Project

Ballyhale Flood Relief Scheme, Ballyhale, Co. Kilkenny

Report Title

Flood Risk Management Option Report

Clients

OPW

Kilkenny County Council

INFRASTRUCTURE

DBFL CONSULTING ENGINEERS

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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 Scope

The purpose of this report is to develop and assess a range of flood relief options that could be implemented in the town of Ballyhale and to outline the procedure of how the preferred option has been developed and selected.

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.

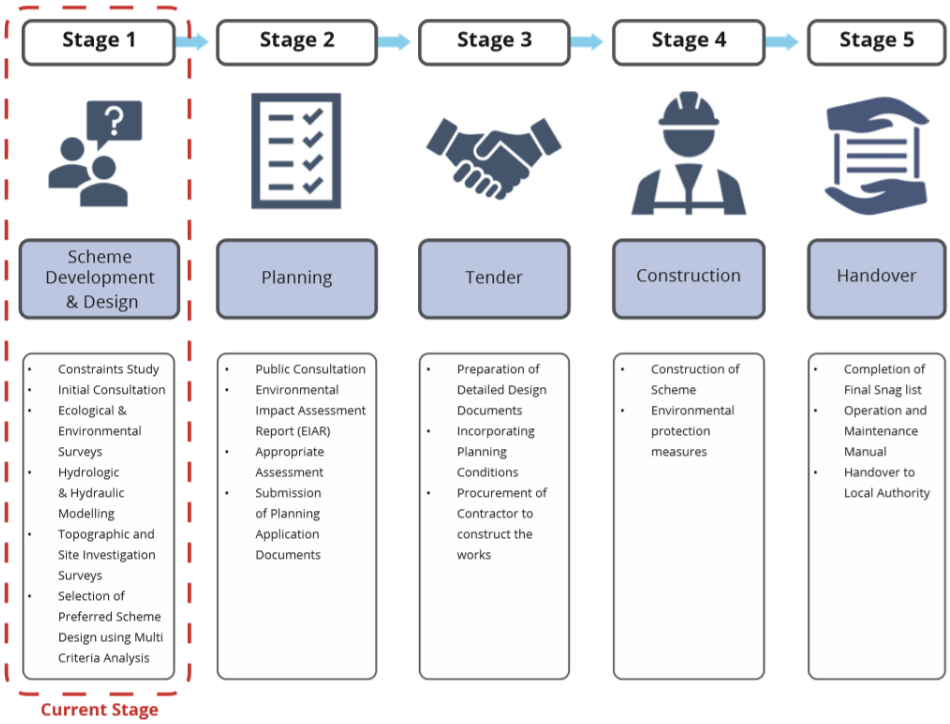

Figure 1-1- Scheme Stage Overview

2 Options Assessment Methodology

A schematic of the Options Assessment methodology is presented in Figure 2-1 below.

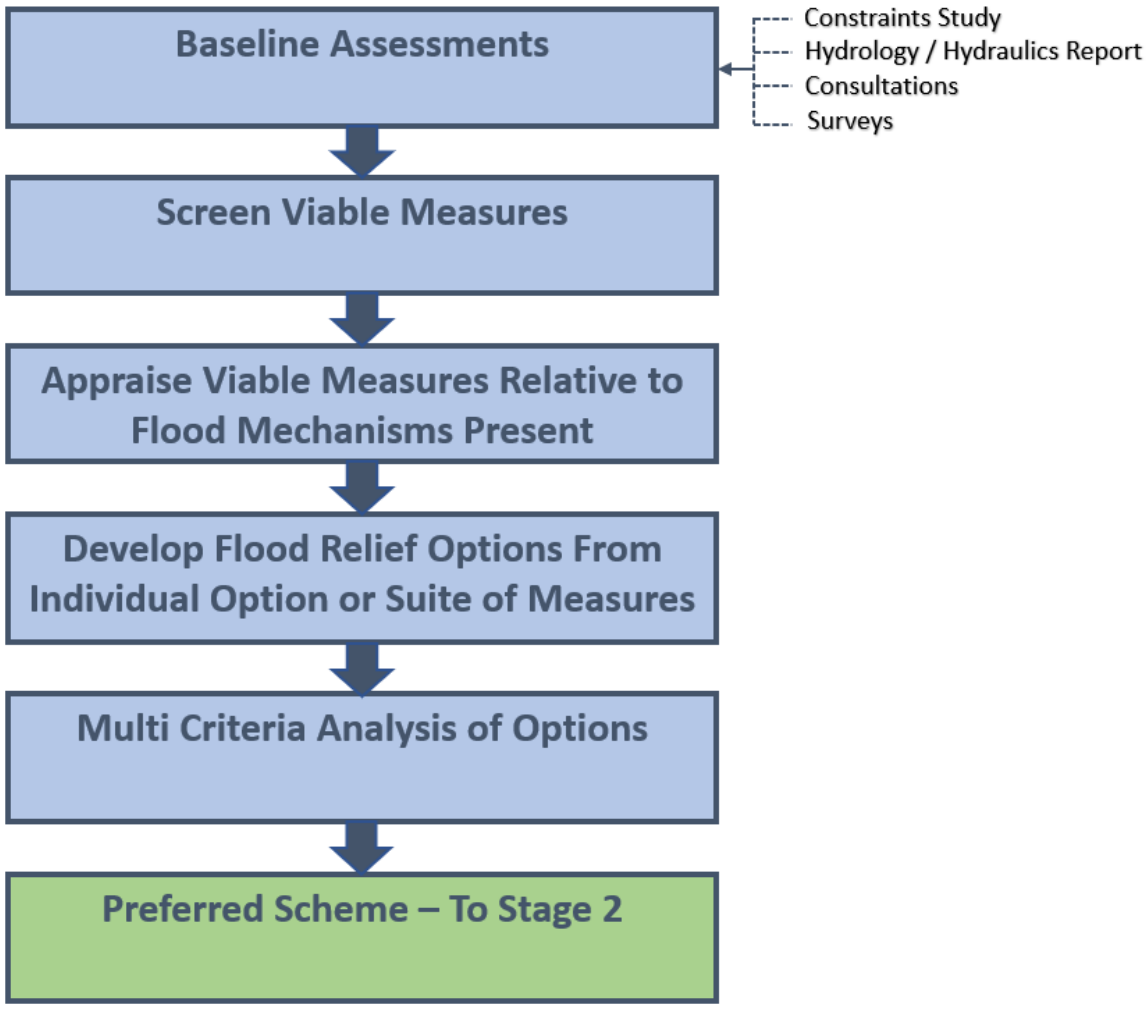

Figure 2-1: Options Assessment Methodology

In order to develop a suitable relief scheme, it is vital to accurately establish the existing Environmental and Flood Risk conditions at the site.

The existing environment is assessed initially in the form of a Constraints Report which establishes key environmental sensitivities and constraints which may affect the design of relief options (see Section 3.4 for summary).

A detailed topographical and river survey of the site has been carried out to capture existing conditions and to provide data for the design of relief works.

The design flood flows at the site were established via the Hydrology Report. A detailed 1D-2D hydraulic model of the watercourse, structures, and surrounding lands has been

developed using Infoworks ICM software as described in the Hydraulics Report. This hydraulic model recreates the river system in the study area and simulates the predicted flooding for a range of return periods. The models are validated against previous flood records. This determines the existing flood mechanisms and flood extents in the town and can be used to simulate the effect of relief options. The model outputs can also be used to estimate the economic damages from flooding.

The next step is to screen a variety of Flood Risk Management techniques to establish which may be viable or unsuitable for the site in question.

The viable measures are then assessed in more detail to determine their suitability to address the specific flood mechanisms in the subject site.

A number of potential relief design options are then developed based on the preceding assessments. These may use a single technique or a combination of measures as appropriate.

The various options are then subject to a Multi Criteria appraisal (see Section 8) in order to select the most suitable option which balances Social, Economic, Environmental and Technical considerations.

The preferred option is then intended to be brought forward to Stage 2 where it will undergo further refinement and detailed design. Planning documentation for statutory approvals will be prepared in Stage 2.

3 Summary of Baseline Information

This options 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 the baseline assessments which include the CFRAM (precursor to current scheme), Hydrology Report, Hydraulics Report and Constraints report

3.1 Flood Risk Background

3.1.1 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.

3.2 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 through 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.

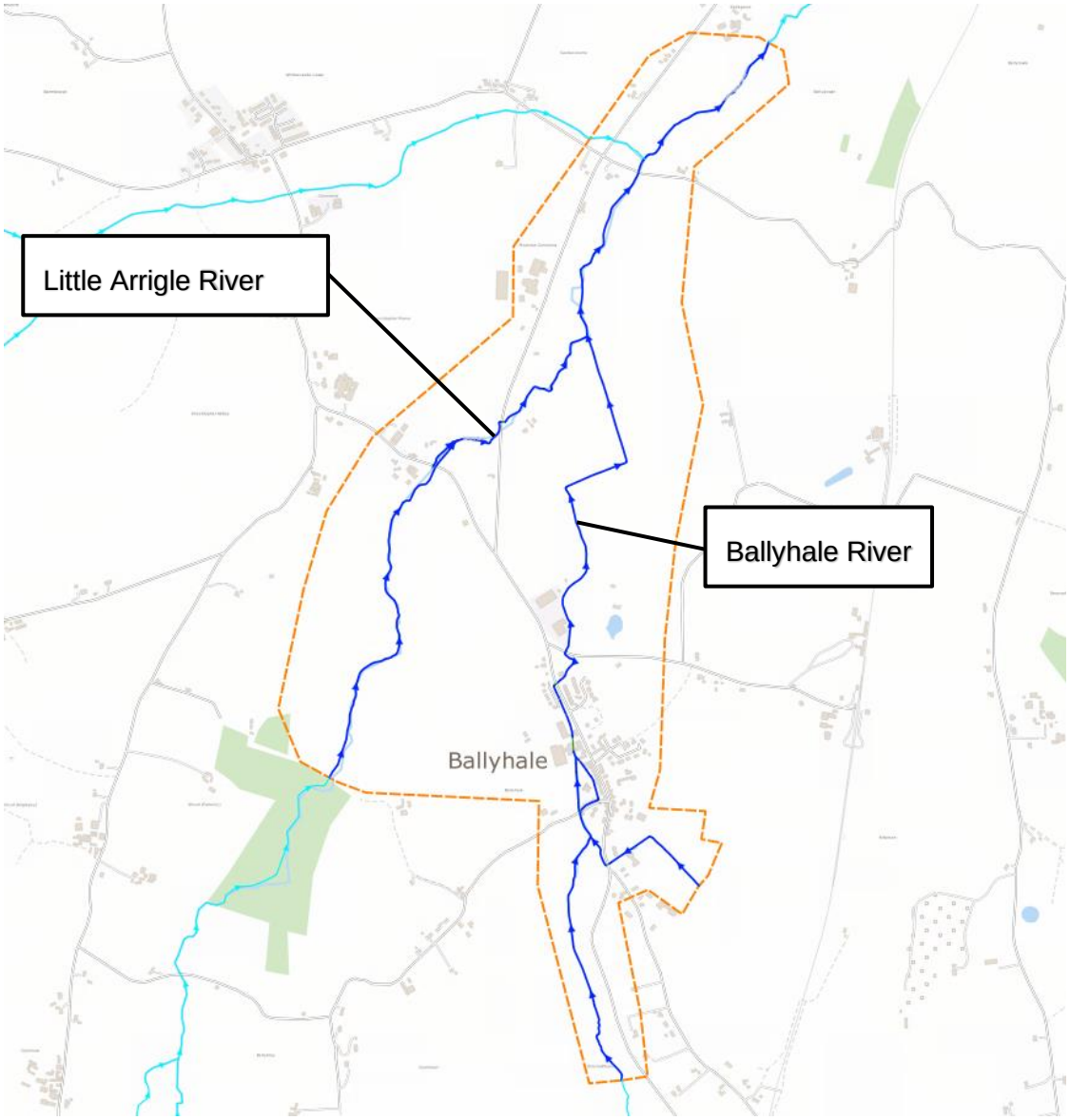

Figure 3-1 – Local Watercourses

3.3 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 3-2.

Figure 3-2 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.

