contracting Authority and the Client for the Project. The Office of Public Works is providing funding.

1.2 Purpose of Cost Benefit Analysis Report

The purpose of this report is to enable ‘a cost benefit analysis’ of the proposed scheme. According to the OPW’s Guidelines on the National ‘CFRAM’ Programme, ‘a cost benefit analysis’ should detail the calculation of the economic (monetary) benefit-cost ratio for options for flood risk management measures to be used for option appraisal and economic flood risk mapping. As well as the Option appraisal against Objective 2.a (Minimise Economic Risk) under the Multi-Criteria Analysis (MCA).

The economic benefits of an option for a flood risk management measure, or of a proposed flood risk management measure, are calculated as the reduction in the economic damages the option or measure will provide.

It is noted that the costings referenced in this report are Preliminary Cost Estimates are developed based on feasibility level Flood Relief Option Designs. The purpose is to allow a comparative assessment of costs across options and to develop approximate costs to establish if the scheme is generally feasible from an economic perspective.

It is expected that cost estimates will change as the project progresses.

1.3 Scheme Stages

This Report forms part of Stage 1 of the Flood Relief Scheme. This builds on the original CFRAM assessment which identified a need for the scheme. The Purpose of Stage 1 is to complete a range of baseline assessments to establish the existing Environmental and Flood Risk conditions at the site and then develop a preferred scheme option to be progressed for planning approval.

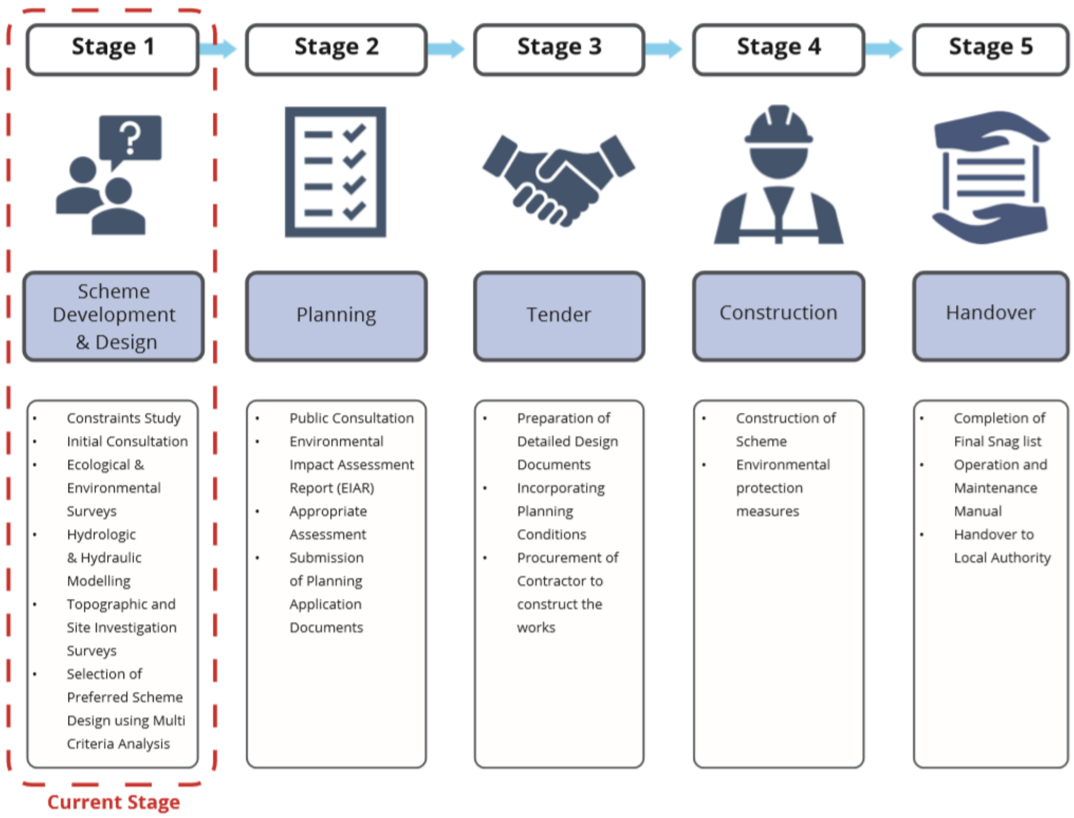

Figure 1-1- Scheme Stage Overview

2 Flood Risk Background

This report is part of a suite of documents which are produced as part of the scheme development. This section provides a high-level summary of certain baseline assessments which include the CFRAM (precursor to current scheme), Hydrology Report & Hydraulics Report.