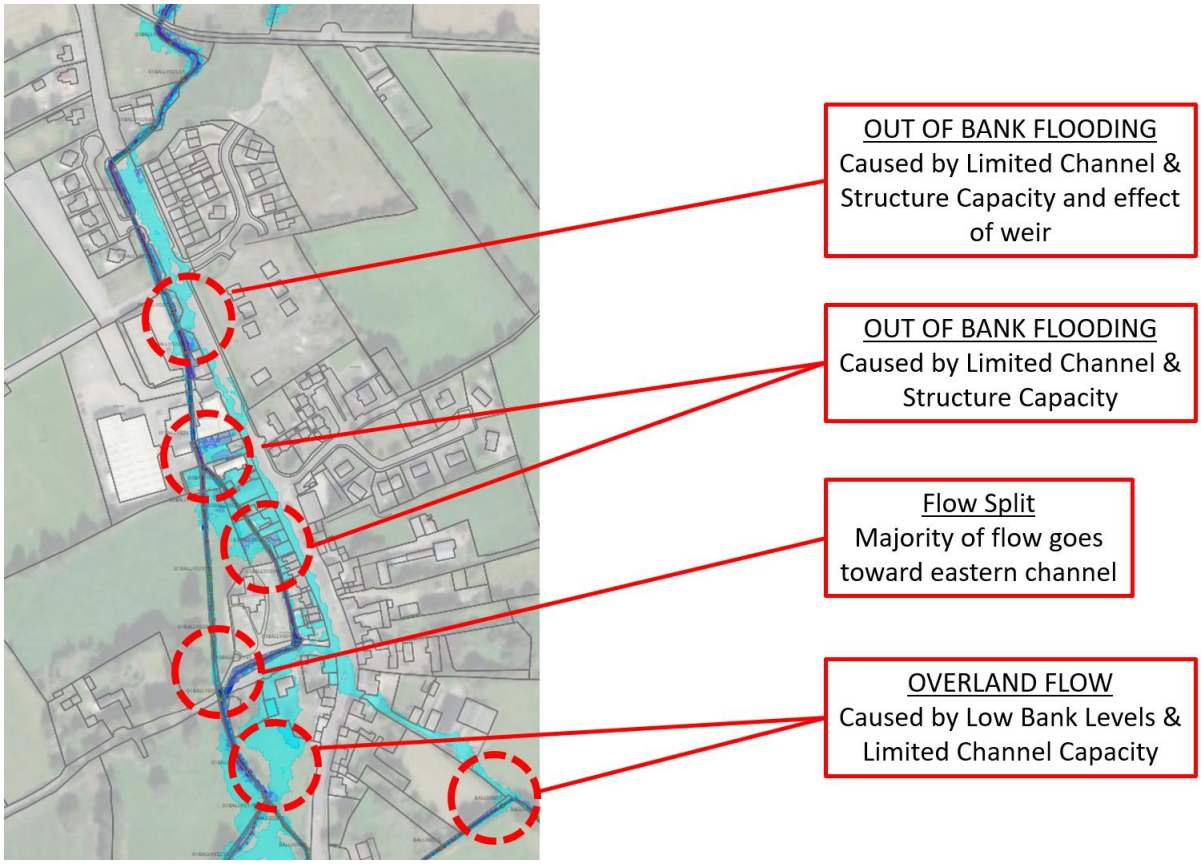

Figure 3-3 Flood Mechanisms - Overview

3.4 Summary of Constraints Assessments

A high-level summary of constraints reports findings is presented in the table below. Detailed reporting is included within the Constraints Report.

Table 3-1: Summary of Constraints Assessments carried out.

Discipline	Constraints Summary
Water Environment	• Watercourses present in the study area consist of The Little Arrigle River, & The Ballyhale River (which includes a split channel section at Ballyhale Church). All are tributaries of the River Nore. • The River Barrow and River Nore SAC begins close to the downstream extent of works and is considered sensitive to potential hydrological impacts on water quality/quantity from the scheme. Therefore, scheme will need to ensure impacts on surface water quality/quantity are avoided. • The bedrock Aquifer is a Regionally Important sandstone aquifer. • No Drinking Water Protection Areas were identified in the vicinity of the site however protection zones are present on the aquifer near Thomastown where there are abstractions for drinking water supplies
Land & Soils	• The Ballyhale Flood Relief Scheme is underlain in its majority by Kiltorcan Formation. The Kiltorcan Formation generally consists of yellow and red sandstone and green mudstone. • A number of bedrock outcrops in the vicinity of the site were noted on geological mapping and some bedrock was visible within stream channels during site walkovers. Bedrock is anticipated to be shallowest at the southern extent of the study area. • GSI Quaternary sediment mapping indicates the majority of the scheme to be underlain by till derived from limestones and alluvium along some stream channels. • No evidence of contaminated ground, mines, quarries, or waste facilities have been identified within the concept route corridors. • No Geological Heritage Sites are within the proposed scheme extents
Biodiversity	• The proposed works are proximate to and potentially within designated sites including Natura 2000 sites of international importance. The primary designated site proximate to/within or downstream of the proposed works is the River Barrow and River Nore SAC and there is a direct hydrological connection to this SAC. In addition, the River Nore SPA is 5km downstream of all instream works • As the start of several of the diversion options there is a large group of trees. The potential impact on this area should be minimised. • Based on the provisional site assessments many of the potential biodiversity issues noted on site can be mitigated and would not impact on the proposed development of the site. • A Natura Impact Statement will be required as all options have a direct pathway to Natura 2000 sites. • For much of its length through Ballyhale the stream is highly modified and channelled. There are few pools, or areas of sanctuary for brown trout or juvenile salmon within the village or within the upstream section. Numerous sections of the stream are bridged and culverted through the town. These include several level changes within the watercourse would obstruct migrating and non-migrating fish within the watercourse. In the upstream section of the stream the stream is silted with some locally impacted areas with “sewage fungus” on the instream rocks. Organic-

	rich sediment line the banksides in the upstream areas. Of particular importance is the improvement of the habitat observed just downstream of Ballyhale where water quality and habitat appeared to improve significantly.
Biodiversity (Bats)	• The following bat species were recorded during this bat survey: common pipistrelle, soprano pipistrelle, Leisler's bat, Daubenton's bat, brown long-eared bat and Natterer's bat. This represents six of the nine resident bat species known to Ireland. • The flood relief route options were assessed in relation to potential impact on local bat populations. Due to the fact that the majority of bat activity was recorded west and north of the village of Ballyhale, any route options that involve loss of treelines and hedgerows will impact on local bat populations due to the removal of commuting routes and foraging habitat.
Cultural Heritage	• A number of sites of archaeological importance are present in the vicinity of Ballyhale church including the church, castle the graveyard and a font. All are listed within the Kilkenny County Development plan and most are listed in the Record of Monuments and Places (RMP) • Additional sites of archaeological importance from the RMP are identified west of the watercourse upstream of the village and include a souterrain and a burnt mound. • Site of Architectural heritage are listed within the National Inventory of Architectural Heritage (NIAH) • NIAH sites in the vicinity of the works include the Church towner, a number of buildings on main street, a water pump on main street. • The existing historic bridges on the Ballyhale River at Church Lane and at Main St (Hazelbrook) are also on the NIAH
Landscape & Visual	• A number of county development plan aims relate to protection of existing woodlands, trees and hedgerows. • The landscape character of this area is defined by a smooth terrain, allowing views over long distances, and vegetation is predominantly low. Land use comprises pasturelands and tree plantations, the area is described as a rural area with scattered, low density settlement patterns. • The area in the vicinity of the Church and to the south has a strong historic character with several key landscape and townscape features, which include mature trees, the historic church tower, stone walls, bridges and steps, and the stream. • Elements which are considered to contribute to the character of the area and should be retained include the mature trees, the stream channel, the stone walls and bridges and Pairc na Seamróg. • The Kilkenny Landscape Character Assessment notes that this landscape unit is perceived as having no special landscape or scenic value. • Trees in Ballyhale are not included on the Tree Register of Ireland or under Tree Preservation Orders.
Air & Noise	• The Air Quality Index for Health indicates that the air quality in Ballyhale is 'Good'. • Ballyhale is not included within the Kilkenny Noise action plan as it is located on the R448 and the noise maps produced do not cover this area as there is less than 3 million vehicles per year on the R448 • Receptors sensitive to noise and air impacts are primarily located along the main street. No operational impacts on noise and air are anticipated however construction stage activities may cause short term impacts.

Figure 3-4: Constraints Mapping

3.5 Summary of Initial Consultations

A range of consultations have been carried out to seek input to the developing scheme and identify items to consider within environmental assessments. Consultations included.

- Non-statutory consultation via Kilkenny County Council consultation portal (https://consult.kilkenny.ie/en/consultation/ballyhale-flood-relief-scheme-public-consultation-no-1). This provided brochure information, links to scheme information and provided means to provide input via consultation portal and details to directly contact KCC project staff. Its purpose was to gather local knowledge on historical flooding to validate modelling and to get local suggestions of flood relief options.
- On online survey was made available and linked from the consultation portal allowing general feedback and seeking targeted responses on a range of environmental topics
- Advertisements on consultation stage via Kilkenny County Council social media channels and local newspapers.
- Consultation with various internal KCC departments
- Consultation with local maintenance staff on site to determine flood history and other items of relevance.
- Consultation with public and landowners during site walkovers
- Letter drop to local area and landowners alerting them of scheme and surveys.
- Consultation with a range of relevant statutory and non-statutory bodies was carried out via scoping report issued to consultees.

Additional consultations will be carried out. A second non-statutory public consultation exercise will be carried out following the selection of the preferred option get initial feedback on the option prior to preparation of Planning Documents. A statutory consultation period shall be incorporated into the planning approval process for the scheme.

4 Initial Screening of Flood Risk Management Options

4.1 Introduction

The purpose of this section is to act as a high-level screening of options, to assess the option's viability in relation to the criteria below;

- Applicability to Relevant Area
- Social
- Economic
- Environmental
- Cultural

Applicability to Relevant Area

Certain FRM methods would simply not be applicable to certain flood risk circumstances and may be rejected on this basis. The flood risk management options which have been reviewed, as part of this screening process are contained in Table 4.1.

Table 4-1: Initial Screening of Flood Risk Management Options

Flood Risk Management Option	Applicability	Social Screening	Economic Screening	Environmental Screening	Cultural Screening	Screening Result
Do Nothing	×					Not Viable
Do Minimum	×					Not Viable
Maintenance Programme	✓	✓	✓	✓	✓	Viable
Flood Forecasting and Warning	×					Not Viable
Individual Property Protection	×					Not Viable
Property Relocation	×					Not Viable
Land Use Management	×					Not Viable
Improvement of Channel Conveyance	✓	✓	✓	✓	✓	Viable
Overland Flood Paths	×					Not Viable
Rehabilitation of Existing Defences	×					Not Viable
Pumping	×					Not Viable
Upstream Flood Storage	✓	✓	✓	✓	✓	Viable
Flow Diversion Structure	✓	✓	✓	✓	✓	Viable
Culverting	×					Not Viable
Hard Defences	✓	✓	✓	✓	✓	Viable
Debris Control Measures	✓	✓	✓	✓	✓	Viable
Natural Retention Measures	✓	✓	✓	✓	✓	Viable

4.2 Non-Viable Flood Risk Management Options

Further to the initial screening in Table 4.1, the non-viable flood risk management options have been described in more detail as to why the options are classed as non-viable.

- **Do nothing** – this scenario is defined as the option involving no future flood defence works or the continuation of existing maintenance of existing defences/ channels. Therefore, the existing flood risk persists and may increase in the study area. This is not considered a sustainable option as the risk of flooding within Ballyhale persists and this option does not meet the needs of residents and business of Ballyhale. Therefore, this option was ruled out during the screening stage.
- **Do Minimum** – this scenario is defined as involving no new future flood defence works but allows any current maintenance and inspection regimes to continue. Therefore, the existing flood risk persists in the study area. This is not considered a sustainable option as the current flood risk persists. This option does not meet the needs of residents and business of Ballyhale.

  However, the 'Do minimum' scenario will be taken forward for further development and costing for the purpose of using it as the baseline scenario for the scheme. This will allow for comparison between the existing situation and the benefits of the various options.
- **Flood Forecasting and Warning** - Flood warning and early warning does not reduce hazard, but generally can reduce risk and can play a significant role in flood defence. Forecasting can reduce risk to human life, but extensive infrastructure damage will still occur. Given the small catchment size and given that Ballyhale is only approximately 1.5km downstream of the watercourse headwaters there is no suitable location far enough upstream to place a gauge which would provide enough warning for the village. Therefore, this option was ruled out during the screening stage. The use of Met Eireann Weather warnings may have some applicability to the inspection and maintenance plans for the overall works.
- **Individual Property Protection** – this scenario is defined as the option involving individual protection in the form of demountable barriers and non-return valves on drains for each of the properties effected by the flood risk in Ballyhale. The current flood paths within the town of Ballyhale are too extensive for the use of individual property protection. Therefore, this option was ruled out during the screening stage.

- **Property Relocation** - this scenario is defined as the relocation of affected properties at flood risk to where there is no flood risk. While this scenario can be beneficial for single properties or a small cluster of properties it is impractical to move a large section of the town of Ballyhale. Therefore, this option was ruled out during the screening stage.
- **Land Use Management** – this scenario is defined as the management of land use to reduce pressure Drainage Systems and direct development to low flood risk areas. While this option can be used to reduce future flood risk, it does not have any effect of the current flood risk in Ballyhale. This is not considered a viable option as it would have minimal effect on the current flood risk. Therefore, this option was ruled out during the screening stage.
- **Overland Flood Paths** – this scenario is defined as the creation of overland flood paths to alleviate the flooding in Ballyhale. This option is not considered viable as one of the current issues is overland flooding of the main street in Ballyhale. There is no feasible overland flood route which would not coincide with existing development. Therefore, this option was ruled out during the screening stage.
- **Rehabilitation of Existing Defences** – this scenario is defined as the inspection and remedial repairs to existing flood defences in Ballyhale. This option is not considered a viable option as there are no current formal flood defences in Ballyhale. Therefore, this option was ruled out during the screening stage.
- **Pumping** – this scenario is defined as the pumping of excess water from the watercourse in Ballyhale to a point further downstream during the design flood event. This would require the construction of a pumping station upstream of the area at risk as well as a channel or piped system to transport the water. The option is not considered a viable option on a main stream channel such as the Ballyhale River as this measure would have significant negative environmental impacts and would have very significant operation and maintenance costs. Therefore, this option was ruled out during the screening stage.
- **"Culverting"** – this scenario is defined as the culverting of the stream through the town of Ballyhale. This option is not considered viable as there are already several culverts on the stream that are causing problems due to structure incapacity. This would require much of the already culverted steam to be removed and replaced with new culverts. Due to the number of culverts required to be replaced and the significant development in the direct vicinity of the stream

this option is not viable. This option would also have significant operational and maintenance costs. Therefore, this option was ruled out during the screening stage.

5 Appraisal of Potentially Viable Options

5.1 Potentially Viable Flood Risk Management Options

Further to the Initial Screening carried out in Section 4 the following options have been taken forward as potentially viable flood risk management options. The implementation of these options will be developed further and are listed below;

- Do Minimum
- Maintenance Programme
- Flow Diversion Structure
- Hard Defences
- Debris Control Measures
- Improvement of Channel Conveyance
- Upstream Storage
- Natural Retention Measures

5.2 Do Minimum

This scenario is defined as involving no new future flood defence works but allows any current maintenance and inspection regimes to continue. This is in order to maintain the existing standard of protection via any existing maintenance schemes. This option is brought forward as a baseline to compare the other Flood Management Options to show the benefits of each viable option.

5.3 Flow Diversion

The “Flow diversion” scenario is the creation of a new channel or culvert to divert excess flood flows from the existing channels. The flow entering the flow diversion would be regulated such that the capacity of the existing watercourse system is not exceeded and therefore a flow diversion structure to redirect flows would be required. It is envisioned that flow would only be directed to the diversion route during extreme floods beyond the capacity of the existing watercourses.

This method would be most applicable to flood mechanisms in the centre of the village which are driven by channel incapacity and restrictions along the watercourse. The flow diversion would seek to remove the excess flow from a point before the flood risk area and safely convey the flow to a suitable downstream location.

The hydraulic analysis undertaken within the hydraulics report has indicated that there is sufficient capacity to convey the 10% AEP (10 year) year peak flow though the village without resulting in property damage. The flow entering the village for this event has

been estimated at approximately 3.34 m^3/s. The estimated peak flow for the design standard 1% AEP (100 year) event is approximately 5.4 m^3/s, therefore the capacity of the Flow Diversion route would be required to be approximately 2.0 m^3/s.

Overland flooding upstream of the village is predicted from both from the main channel and the tributary channel alongside the school. A suitable flow diversion on the main channel would still require works to the tributary channel. Therefore, flow diversion will be considered in combination with other options.

5.4 Hard Defences

The “Hard Defences” option is defined as the creation of physical barriers to prevent flood flows from entering an area. Hard defences are flood walls, embankments, and barrages. A review was carried out to determine the locations required for Hard Defences during a 1% AEP event.

It is considered that hard defences are likely to be appropriate to resolve the overland flow flood mechanisms identified upstream of the village as these appear to be driven by low bank levels along limited portions of the watercourse banks.

The flood mechanisms in the centre of the village are driven by watercourse incapacity issues which result in out of bank flooding into adjacent properties. The affected properties are largely located beyond the eastern bank of the channel and therefore hard defences on the eastern bank may be appropriate to protect these properties. It however noted that constructing new defences in this location would require the demolition and reconstruction of the existing boundaries for approximately 15 properties. Additionally, in a number of locations there are domestic bridges spanning the watercourse to domestic gardens/ land parcels at the other side of the watercourse. These accesses would likely be required to be removed which would sever access to these parcels. It is considered unlikely this significant impact to a large number of properties would be socially acceptable.

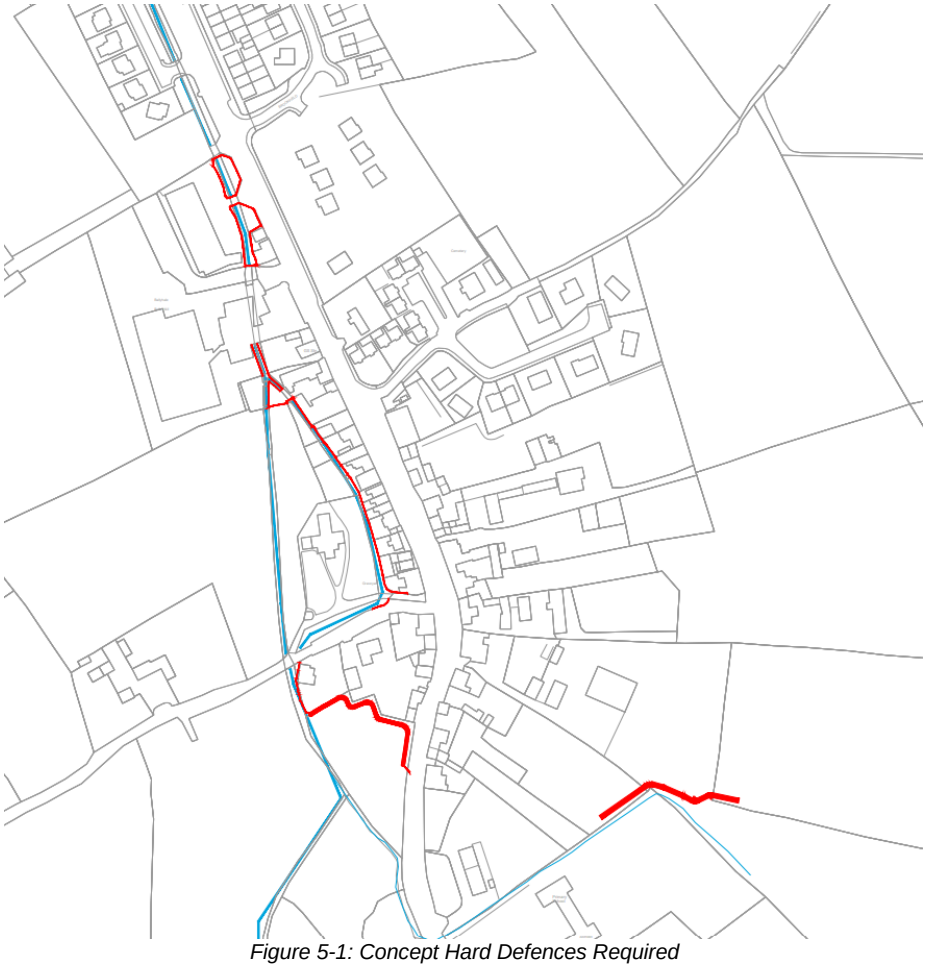

Figure 5-1: Concept Hard Defences Required

Hard defences are therefore considered to have applicability to resolve certain flood mechanisms affecting the village and will be considered in conjunction with other measures.

5.5 Maintenance Program

The “Maintenance Program” option is defined as the creation of an Inspection and Maintenance Regime. The maintenance programme would be a series of regular inspections as well as inspections pre and post storm events along the route of the channel. Remedial and preventative works would be undertaken to maintain existing channel capacity. The measure may also involve minor channel conveyance improvements. Local anecdotal evidence suggests that there were blockages of watercourse structures during previous flood events which have exacerbated flooding.

The aim of the maintenance programme would be to reduce the risk of blockage events within the watercourse channel and structures. The aim would be to engage the community to help in relation to these blockages and alert officials of problems with the watercourse.

With a maintenance program in place the risk of blockage events would be reduced however flood mechanisms exist in Ballyhale in the absence of blockage and thus the maintenance program would not reduce the risk on its own. The program may reduce the residual risk from blockage events. Therefore, this option will be considered in combination with other options.

5.6 Debris Control Measures

Debris Control Measures can take the form of screening devices which aim to capture debris carried in the watercourse in a safe location which minimises flood risk and facilitates easy removal This prevents the debris passing through the watercourse and potentially causing blockage in a critical structure which can drastically impact flood levels and extents. Blockages of the various hydraulic structures that exist on the watercourse are known to have been a mechanism of flooding in the past.

Since the flood risk is present in Ballyhale in the absence of any blockage event this measure will be unsuitable as a standalone measure but may have merits in combination with other measures to reduce residual blockage risk.

5.7 Improvement of Channel Conveyance

The river channel in Ballyhale has a number of culverts, weirs and restrictions which reduce the overall capacity of the channel. The “Improvement of Channel Conveyance” option would seek to remove flow restrictions and increase the flow capacity available within the watercourse system so that the design flow can be accommodated without flooding. This may involve removing or replacing structures affecting capacity, widening the channel, or modifying the channel gradient.

Hydraulic modelling and analysis to date has established a number of capacity constraints. Key constraints include;

- A number of weirs as are present on the watercourse which tend to reduce overall channel gradient and increase flood levels. Removal of weirs would have the potential to increase capacity and reduce flood levels.
- Various minor structures span the watercourse which tend to reduce capacity, increase blockage risk and inhibit maintenance. Removal of structures and reinstatement of natural river corridor morphology will provide a range of benefits where feasible.
- A long culvert is present under the industrial estate which presents a capacity restriction. This also results in fisheries impact and inhibits maintenance. It is noted however that an industrial building is constructed over the line of the

culvert and therefore and works would require the demolition/replacement of the building and the compensation to the owners which is not considered to be economically viable.

- The existing Main St culvert at Hazelbrook is a twin arch structure which presents a capacity restriction and has poor inlet conditions due to a sharp inlet bend and siltation. Major works at this location are restricted since the culvert does not appear to directly cause any property flooding and since the bridge is a National Inventory of Architectural Heritage site.

It is unlikely that conveyance improvements can resolve all flood mechanisms in Ballyhale as a standalone measure however this option will be considered in combination with the other measures.

5.8 Upstream Flood Storage

The Upstream Flood Storage option is defined as the use of areas where flood water can be stored and then safely discharged at a controlled rate. The Upstream Storage involve the construction of a flow control to throttle pass-forward flows such that the capacity of the existing watercourse system downstream is not exceeded. An embankment/dam would be created at the flow control behind which flood waters could be temporarily stored for the period where peak incoming flows exceed the downstream capacity.

The hydraulic analysis undertaken within the hydraulics report has indicated that there is sufficient capacity to convey the 10% AEP (10 year) year peak flow though the village without resulting in property damage. The flow entering the village for this event has been estimated at approximately 3.34 m^3/s. The estimated peak flow for the design standard 1% AEP (100 year) event is approximately 5.4 m^3/s. An estimate of flood storage required has therefore been determined by applying an attenuated profile to the design Q100 inflow hydrograph and determining the volumetric difference between the attenuated and design profile (see Figure 5-2).