2.1 CFRAM Assessment

The CFRAM was a regional scale study of Flood Risk which predates the current assessment. The South Eastern CFRAM Study Flood Risk Review report (IBE0601Rp0001) identified Ballyhale as an Area for Further Assessment (AFA). The CFRAM study carried out initial hydraulic modelling of the watercourse and determined a flood risk in the Village. The CFRAM Preliminary Option Report (IBE0601Rp0025) identified a range of Preliminary Options to resolve flooding and determined that an Option involving a flow diversion and hard defences may be appropriate to resolve flood risk. The modelling and outline designs in the CFRAM Reports has been reviewed as part of the current project level assessment however these are superseded by the more detailed project level assessment currently underway.

Although the predicted flood extents and mechanisms identified in the Hydraulics Report are broadly similar to those identified at CFRAM stage, there is a significant difference in the level of detail in the analysis for the CFRAMS stage and the current stage which has refined the level of property impact and resultant damages assessments. The primary differences are

- Significantly increased level of detail for topography. This revised assessment relies on detailed ground based topographical survey and surveyed building levels for overland routing rather than a LiDAR grid data used previously at CFRAM stage.
- Spacing of channel cross sections increased relative to CFRAM assessment
- Additional tributary channel has been included in the revised assessment in order to represent flooding from this source
- Use of updated damage data tables from more recent version of the Handbook for Economic Appraisal which affects estimated flood damage values.

2.2 Catchment Description

Ballyhale is within the catchment of the Little Arrigle River which is a tributary of the River Nore. The main channel of the Little Arrigle runs to the west of the village and a tributary of the Little Arrigle runs though the village. This tributary is also known locally as the Little Arrigle however will be termed the Ballyhale River for the purposes of this assessment (this is also referred to in EPA mapping as Knockwilliam Stream). The Ballyhale River rises approximately 2.9km south of the town of Ballyhale. It begins in a forested region and flows north through largely agricultural land. The Ballyhale River enters the village near the church and splits into two channels either side of the church. The western branch flows in a generally open channel though agricultural land. The eastern channel flows through the rear of a number of domestic properties though a heavily modified channel with frequent structures of varying construction type. The branches merge upstream of Arrigle Business Park and flow though a long (circa 50m) culvert under buildings in the business park. Several additional culverts/bridges are present on the watercourse along its remaining route through the village. A number of weirs are also present on the channel within the village. The Ballyhale River leaves Ballyhale and merges with the Little Arrigle approximately 850 m north of Ballyhale.