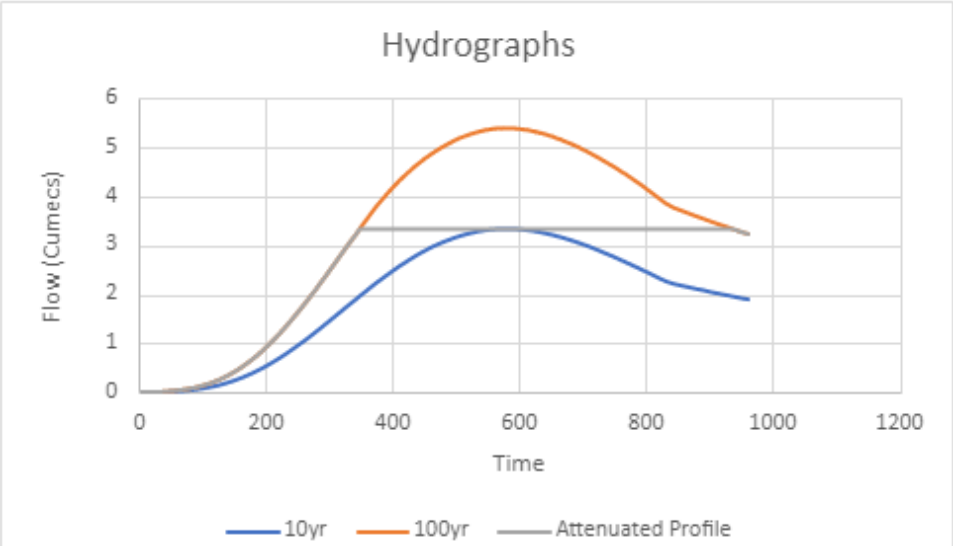

Figure 5-2: Attenuated Hydrograph

The analysis indicates that an attenuation volume in excess of 200,000m³ is required to restrict Q100 flows to the Q10 peak. A review of potential storage locations has been undertaken to establish the viability of accommodating this volume. A defined topographic valley is present on the watercourse upstream of Ballyhale which may represent a suitable location. The storage volume mobilised by an embankment of up to 5m height across this valley has been established by comparison of a simulated water surface against topographic data (see figure below). This indicates that the area identified (approx. 3 ha) would only hold approximately 55,000 m³ and therefore a number of such storage locations would be required along the upstream catchment. The economic, social and environmental impacts of a number of major embankments and flood storage areas would be unacceptable. Additionally there would be significant operation and maintenance requirements of the control structures and also health and safety obligations in relation to impoundment structures. Therefore, this option shall not be considered as part of further option development.

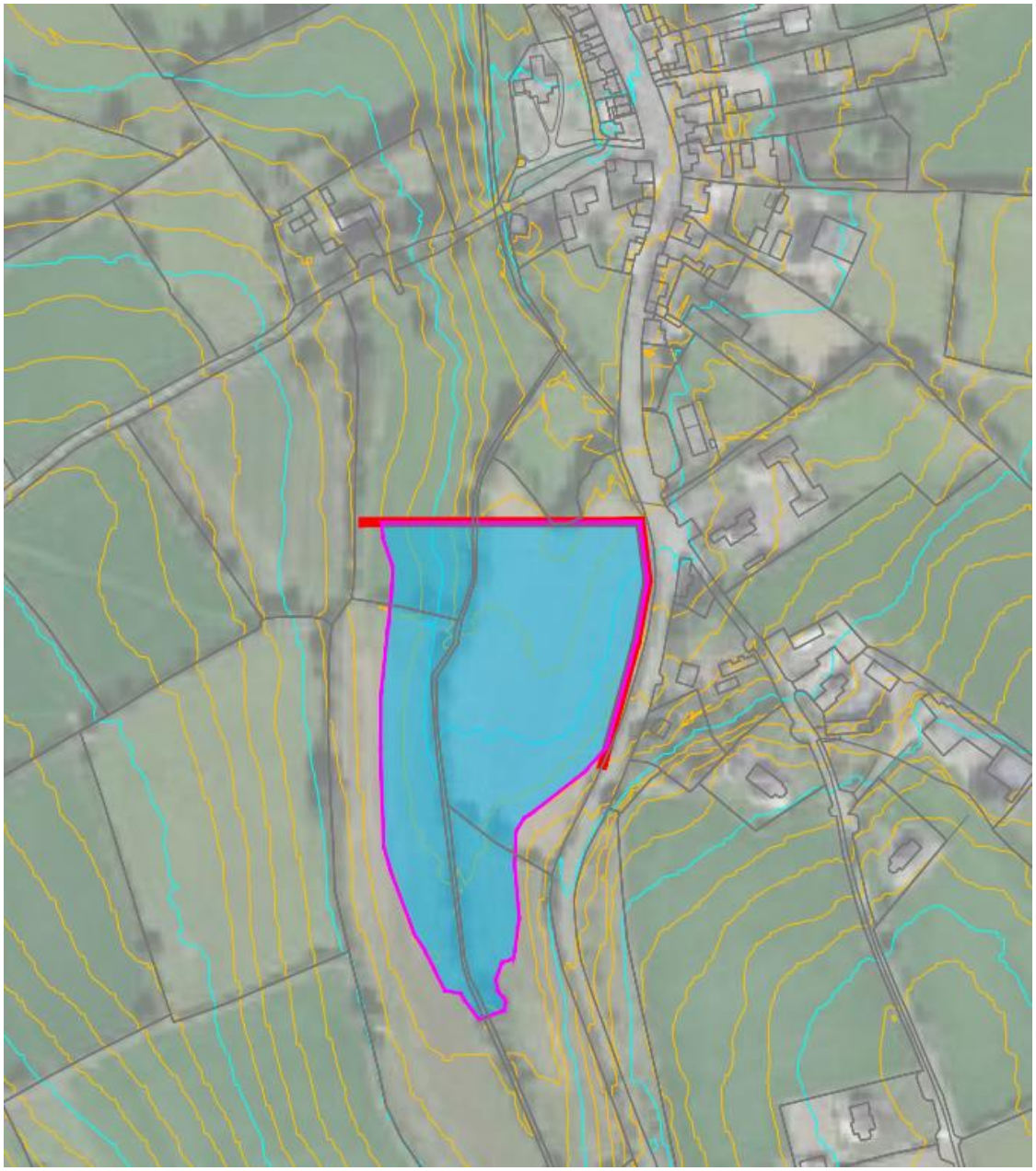

Figure 5-3: Concept Upstream Storage Location

5.9 Natural Retention Measures

The natural retention measures would entail a series of programmes to increase the natural water retention in the surrounding catchment of Ballyhale in order to reduce the peak flow rates such that flood risk is alleviated. In addition to reduction in flood risk, the measures may offer complementary benefits on biodiversity and water quality. Best practice guidance on Natural Retention Measures is included in the Scottish Environmental Protection Agency – Natural Flood Management Handbook.

The following Natural Retention Measures were considered;

1. Land Drainage Channel Modifications - The surrounding catchment area is used for agricultural purposes and this land has a large amount of land drainage channels which drain directly into the Ballyhale River. This method would propose the modification of these land drainage channels to slow down and reduce the peak flows entering the Ballyhale River. This could be achieved with the installation of small barriers within the drainage channels to slow down the flow and reduce the peak flow within the Ballyhale River. This would reduce the effectiveness from an agricultural drainage perspective but would reduce flood rates and volumes.
2. Floodplain Planting – This method would involve the upstream planting of forestry along the floodplain of the river. Floodplain woodlands are thought to offer the greatest potential for downstream flood mitigation, although its value as an Flood Mitigation measure depends on the size of the floodplain.
3. Catchment Woodlands – Woodlands, hedgerows, and trees established with careful placement, can reduce peak runoff at field and small catchment scale, and could therefore make a contribution to slowing flows and reducing peak flows. In addition, woodland planting offers additional co-benefits such as biodiversity, amenity, soil stability, interception & uptake of nutrients and carbon sequestration.
4. Sediment Traps - The catchment that feeds into the Ballyhale River has been heavily modified. Much of the surrounding area has land drainage channels on the agricultural land. There is local anecdotal information that suggests that the siltation is an issue. One way that this could be alleviated is with sediment traps being installed in the land drainage channels to reduce both coarse and fine sediments input to the main channel. This would also help to slow the flows and alleviate the peak flows.
5. River Morphology and Floodplain Restoration – This is most applicable where the existing morphology of the river has been changed. The greatest potential to alter morphology is upstream of the village in agricultural lands however the channel does not appear to have been subject to historical changes or modification in this area. The Watercourses is heavily modified though the village however the presence of existing development does not allow the recreation of floodplain in this area.
6. Non-floodplain wetlands – This would involve the creation of wetlands outside of the existing floodplain as a way of slowing and storing flood water.

7. Instream Structures – These structures would aim to create areas of natural water retention and slow down the water flow through overland flooding. Instream structures are typically locally derived as cut timber from large trees. Wooden structures can be designed with varying levels of complexity ranging from one or two pieces of wood located across a channel to dozens of stacked logs secured to the riverbank.

It is noted that the majority of these measures need to be implemented at catchment scale and therefore require a high level of public buy-in and engagement across large number of landowners. Many measures also require a significant land take which can be at the expense of agricultural land use. It is also noted that many measures require a number of years of establishment before the effects on flood flows are realised (forestry, wetlands etc).

Land management and its impact on flood risk is currently an active topic of research in academic and government sectors. Detailed validation data to determine the specific impact of individual land management changes across a catchment are not currently available. Established approaches which can be reliably applied to current hydrological and hydrological modelling techniques to reflect land management changes are also not currently available.

In light of the above, Natural Retention Measures shall not be progressed as part of the primary measures for flood relief in Ballyhale.

There may be opportunities to separately implement pilot studies for certain measures within the Ballyhale catchment given its relatively small size and upstream agricultural land use. Should this be progressed, it would be recommended that baseline flow and rainfall monitoring be established in advance of the measures being implemented to determine the current rainfall-response profile. Then data could continue to be collected during the establishment and operation of the measures to quantify the impact of the measures. This data may be useful for future schemes.

6 Design Considerations

6.1 Design Standard

The design standard for this study is the 1% AEP event for fluvial flood risk. The options shall also be assessed for climate change adaptability.

6.2 Freeboard

Freeboard is a safety margin to account for uncertainties in water-level prediction and/or structural performance. It is the difference between the height of the flood defence or floor level and the design flood level. Freeboard should account for uncertainty in hydrological predictions, wave action, modelling accuracy, topographical accuracy and the quality of digital elevation models.

The OPW standard freeboard allowance is 0.3m for hard defences and 0.5m for soft defences. This allowance shall be applied to new defences at a minimum and is appropriate for most situations.

Increased freeboard may be applied at certain locations or in certain options based on professional judgement in response to specific conditions (for example a location with a higher risk or sensitivity to culvert blockage). Where additional freeboard allowances are proposed, it shall be described in the option summary.

6.3 Climate Change Adaptability

In the development of options, it is required that the proposals represent solutions which are flexible and can be adapted to the changes in the climate and its potential impact on flood risk over the course of its lifetime.

The options have been developed taking consideration the following allowances for future scenarios.

Table 6-1: Allowances for Future Scenarios

	MRFS	HEFS
Extreme Rainfall Events	+ 20%	+ 30%
Flood Flows	+ 20%	+ 30%
Mean Sea Level Rise	+ 500 mm	+ 1000 mm

Climate Change Adaptability of each option is considered within the Multi Criteria Analysis under the Technical category.

7 Development of Flood Risk Management Options

7.1 Prerequisite Measures for all Options

Due to the nature of the Flooding within Ballyhale there are elements of works which will be required for all flood options.

The first element of work is in relation to the tributary channel that is fed from the land drainage channels in agricultural lands and flows past the school and into the Ballyhale River upstream the town. 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 resulting in an overland flow path flowing down 'Sheff's Lane' that emerges onto the Main Street. Hard defences have been identified as the most appropriate measure to resolve this flooding. It is envisioned that this will take the form of localised land raising/embankments largely following existing agricultural tracks and accesses. Total depths of embankments anticipated at this location are quite low (approx. 0.3m- 0.7m). Complementary works will include clearance of overgrown vegetation within watercourse channels to maintain channel capacity and reduce blockage risk.

The second element of work which is required on all options is in relation to the flooding originating upstream from the town. Flood modelling indicates that flow over the eastern bank 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. Hard defences have been identified as the most appropriate measure to resolve this flooding. It is envisioned that this will take the form of an embankment with approximate height of 1m located to the rear of the properties affected by the flood route. This will cut off the overland flow path and redirect water to the main channel. An alternative location for this embankment would be directly alongside the main channel however this would not utilise the existing (minor) flood storage volume within the agricultural lands.