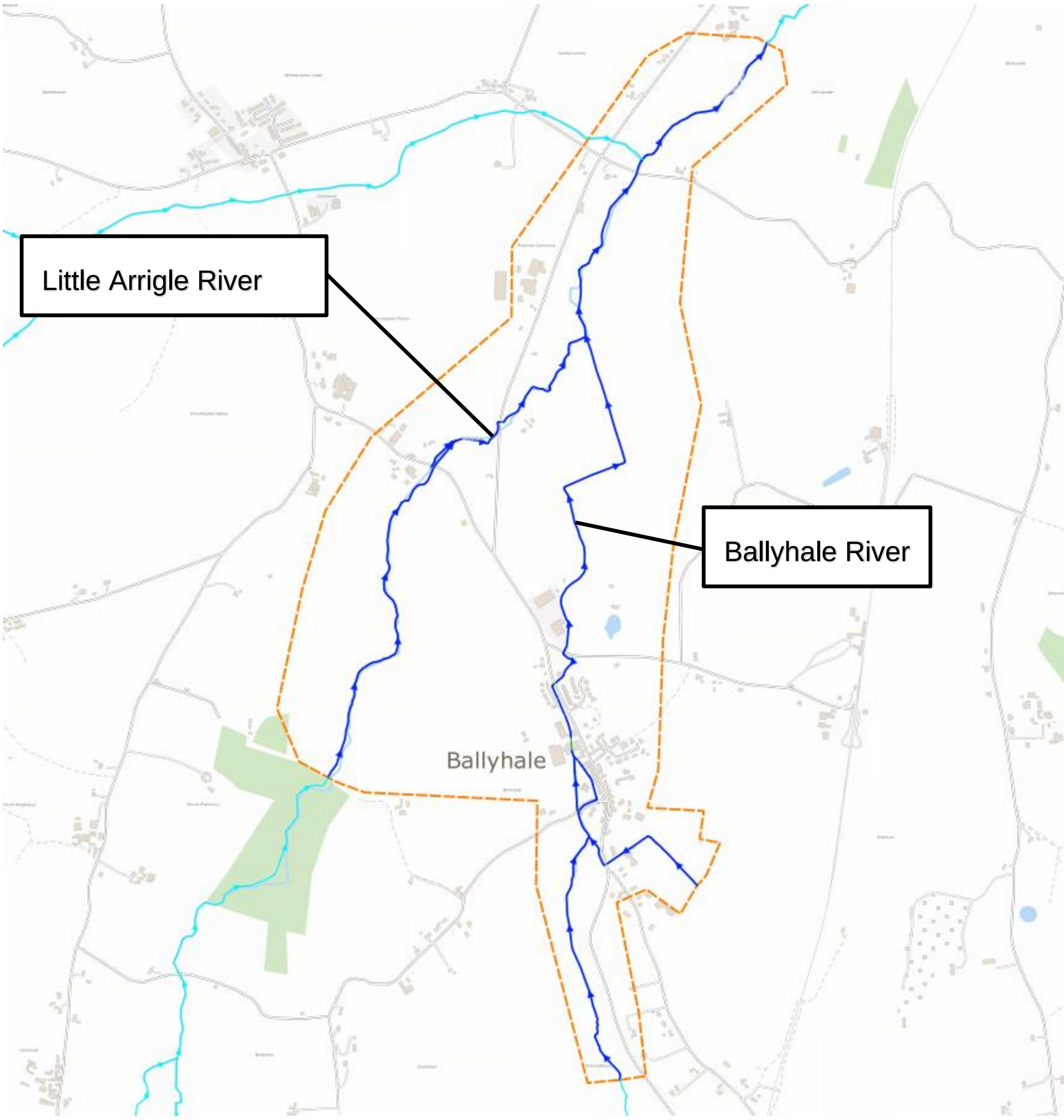

Figure 2-1 – Local Watercourses

2.3 Existing Flood Risk Environment

A detailed hydrological study and hydraulic modelling of the existing flood risk environment has been carried out as part of this project. The existing flood risk and flood mechanisms are described in the Hydrology Report and Hydraulics Report. The predicted Q100 flood events are shown in Figure 2-2.

Figure 2-2 Fluvial Flood Extents 1% AEP
(Source – McCloy Consulting – Hydraulics Report Ballyhale, Co. Kilkenny)

The primary flood mechanism for the flooding within the village is caused by structure incapacity with resulting backwater effect causing out of bank flooding along the Ballyhale River resulting in flooding at the rear of the Main Street properties, coupled with two significant overland flow routes from the south of the village.

Channel incapacity upstream of the village from the Ballyhale River creates an overland flow path that flows northerly towards Chapel Lane, re-entering the western church reach of the Ballyhale River at the church access bridge.

A second overland flow route is evident from an unmapped tributary of the Ballyhale River that flows adjacent to the school boundary. A low point in the bank where the channel turns at an approximately 90 degree bend coupled with unmaintained vegetation restricting flows within the channel downstream causes flooding from the right hand bank flowing down 'Sheff's Lane' that emerges onto the Main Street. The flow route diverges at the Chapel Lane junction, flows that tend down Chapel Lane enters the western church reach at the church access bridge. Flows that tend down Main Street enters the main Ballyhale River at the former Garda Station.

In higher flow events, the flow path on the Main Street continues and re-joins the Ballyhale River at either the downstream section of the 'Main Street Bridge' at the Hazelbrook development or downstream of the Station Road bridge.

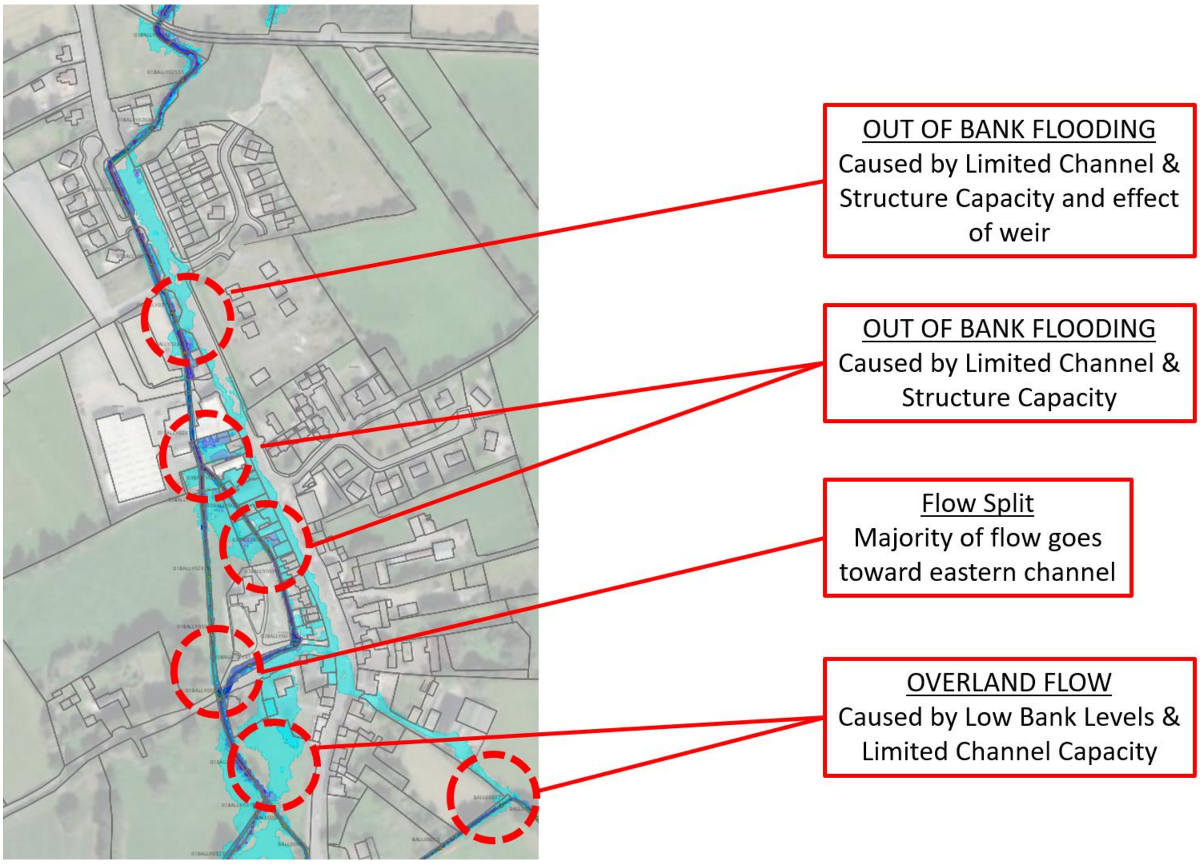

Figure 2-3 Flood Mechanisms - Overview

2.4 At Risk Properties

OSi Prime2 mapping was used as a basis to define building geometries, updated with topographical surveyed outlines where data was available. Threshold surveys were carried out for the majority of at risk properties. Threshold levels were established for other properties based on based on available topographical data. Property polygons were linked to An Post Geodirectory data which provided additional information on the property type and usage.

The flood extents and depths for Ballyhale for the return periods of interest have been established as part of Hydrology/Hydraulics report deliverables.

Using the building geometry data and the flood data, the resultant flood depths at/in each building polygon for each return period could then be extracted to form the basis of the damages assessment as described in Section 3.

Table 2-1: Present Day Flood Risk.