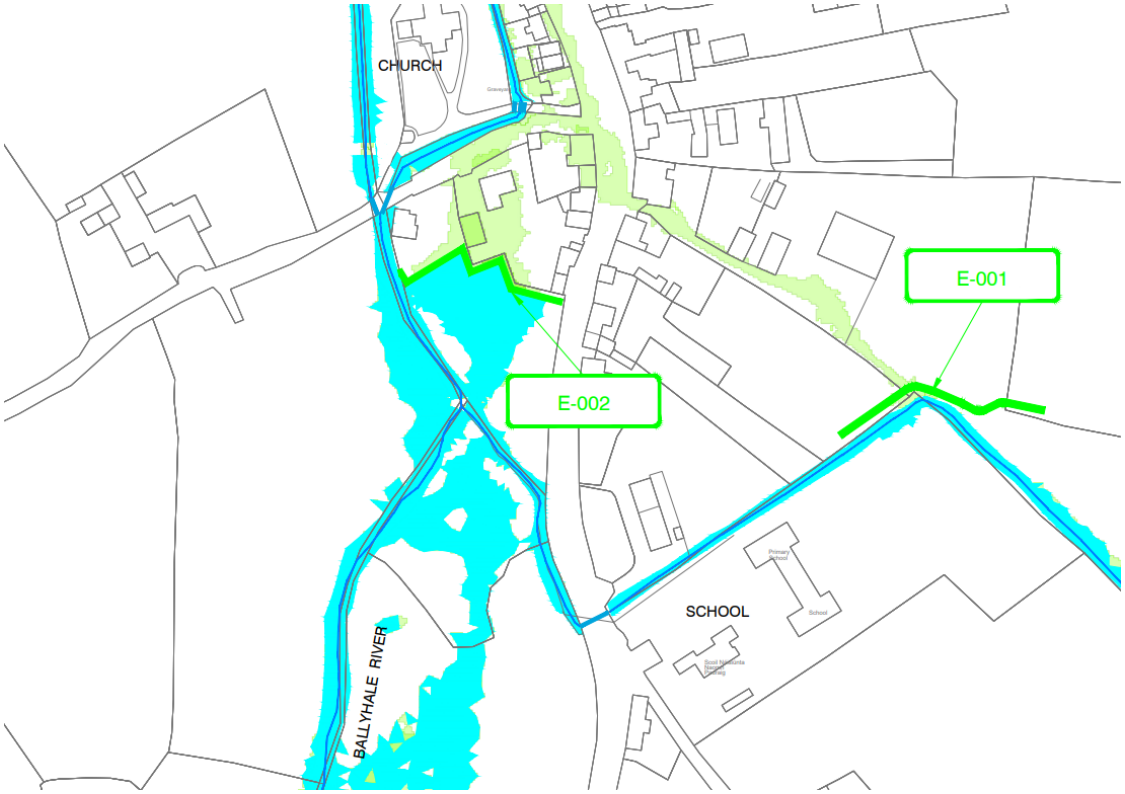

Figure 7-1: Concept Layout – Upstream Embankments (All Options)

7.2 Option A

Option A consists of a range of interventions along the watercourse reach. The general intent of Option A is to enhance the flow capacity and level of defence through the town so that the design flows can be conveyed through the town without causing property flooding.

It seeks to remove the existing flow split at the church and direct all flow to the open channel western branch. This removes flow from the heavily modified and under capacity eastern channel which is adjacent to a number of at-risk properties. It allows a continuous flood defence to be provided between all river flows and the at risk properties.

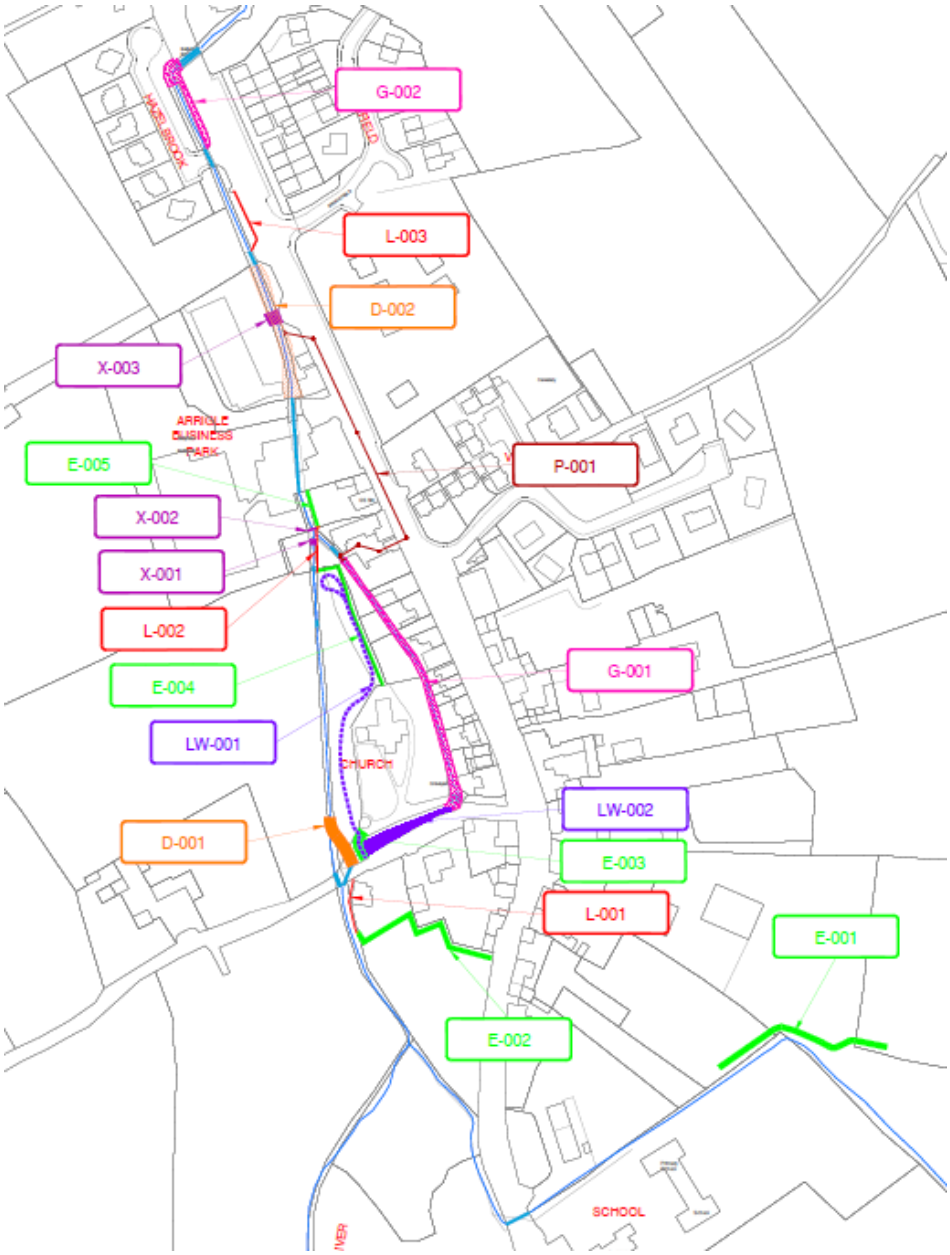

Figure 7-2: Concept Option A Layout (Refer to Appendix A for Additional Info)

A drawing showing the proposed option is included in Appendix A. A Summary figure is presented above and a high-level text summary of the primary measures in this option is presented below;

- Upstream embankments (E-001 & E-002) are provided to resolve overland flood routing issues as per Section 7.1
- A new Channel will be created (D-001) re-connecting all outlet barrels from the bridge into the western river branch and removing the flow split. This will require excavation of the existing church pedestrian access and replacement via a new pedestrian connection (E-003) which also serves to form a new bank to the redirected stream.
- Flood Defences (E-005, L-002, E-006) will be created where required between the western channel (which now carries all flow) and the properties at risk on Main St. It is anticipated the land acquisition for E-005 will require some landscaping works (LW-001) which may facilitate the provision of a public riverside walkway.
- X-001 is one of two existing minor private bridges providing access across the river to a small private land parcel. Providing the continuous defence L-002 would partially block off one side of this bridge affecting its use. Leaving a gap in the defence at the bridge would provide a potential flood route from the opposite side, over the bridge deck and through the flood defences. Therefore it is proposed to remove this bridge. Access to the parcel will be maintained by retrofitting the second bridge with a slightly increased deck level (to flood defence level) along with steps/ramps as needed. Removal of the structure also increases channel capacity and removes a potential blockage risk
- The existing weir at the Ballyhale Business Park will be removed (X-003) 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.
- X-002 is a wall spanning the watercourse which serves no function other than boundary demarcation. It will be removed to facilitate the installation of the new flood defences. Removal of the structure also increases channel capacity and removes a potential blockage risk
- A low wall (L-003) is proposed alongside the road to prevent out of bank flows emerging onto the road surface.

- Minor works will be carried out at the existing Main St bridge (G-002) to improve inlet conditions.
- Following reconnection of the flow split, the channel of the eastern branch will have a significantly reduced inflow and will serve a local drainage function only. The channel has a very wide cross section in front of the church (circa 8m width) which is prone to overgrowth and siltation even in the existing flow situation. It is envisioned that that this area will require landscaping works to allow for a low maintenance channel (LW-002).
- The remainder of the channel runs alongside and through a number of properties. In light of the reduced inflow, it is proposed to line with clean stone and create a low flow channel to aid maintenance (G-001)

A number of considerations beyond the design standard are considered appropriate in this option.

- A low wall (L-001) is proposed alongside the “Arrigle View” property on Church Lane. Although this property is not anticipated to flood in the baseline scenario, hydraulic modelling indicates that a flow route though and around this property would be anticipated in the event of a blockage of the adjacent bridge. Therefore, providing a defence at this location reduces residual risk to this property and to downstream properties which may be affected by the overland flow. The height of this wall shall be set to retain the flood level associated with a 50% blockage event of the adjacent bridge. Since this bridge is the first structure downstream of a significantly vegetated catchment it is considered at a higher risk of blockage.
- It is proposed to increase the freeboard for defences E-005, L-002 & E-006 such that they would retain the flood level associated with a 50% blockage of the long culvert under Arrigle Business Park. This culvert is considered to have a higher risk of blockage to the length of the culvert, the change in cross section though the barrel and the level of visibility.

7.3 Option B

Option B aims to create an overflow diversion channel to provide a bypass route for flows in excess of the existing flow capacity though the village. It diverts the flow around the village and discharges to the Little Arrigle River. This option is similar to what was proposed in the original CRFAM Options report however the route has been amended to avoid the GAA grounds due to unacceptable social/cultural impacts.

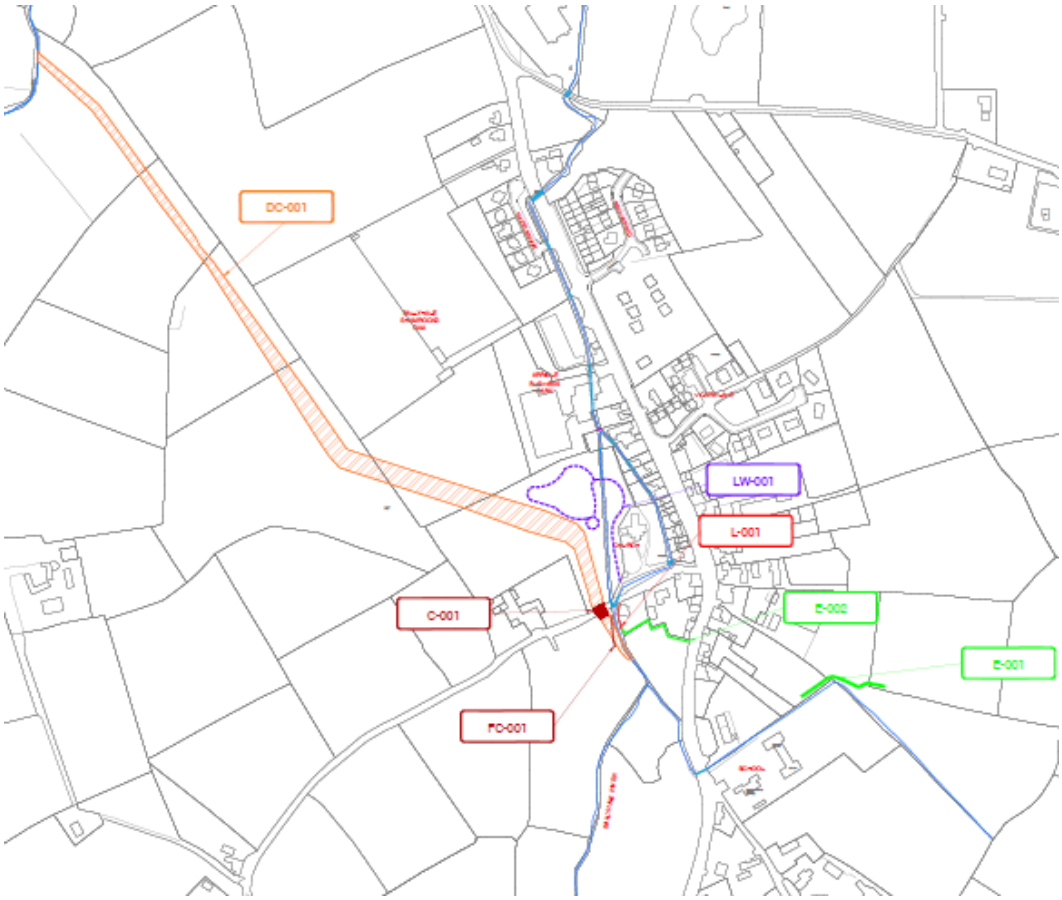

Figure 7-3: Concept Option B Layout (Refer to Appendix A for Additional Info)

A drawing showing the proposed option is included in Appendix A. A Summary figure is presented above and a high-level text summary of the primary measures in this option is presented below;

- Upstream embankments (E-001 & E-002) are provided to resolve overland flood routing issues as per Section 7.1
- A new Flow Channel (DC-001) will be created from the Ballyhale River to a discharge point on the Little Arrigle. It is noted that topography between the two points in not conducive to a gravity channel as the ground rises significantly as the route moves west to avoid the existing receptors in the

village such as the existing GAA and business parks. It is anticipated that the channel will be required to cut to depths of approximately 5.5m resulting into overall channel dimensions of up to 25m wide. Given the shallow bedrock present in the areas significant rock excavation would also be anticipated which would require the use of heavy rock breakers or blasting.