Probability of Flood	Residential Properties	Commercial Properties	Total
50%	0	0	0
20%	1	0	1
10%	1	0	1
5%	15	3	18
2%	20	4	24
1%	20	7	27
0.50%	24	8	32
0.10%	33	9	42

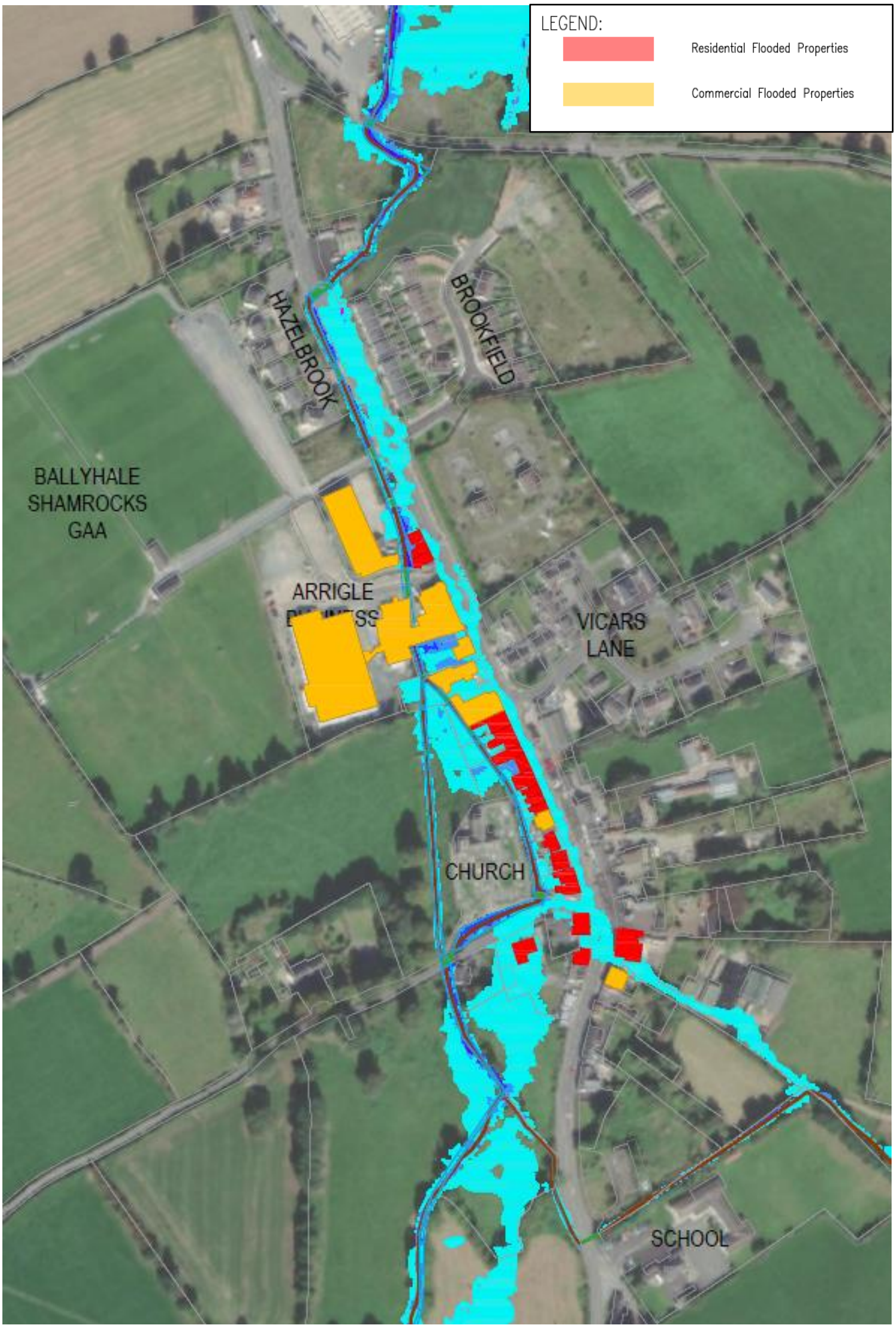

Figure 2-4 Properties subject to Flood Damage Q100 Event

3 Calculation of Baseline Damages - Methodology

The calculation of flood damages was undertaken using standardised guidelines and figures set out in the ‘Multi-Coloured Manual’ of 2020 (FHRC, 2020) as referred to in FHRC 2020, subject to caveats, amendments and clarifications set out herein as per OPW guidance document - NATIONAL 'CFRAM' PROGRAMME Technical Methodology Note - Cost-Benefit Analysis (CBA).

The assessment of economic damages associated with flooding is comprised of the following elements;

- Principal Direct Damages
- Intangible and Indirect Damages
- Infrastructure Utility Damages
- Emergency Services

3.1 Principal Direct Damages

The Principle Direct Damages were calculated based on the sum of the direct property damages to residential properties and non-residential properties.