- The flow entering the flow diversion channel would be regulated such that the capacity of the existing watercourse system is not exceeded and therefore a flow diversion structure (FC-001) to redirect flows would be required. It is envisioned that flow would only be directed to the diversion route during extreme floods beyond the capacity of the existing watercourses.
- The hydraulic analysis undertaken within the hydraulics report has indicated that there is sufficient capacity to convey the 10% AEP (10 year) year peak flow though the village without resulting in property damage. The flow entering the village for this event has been estimated at approximately 3.34 m^3/s. The estimated peak flow for the design standard 1% AEP (100 year) event is approximately 5.4 m^3/s, therefore the capacity of the Flow Diversion route would be required to be approximately 2.0 m^3/s.
- A new culvert (C-001) would be required on Chapel Lane.
- It is anticipated the land acquisition will require some landscaping works (LW-001).
- It is noted that this option request in diversion of flow to a different watercourse (Little Arrigle) upstream of its current discharge point. The Little Arrigle is designated as an SAC at this location.
- A low wall (L-001) is proposed alongside the “Arrigle View” property on Church Lane associated with the flow diversion structure (FC-001)

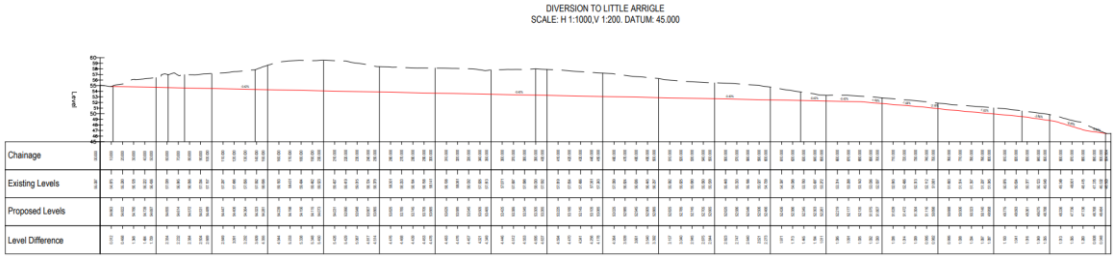

Figure 7-4: Option B Concept Longitudinal Section showing existing and proposed levels

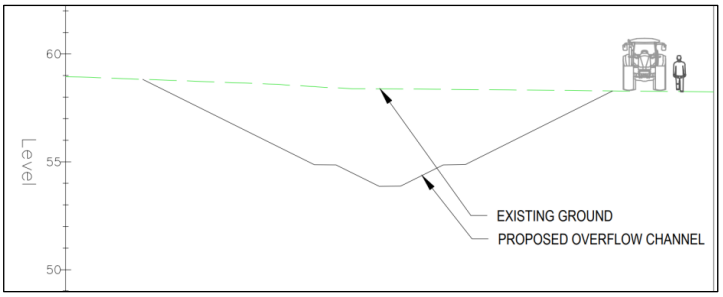

Figure 7-5: Concept Cross Section in deep cut section showing existing and proposed levels

7.4 Option C

Option C aims to create an overflow diversion channel to provide a bypass route for flows in excess of the existing flow capacity though the village. It diverts the flow around the village and discharges back into the Ballyhale River downstream of the village.

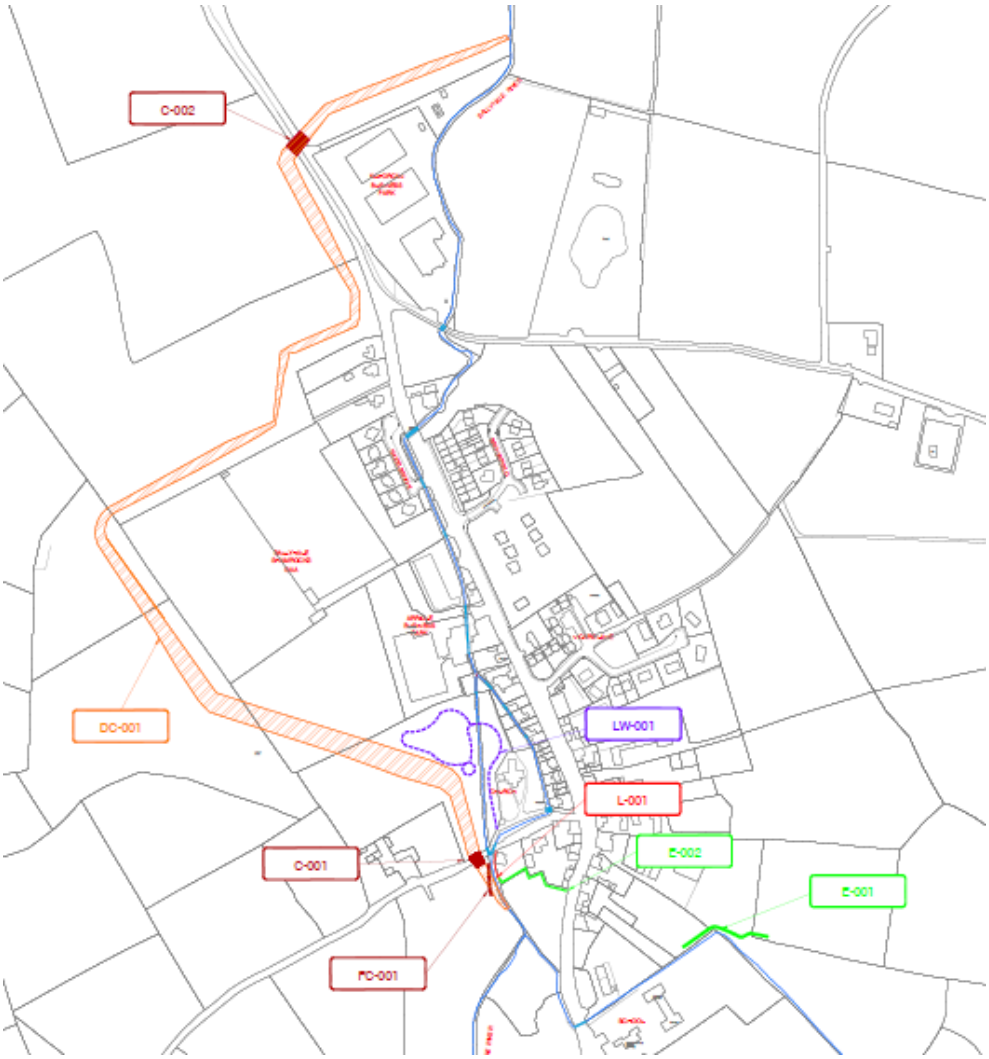

Figure 7-6: Concept Option C Layout (Refer to Appendix A for Additional Info)

A drawing showing the proposed option is included in Appendix A. A Summary figure is presented above and a high-level text summary of the primary measures in this option is presented below;

- Upstream embankments (E-001 & E-002) are provided to resolve overland flood routing issues as per Section 7.1
- A new Flow Channel (DC-001) will be created from the Ballyhale River to a discharge point on the Ballyhale River Downstream of the Village. It is noted that topography between the two points in not conducive to a gravity channel as the ground rises significantly as the route moves west to avoid the existing receptors in the village such as the existing GAA and business parks. It is anticipated that the channel will be required to cut to depths of approximately 5.5m resulting into overall channel dimensions of up to 25m wide. Given the shallow bedrock present in the areas significant rock excavation would also be anticipated which would require the use of heavy rock breakers or blasting.
- The flow entering the flow diversion channel would be regulated such that the capacity of the existing watercourse system is not exceeded and therefore a flow diversion structure (FC-001) to redirect flows would be required. It is envisioned that flow would only be directed to the diversion route during extreme floods beyond the capacity of the existing watercourses.
- The hydraulic analysis undertaken within the hydraulics report has indicated that there is sufficient capacity to convey the 10% AEP (10 year) year peak flow though the village without resulting in property damage. The flow entering the village for this event has been estimated at approximately 3.34 m^3/s. The estimated peak flow for the design standard 1% AEP (100 year) event is approximately 5.4 m^3/s, therefore the capacity of the Flow Diversion route would be required to be approximately 2.0 m^3/s.
- A new culvert (C-001) would be required on Chapel Lane and a another would be required (C-002) on the R448.
- It is anticipated the land acquisition will require some landscaping works (LW-001).
- A low wall (L-001) is proposed alongside the “Arrigle View” property on Church Lane associated with the flow diversion structure (FC-001)

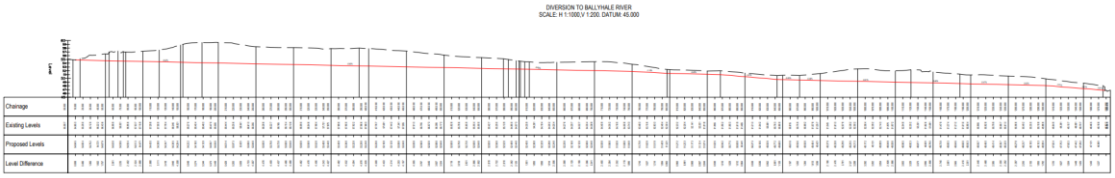

Figure 7-7: Option B Concept Longitudinal Section showing existing and proposed levels

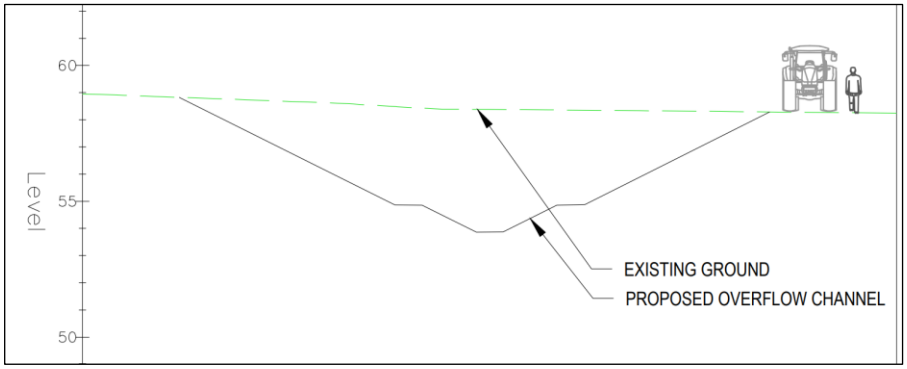

Figure 7-8: Concept Cross Section in deep cut section showing existing and proposed levels

7.5 Option D

Option D aims to create an overflow diversion pipe to provide a bypass route for flows in excess of the existing flow capacity though the village. It diverts the flow through a new pipe along the main street and discharges back into the Ballyhale River downstream of the village.

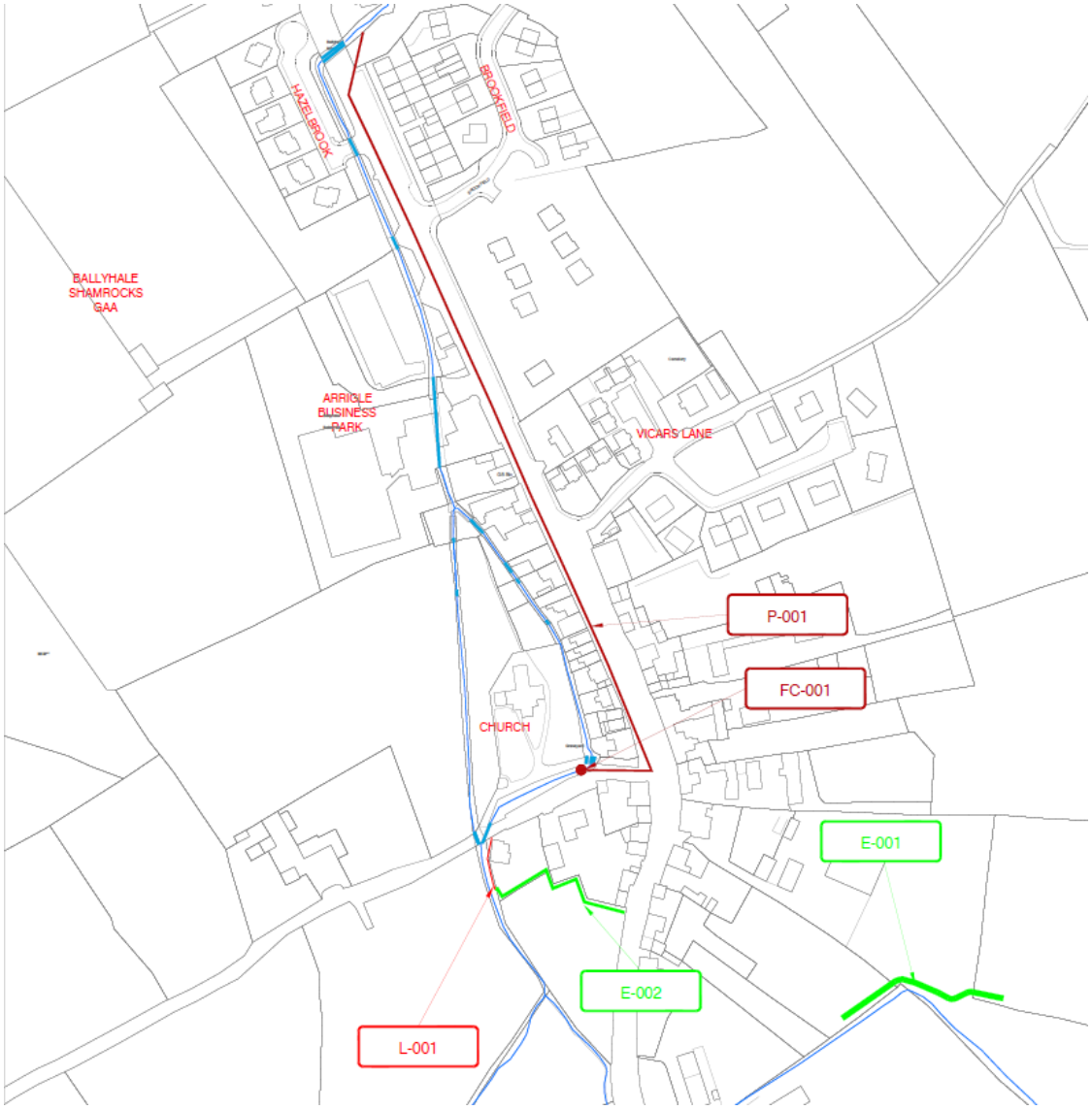

Figure 7-9: Concept Option D Layout (Refer to Appendix A for Additional Info)

A drawing showing the proposed option is included in Appendix A. A Summary figure is presented above and a high-level text summary of the primary measures in this option is presented below;

- Upstream embankments (E-001 & E-002) are provided to resolve overland flood routing issues as per Section 7.1
- A new Piped Route (P-001) will be created from the Ballyhale River to a discharge point on the Ballyhale River Downstream of the Village. Given the capacity requirements it anticipated that this pipe would need to be a minimum of 1050mm diameter along most of the route. In the lower stages of the route there is restrictions on pipe gradient and available depth of cover from the carriageway and therefore it would need to transition to a box culvert section for the last approx. 150m.
- The flow entering the diversion pipe would be regulated such that the capacity of the existing watercourse system is not exceeded and therefore a flow diversion structure (FC-001) to redirect flows would be required. It is envisioned that flow would only be directed to the diversion route during extreme floods beyond the capacity of the existing watercourses.
- The hydraulic analysis undertaken within the hydraulics report has indicated that there is sufficient capacity to convey the 10% AEP (10 year) year peak flow though the village without resulting in property damage. The flow entering the village for this event has been estimated at approximately 3.34 m^3/s. The estimated peak flow for the design standard 1% AEP (100 year) event is approximately 5.4 m^3/s, therefore the capacity of the Flow Diversion route would be required to be approximately 2.0 m^3/s.

8 Multi Criteria Appraisal (MCA) Methodology

In order to arrive at the preferred option, the Potentially Viable Options have been assessed against the National 'CFRAM' Programme Flood Management Objectives and are assigned scores. The options are already assessed for its Applicability to Relevant Area and have thus been brought forward and the remaining objectives are defined under four categories.

1. Social
2. Economic
3. Environmental
4. Technical

8.1 Social Objectives

In considering the social dimension during the screening process, outcomes of consultation processes previously undertaken are considered, along with the application of professional judgement and experience in relation to the Social Objectives. These objectives are;

1. Minimize the risk to human health and life.
    a. Minimize risk to human health and life of residents.
    b. Minimize risk to high vulnerability properties.
2. Minimize the risk to the community.
    a. Minimize risk to social infrastructure and amenity.
    b. Minimize risk to local employment.

8.2 Economic Objectives

While the screening process is an indicative appraisal, it will make use of available information. The economic risk assessment undertaken will provide an envelope of potential economic benefits. On the basis, an indicative benefit – cost ratio for a method, in isolation or potential combination with other methods, can be determined. In assessing the potential benefits of a method, the standard of protection and the effectiveness of the method in reducing risk are considered in relation to the Economic Objectives. These objectives are;

1. Minimize the economic risk,
2. Minimize the risk to transport infrastructure,
3. Minimize the risk to utility infrastructure.
4. Minimize the risk to agriculture.

8.3 Environmental Objectives / Cultural Objectives

The environmental screening made use of the SEA scoping and the other environmental assessment work done for the Ballyhale Flood Assessment. Screening considered the degree of detrimental impact on the site, the scope for mitigation and whether there are apparently viable and acceptable alternative approaches available in relation to the Environmental Objectives. These objectives are;

1. Support the objectives of the WFD
    a. Provide no impediment to the achievement of water body objectives and, if possible, contribute to the achievement of water body objectives.
2. Support the objectives of the Habitats Directive
    a. Avoid detrimental effects to, and where possible enhance, Natura 2000 network, protected species and their key habitats, recognizing relevant landscape features and stepping stones.
3. Avoid damage to, and where possible enhance, the flora and fauna of the catchment.
    a. Avoid damage to or loss of, and where possible enhance, nature conservation sites and protected species or other know species of conservation concern.
4. Protect and where possible enhance fisheries resource within the catchment,
    a. Maintain existing, and where possible create new, fisheries habitat including the maintenance or improvement of conditions that allow upstream migration for fish species.
5. Protect and where enhance landscape character and visual amenity within the river corridor
    a. Protect, and where possible enhance, visual amenity, landscape protection zones and views into / from designated scenic areas
6. Avoid damage to or loss of features institutions and collections of cultural heritage importance and their setting.
    a. Avoid damage to or loss of features, institutions and collections of architectural value and their setting.
    b. Avoid damage to or loss of features, institutions and collections of archaeological value and their setting.

8.4 Technical Objectives

In considering the technical objectives, options are screened to ensure that the options are operationally robust, are minimized for health and safety risk and that the options are adaptable to future flood risk and the potential impacts of climate change. These objectives are;

1. Ensure flood risk management options are operationally robust,
2. Minimize health and safety risks associated with the construction, operation, and maintenance of flood risk management options,
3. Ensure flood risk management options are adaptable to future flood risk, and the potential impacts of climate change.

8.5 Basic Requirements and Aspirational Targets

The objectives are termed as general aims for the management or reduction of flood risk, or for the other benefits that can be accrued through the implementation of flood risk management measures. The Basic Requirements and Aspirational Targets are set in terms of defined indicators through both global and local weighting set for the Flood Risk Management Objectives.

Each Flood Risk Management Objective has a Basic Requirement and Aspirational Target associated with it. An option that meets the basic requirement is given a score of zero and an option that reaches the Aspirational Target is given the full local weighting as per the 'National CFRAM Programme – Technical Methodology Note – Option Appraisal and Multi-Criteria Analysis (MCA) Framework'. The Basic Requirement is not an absolute minimum requirement for acceptability, but a benchmark to define positive versus negative impacts or performance associated with each flood management option.

8.6 Global Weights

Global Weightings are assigned to each objective to give it more or less weight in the overall assessment of the suitability or value of the option. The Global Weightings are fixed nationally to ensure a consistent approach and basis for prioritisation and are intended to represent the 'societal value' for the objective relative to the others, i.e., with those of most weight representing the most important objectives, and have been based on public consultation.

8.7 Local Weights

The Local Weightings are assigned to each objective for each location under consideration (i.e., each SSA), and are intended to represent the local importance of that objective within the local context.

Local Weightings for some objectives are numerically determined according to the degree of risk (e.g., economic annual average damages, number of properties, etc.), but for some others are set by professional judgement. In both instances however, the assignment took into account local knowledge provided at the stakeholder and public consultation events.

CRITERIA		OBJECTIVE		SUB-OBJECTIVE		GLOBAL WEIGHTING	LOCAL WEIGHTING
1	Social	A	Minimise risk to human health and life	i	Minimise risk to human health and life of residents	27	3.12
				ii	Minimise risk to high vulnerability properties	17	2.5
		B	Minimise risk to community	i	Minimise risk to social infrastructure and amenity	9	5
				ii	Minimise risk to local employment	7	1
2	Economic	A	Minimise economic risk	i	Minimise economic risk	24	2.56
		B	Minimise risk to transport infrastructure	i	Minimise risk to transport infrastructure	10	2.75
		C	Minimise risk to utility infrastructure	i	Minimise risk to utility infrastructure	14	1
		D	Minimise risk to agriculture	i	Minimise risk to agriculture	12	3
3	Environmental	A	Support the objectives of the WFD	i	Provide no impediment to the achievement of water body objectives and, if possible, contribute to the achievement of water body objectives.	16	5
		B	Support the objectives of the Habitats Directive	i	Avoid detrimental effects to, and where possible enhance, Natura 2000 network, protected species and their key habitats, recognising relevant landscape features and stepping stones.	10	5
		C	Avoid damage to, and where possible enhance, the flora and fauna of the catchment	i	Avoid damage to or loss of, and where possible enhance, nature conservation sites and protected species or other know species of conservation concern.	5	3
		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.	13	4
		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	8	1
		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.	4	2
				ii	Avoid damage to or loss of features, institutions and collections of archaeological value and their setting.	4	2
4	Technical	A	Ensure flood risk management options are operationally robust	i	Ensure flood risk management options are operationally robust	20	5
		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	20	5
		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	20	5

8.8 MCA Scoring Method

A total weighted score was then calculated for each objective as the sum of the weighted scores across the 15 flood risk management objectives. This MCA score reflected the performance of the option in terms of the study's objectives.

The weighted score was calculated as follows:

WS = (GW x LW) x S

Where:

- WS = Weighted Score

- GW = Global Weighting

- LW = Local Weighting

- S = Score

The total MCA score was the sum of the scores for each objective.

The detailed MCA assessment is included in Appendix C.

8.9 MCA Outputs

1. Criteria Score: Once the MCA has been applied, each option will have a weighted score for each objective. For each option, the scores for each of the four criteria are summed to provide the Criteria Score.
2. MCA Benefit Score: The scores for the Economic, Social and Environmental Criteria Scores are summed to derive the MCA Benefit Score. The score represents the net benefits of the option.
3. Option Selection MCA Score: The scores for all four of the criteria are summed to get the Option Selection MCA Score. The 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.
4. MCA Benefit – Cost Ratio: The MCA Benefit Score is divided by the cost of the option to provide a numerical, but non-monetarised, MCA Benefit – Cost Ratio that provides an indication of the overall benefits that can be delivered.
5. Economic Benefit – Cost Ratio: The Economic Benefit is calculated using the FHRC Multi-Coloured Manual.