Residential Property Damages

For the purposes of determining the appropriate residential property damages and depth-damage curve the data used took into account the property type (detached, semi-detached, terraced, bungalow etc) but not the following:

- Property age
- Social class (and without inclusion of the Distributional Impact Factor)
- Property size

Flood damages were assumed to begin at depths of 0.3m relative to floor levels (only where the buildings whose footprint lies within the flooded area).

Non-Residential Property Damages

For the purposes of determining the appropriate non-residential property damages and the depth damage curve the data used took into account the property type and property area.

3.2 Intangible and Indirect Damages

For residential properties, the intangible and indirect flood damages are set equal to the total (direct) property damage as per OPW guidance.

Intangible damages were also applied in the case of small, individually, or family-owned businesses where the intangible impact would be personal and similar in nature to that which might be experienced were the property residential.

3.3 Infrastructure Utility Damages

Economic damages to infrastructural utility assets (e.g., electrical sub-stations, gas installations and pipework, telecommunications assets, etc.) were calculated as 20% of total PDD Costs for the AFA or SSA.

3.4 Emergency Services

Costs to emergency services (which include evacuation costs) were included in the economic damages and were calculated as 8.1% of the total PDD Costs for the AFA or SSA.

3.5 Price Conversions

Prices (damage costs) in the data provided by FHRC 2020 were converted to euro rates applicable to Ireland in 2021 by:

- Applying a ‘PPP’ multiplication factor of 1.279. This is derived from the relative OECD Purchasing Price Parity values for the UK and for Ireland for 2010. The 'PPP' factor is net of currency conversion (i.e., already includes for exchange rates as well as price differences, and so no currency conversion rate should be applied in addition to this factor)

3.6 Scope of Assessment

The calculation of flood damages was undertaken for:

- AFAs and areas along MPWs
- The current scenario and MRFS based on each of the range of flood event probabilities as set out in Section 6.5.1 of the Generic CFRAM Project Brief
- The HEFS in an indicative manner, making use of calculated damages for the 10%, 1% (0.5% for coastal flooding) and 0.1% damages for the HEFS, and using these values to shift the MRFS damage curve to derive an indicative damage curve for the HEFS.

3.7 Flood Duration

In line with OPW guidance the damages were calculated assuming long duration (>12 hours) flooding for residential properties.

3.8 Calculation of Annual Average Damages

The Annual Average Damage (AAD) was calculated using linear interpolation between damage values for each of the eight defined design event probabilities, i.e., with a damage value calculated for each ‘slice’ based on the average of the damages for the design event damages that form the probability boundaries for the ‘slice’, and the probability range of the ‘slice’.

The AAD was calculated as the sum of the damage values of each slice, up to and including the ‘slice’ with the 0.1% AEP event as the upper bounding event.

3.9 Capping

A capping value was established for all at risk properties. Capping values were based on available estate agent listings and property price register data for the local area. Capping values are applied to the Present Value Benefit (PVb) of an option when undertaking an economic CBA. This ensures that scheme costs do not exceed the total value of the property and associated intangible damages.

4 Results of Damages Assessment

4.1 Calculation of the Present Value of Damages (PVd)

Table 4-1 below presents a summary of Monetary Damages by Event

Table 4-1: Monetary Damages by Event.

Type of Risk	Flood Risk for Design AEP (%) Event		
	10% AEP	1% AEP	0.1% AEP
Current Scenario (Present Day)			
Event Damage	€ 112,350.03	€ 4,666,904.85	€ 8,660,426.26
No. Residential Properties at Risk	1	20	33
No. business Properties at risk	0	7	9
Mid-Range Future Scenario			
Event Damage	€ 822,049.10	€ 6,644,463.72	€ 9,699,276.73
No. Residential Properties at Risk	17	24	36
No. business Properties at risk	2	9	11
High-End Future Scenario			
Event Damage	€ 1,329,183.63	€ 6,796,622.33	€ 11,259,417.54
No. Residential Properties at Risk	19	24	37
No. business Properties at risk	4	10	12

As described in Section 3.8 the Average Annual Damages was calculated using linear interpolation between damage values for each of the eight defined design event probabilities.

The calculated Average Annual Damages AAD is **€191,652.25**

The PVd was calculated as the discounted sum of the annual average damages over the project horizon, where:

- The discount rate to be applied is 4%.
- The project horizon is 50 years.

The calculated PVd is **€4,117,109**

5 Cost Estimate

5.1 Cost Estimate Methodology

It is noted that the costings referenced in this report are Preliminary Cost Estimates and are developed based on feasibility level Flood Relief Option designs. The purpose is to allow a comparative assessment of costs for Multi Criteria Assessment of options and to develop approximate costs to establish if the scheme is generally feasible from an economic perspective.

It is expected that cost estimates will change as the project progresses.

The cost estimate has been calculated in accordance with available construction rates from the following sources;

- OPW Unit Cost Database
- Transport Infrastructure Ireland (TII) Schedule of Rates
- Professional Judgement based on completed projects of similar scope

The costings generally follow established OPW methodologies established in the CFRAM program. The Costs include for

- Construction Capital Costs
- Construction Preliminaries
- Operation & Maintenance Costs
- Environmental Mitigation Measures
- Land Acquisition, Legal & Compensation Costs
- Detailed Design & Site Supervision Costs
- Art
- Allowance for optimism bias

Key exclusions for the cost estimates include.

- Pre Planning Design Fees
- Pre-Planning Survey costs (environmental, topographical, site investigation)
- VAT

Preliminary costings for a variety of flood relief measures were presented in the Scheme Option Report (200055-DBFL-XXXX-XX-RP-C-0004). The Option Report determined an emerging preferred scheme (Option A), and the Cost Benefit Analysis has been prepared based on this option. Refer to the Option Report for descriptions and costings of the options considered.

5.2 Emerging Preferred Option Details

The scheme comprises of the following measures;

- E-001 - Raised ground levels along existing Agricultural tracks to prevent overland flow path.
- E-002 – Embankment / berm works at the rear of properties to prevent overland flow path.
- E-003 - Embankment works to close off Ballyhale Church Channel and form new pedestrian connection to Church Walkway. Works will take place to divert the flow away from the church stream and contain the flow within the secondary channel.
- E-004 – Embankment / berm works along the rear of properties. Works will take place along the rear of the properties to form an embankment.
- E-005 – Embankment / berm works at the rear of Garda Station. An embankment will be installed along the rear of the Garda Station property
- D-001 – New channel to be form from outlet on Ballyhale Church Channel to remove flow split and combine both branches to single main channel.
- D-002 – Regrade exiting Channel to form constant gradient.
- L-001 – Flood Wall along the rear of Arrigle View.
- L-002 - Flood Walls along the rear of Garage / Pub.
- L-003 – Flood Walls to infill existing gap in roadside boundary wall.
- X-001 – Remove Existing Access Bridge.
- X-002 – Remove Existing Wall spanning channel.
- X-003 – The existing weir at the Ballyhale Business Park will be allowing the channel gradient to be increased along this section which increases capacity (D-002). If this weir cannot be removed without undermining the existing bridge the existing bridge shall be replaced.
- G-001 – Clear channel and line with riprap and create low flow channel to aid maintenance.

- G-002 – Realign channel at roadway bridge to remove siltation and improve inlet condition. Works will also be done to provide riprap bank lining upstream of culvert where erosion is evident.
- P-001 – The outlet from the church channel shall be diverted to connect to a downstream location on the Ballyhale River to avoid elevated flood levels backing up into this channel.
- LW-001 – Landscaping works within lands acquired for flood works. The scheme will seek to deliver a riverside walkway as part of landscaping works associated with the flood scheme.
- LW-002 – Landscaping works to channel to respond to reduced flow conditions.
- Ongoing maintenance to watercourses, watercourse structures and relief works in the scheme area.

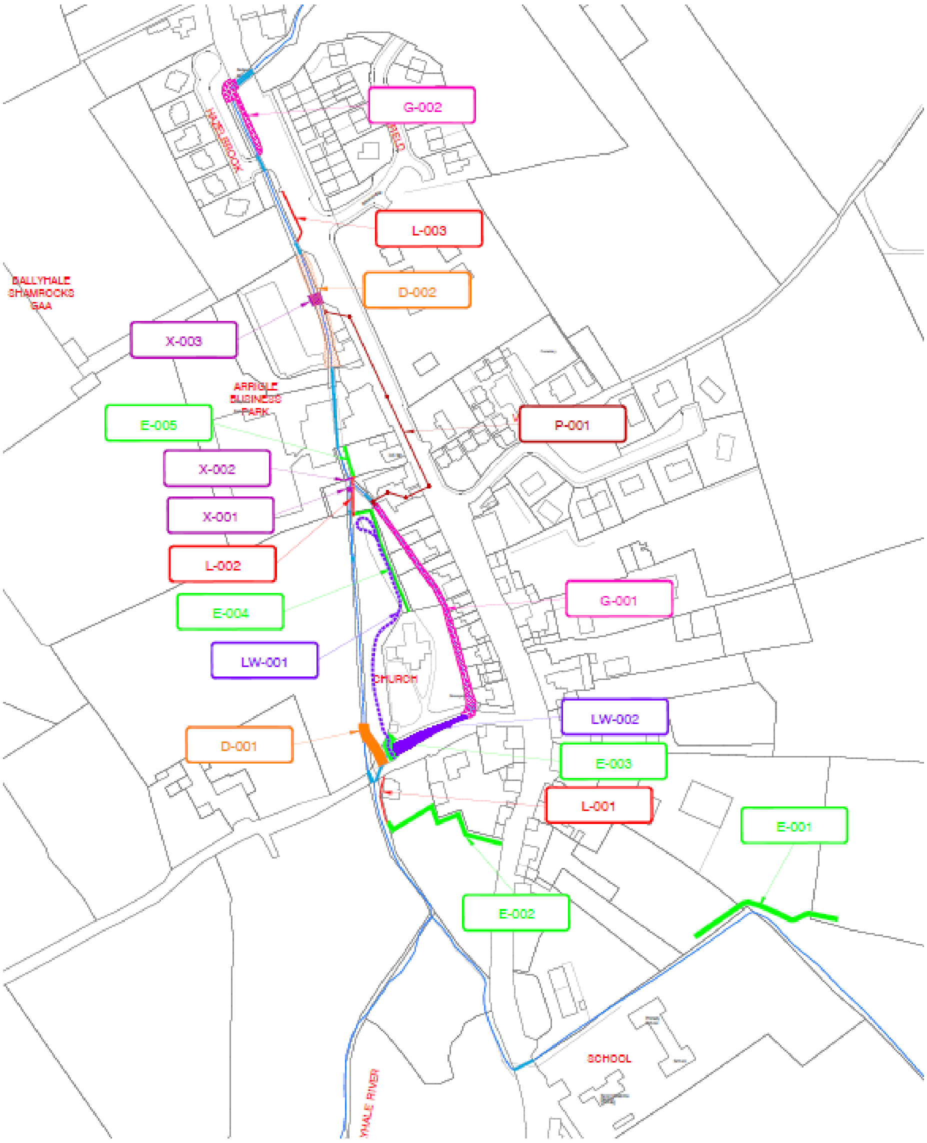

Figure 5-1: Concept Option Layout

6 Cost Benefit Analysis

6.1 General Methodology

The benefit-cost ratio (BCR) produced as the output of the cost-benefit analysis was calculated by dividing the PVb for an option or measure, capped as appropriate, by the whole life cost (PVc) of that option or measure.

The Net Present Value of the benefits (NPVb) of the option should also be calculated by deducting the PVc from the capped PVb. The whole life cost is determined from the sum of the costs over the project horizon, with future costs discounted by the set discount rate.

For the design standard event 1% AEP the Capped Present Value of Damages (PVd) is **€4,117,109**. The proposed option is predicted to entirely remove property damages in the study area for the design event, therefore the scheme benefits PVb can be considered equal to the damages value.

6.2 Cost Benefit Analysis Summary

The Benefit to Cost Ratio (BCR) and the Net Present Value of the Benefits (NPVB) for the scheme is presented below.

Table 6-1: Cost Benefit Summary.

Scheme Benefit	€ 4,117,109
Whole Life Costs	€ 1,799,076
Benefit Cost Ratio (BCR)	2.29
Net Present Value of Benefits	€ 2,317,109

Based on this assessment the scheme is cost beneficial.

Appendix A

Emerging Preferred Scheme Layout

Appendix B

Summary Cost Estimate