9 MCA Option Scoring

9.1 Social

The Social scores were derived from the number of social infrastructure receptors affected by flooding, and the highest probability (lowest magnitude) of flood event that causes flooding for each of the social objectives as set out in the OPW MCA Methodology. Each of the options was scored individually on its ability to reduce flooding in relation to these social objectives with 5 denoting that flooding had been removed and 0 denoting that the flooding remained once the option had been put in place.

A full summary of the scores and weighting associated with each option is set out in Appendix B. A summary table of the scores is shown in Table 9-1 Social Scores.

Since all options are anticipated to resolve all flooding to social receptors all options received the same scoring.

Table 9-1 Social Scores

CRITERIA		OBJECTIVE		SUB-OBJECTIVE		TOTAL OBJECTIVE WEIGHTING	OPTION SCORING			
							OPTION A	OPTION B	OPTION C	OPTION D
1	Social	A	Minimise risk to human health and life	i	Minimise risk to human health and life of residents	84.18	5	5	5	5
				ii	Minimise risk to high vulnerability properties	42.5	5	5	5	5
		B	Minimise risk to community	i	Minimise risk to social infrastructure and amenity	45	5	5	5	5
				ii	Minimise risk to local employment	7	5	5	5	5

9.2 Economical

The Economic Scores were set for the total Average Annual Damages as well as the various Transport Infrastructure, Utility Infrastructure and Agricultural Land impacted by the flooding within the Study Area. Each of the options was scored on its ability to reduce the flooding impact in relation to the objectives set through the OPW MCA Methodology with 5 denoting that flooding had been removed and 0 denoting that the flooding remained once the option had been put in place.

Since all options are anticipated to resolve all flooding to economic receptors all options received the same scoring.

A full summary of the scores and weighting associated with each option is set out in Appendix B. A summary table of the score is shown in Table 9-2 Economic Scores.

Table 9-2 Economic Scores

CRITERIA		OBJECTIVE		TOTAL OBJECTIVE WEIGHTING	OPTION SCORING			
					OPTION A	OPTION B	OPTION C	OPTION D
2	Economic	A	Minimise economic risk	61.38	5	5	5	5
		B	Minimise risk to transport infrastructure	22.5	5	5	5	5
		C	Minimise risk to utility infrastructure	14	5	5	5	5
		D	Minimise risk to agriculture	36	5	5	5	5

9.3 Environmental

The Environmental Scores were set to show the level of environmental and cultural heritage within the study area. The options were scored on the impact to environmental aspects or improvements to these aspects as set out in the OPW MCA Methodology.

A full summary of the scores and weighting associated with each option is set out in Appendix B. A summary table of the score is shown in Table 9-3 Environmental Scores.

Table 9-3 Environmental Scores

CRITERIA		OBJECTIVE			TOTAL OBJECTIVE WEIGHTING	OPTION SCORING			
						OPTION A	OPTION B	OPTION C	OPTION D
3	Environmental	A		Support the objectives of the WFD	80	-1	-3	-2	-2
		B		Support the objectives of the Habitats Directive	50	-1	-3	-3	-2
		C		Avoid damage to, and where possible enhance, the flora and fauna of the catchment	15	1	-4	-3	-1
		D		Protect, and where possible enhance, fisheries resource within the catchment	52	0	-4	-3	-4
		E		Protect, and where possible enhance, landscape character and visual amenity within the river corridor	8	0	-4	-4	-1
		F	i	Avoid damage to or loss of features, institutions and collections of architectural value and their setting.	8	1	1	1	1
			ii	Avoid damage to or loss of features, institutions and collections of archaeological value and their setting.	8	1	1	1	1

9.4 Technical

The Technical Scores are set at a standard value by the OPW through Guidance Documentation in relation to each of the Technical Objectives. Each of the options was scored in relation to each of these objectives and their ability to meet the criteria set out through the MCA.

A full summary of the scores and weighting associated with each option is set out in Appendix. A summary table of the score is shown in Table 9-4 Technical Scores.

Table 9-4 Technical Scores

CRITERIA		OBJECTIVE		TOTAL OBJECTIVE WEIGHTING	OPTION SCORING			
					OPTION A	OPTION B	OPTION C	OPTION D
4	Technical	A	Ensure flood risk management options are operationally robust	100	4	5	5	3
		B	Minimise health and safety risks associated with the construction, operation, and maintenance of flood risk management options	100	3	2	2	2
		C	Ensure flood risk management options are adaptable to future flood risk, and the potential impacts of climate change	100	3	4	4	0

10 Cost Benefit Analysis

A high-level assessment of Scheme Benefit and Initial Option costing is presented in the report for the purposes of option appraisal. Refer to the Project Cost Benefit Analysis Report for detailed information on calculation of baseline damages, assessment of benefit and costing of the preferred option.

10.1 Calculation of Scheme Benefit

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

Refer to the Project Cost Benefit Analysis Report for detailed information on calculation of baseline damages. A summary of flood event damages is presented in Table 10-1.

Table 10-1 Baseline Flood Damages

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	€ 4,696,971.36	€ 8,660,426.26
No. Residential Properties at Risk	1	20	33
No. business Properties at risk	0	8	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

For the design standard event 1% AEP the Capped Present Value of Damages (PVd) is therefore **€4,696,971**. All proposed options are predicted to entirely remove property damages in the study area for the design event, therefore the scheme benefits PVb for all options can be considered equal to the damages value.

10.2 Cost Estimate of Options

At options assessment stage a high-level option costing has been carried out in order to provide a comparative assessment of option costs.

These cost estimates have 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 Cost Estimate
- Construction Preliminaries (20%)
- Allowance for Environmental Mitigation Measures (5%)
- Construction Contingency (10%)
- Land Acquisition, Legal & Compensation Costs (15%)
- Detailed Design and Site Supervision Costs (10%)
- Allowance for optimism bias (30%)
- Operation & Maintenance Costs (1% of Total Capital Cost)

Key exclusions for the cost estimates include.

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

Additional detail on option costing methodologies is included in the Cost Benefit Analysis report.

A summary of option costing is presented below, option costing has been rounded to the nearest €100,000 to reflect the early stage of design information available.

- Option A is anticipated to have the lowest cost by virtue of the limited scale of civil works in comparison to other options. It is anticipated to have some significant costs associated with public realm and reinstatement works in the vicinity of the church channel.
- Options B and C have high costs associated with the large earthworks and rock cut quantities associated with cutting open channels against the natural topography.
- Option D has relatively high cost associated with constructing a large diameter pipe/culvert down an existing public road.

Option	Approximate PV Cost
A	€1,800,000
B	€2,500,000
C	€3,300,000
D	€2,100,000

11 Selection of Preferred Option

The selection stage follows the below process:

- Obtain MCA and economic scores for each option
- Provide a comparison of the options using the MCA and economic scores
- Make a recommendation on the preferred option.

11.1 Summary of Option Scoring

11.1.1 Option A

Option A - Hard Defences and Conveyance Improvements – This option scored high in the Social and Economic Criteria Scores due to it removing the flood risk from the study area.

This option scored high in the environmental objectives relative to the other options due to its low impact on the surrounding landscape and habitats. However, it still would have a temporary negative impact within the stream due to construction elements.

This option scored high in the Technical Criteria as the works are readily adaptable at moderate cost to address potential future flood risk areas with the flood walls and embankments being designed to permit extension in height to maintain a standard of protection to address potential future flood risk areas. A summary of the scores is shown in Table 11-1 MCA Scores Option A.

Table 11-1 MCA Scores Option A

Multi-Criteria Analysis - Flood Relief Scheme Ballyhale			
Option:	**Option A - Hard Defences and Conveyance Improvements**		
Criteria Scores			
Social	**Economical**	**Environmental**	**Technical**
894.78	489.40	-99	1000
MCA Benefit Score			
1285.18			
Option Selection MCA Score			
2285.18			
MCA Benefit - Cost Ratio BCR			
0.000714359			
Economic Benefit - Cost Ratio (BCR) Monetarised			
2.29			

11.1.2 Option B

Option B - Hard Defences & Flow Diversion to Little Arrigle – This option scored high in the Social and Economic Criteria Scores due to it removing the flood risk from the study area.

The low Environmental Score for this option is due to the impacts the diversion channel will have on the surrounding landscape. The diversion channel will remove flow from the Ballyhale Stream and displace this flow to the Little Arrigle. This will influence habitats in the Little Arrigle which is a Special Area of Conservation and is Part of the Nore SAC.

This option scored high in the Technical Criteria as the diversion channel is readily adaptable at moderate cost to address potential future flood risk areas. A summary of the scores is shown in Table 11-2 MCA Scores Option B.

Table 11-2 MCA Scores Option B

Multi-Criteria Analysis - Flood Relief Scheme Ballyhale			
Option:	**Option B - Hard Defences & Flow Diversion to Little Arrigle**		
Criteria Scores			
Social	**Economical**	**Environmental**	**Technical**
894.78	489.40	-674	1100
MCA Benefit Score			
710.18			
Option Selection MCA Score			
1810.18			
MCA Benefit - Cost Ratio BCR			
0.000284106			
Economic Benefit - Cost Ratio (BCR) Monetarised			
1.65			

11.1.3 Option C

Option C - Hard Defences & Flow Diversion to Ballyhale River – This option scored high in the Social and Economic Criteria Scores due to it removing the flood risk from the study area.

The low Environmental Score for this option is due to the impacts the diversion channel will have on the surrounding landscape. The diversion channel will remove flow from the Ballyhale Stream and displace to a location downstream.

This option scored high in the Technical Criteria as the diversion channel is readily adaptable at moderate cost to address potential future flood risk areas. A summary of the scores is shown in Table 11-3 MCA Scores Option C.

Table 11-3 MCA Scores Option C

Multi-Criteria Analysis - Flood Relief Scheme Ballyhale			
Option:	**Option C - Hard Defences & Flow Diversion to Ballyhale River**		
Criteria Scores			
Social	**Economical**	**Environmental**	**Technical**
894.78	489.40	-527	1100
MCA Benefit Score			
857.18			
Option Selection MCA Score			
1957.18			
MCA Benefit - Cost Ratio BCR			
0.000260145			
Economic Benefit - Cost Ratio (BCR) Monetarised			
1.25			

11.1.4 Option D

Option D - Hard Defences & Piped Flow Diversion – This option scored high in the Social and Economic Criteria Scores due to it removing the flood risk from the study area.

This option scored low due to the diversion pipe removing flow from a point in the stream and displacing it to a lower point downstream. This will have impacts on habitats within the stream.

The low Technical Score in relation to the other three options is due to the piped diversion route not being readily adaptable without significant cost. The option does not however hinder future interventions to address new potential future risk areas. This option also has a very low operational risk requiring regular monitoring and maintenance to check for blockages. A summary of the scores is shown in Table 11-4 MCA Scores Option D.

Table 11-4 MCA Scores Option D

Multi-Criteria Analysis - Flood Relief Scheme Ballyhale			
Option:	**Option D - Hard Defences & Piped Flow Diversion**		
Criteria Scores			
Social	**Economical**	**Environmental**	**Technical**
894.78	489.40	-475	500
MCA Benefit Score			
909.18			
Option Selection MCA Score			
1409.18			
MCA Benefit - Cost Ratio BCR			
0.000426424			
Economic Benefit - Cost Ratio (BCR) Monetarised			
1.93			

11.2 Comparative Scoring Assessment

Table 11-5 below presents a comparative assessment of the option scoring.

Table 11-5- Compative Scoring Table

Option	Criteria								
	1 Social	2 Economic	3 Environmental	4 Technical	Option Selection MCA *[Sum of 1-4]*	MCA Benefit [Sum of 1-3]		PV Cost	Economic BCR
Option A	894.78	489.404	-99	1000	2285	1285.18		€1,800,000	2.29
Option B	894.78	489.404	-527	1100	1810	710.18		€2,500,000	1.65
Option C	894.78	489.404	-674	1100	1957	857.18		€3,300,000	1.25
Option D	894.78	489.404	-475	500	1409	909.18		€2,100,000	1.93

11.3 Recommendation of Preferred Option

Based on Table 11-5 It can be seen that Option A has received the most advantageous scoring. This option

- Receives the Highest MCA Option Selection Score
- Receives the highest MCA Benefit Score
- Represents the lowest PV Cost
- Provides the Highest Economic BCR

Based on this assessment it is recommended that Option A is progressed to Stage 2

Appendix A

Concept Scheme Options

ON ORIGINAL

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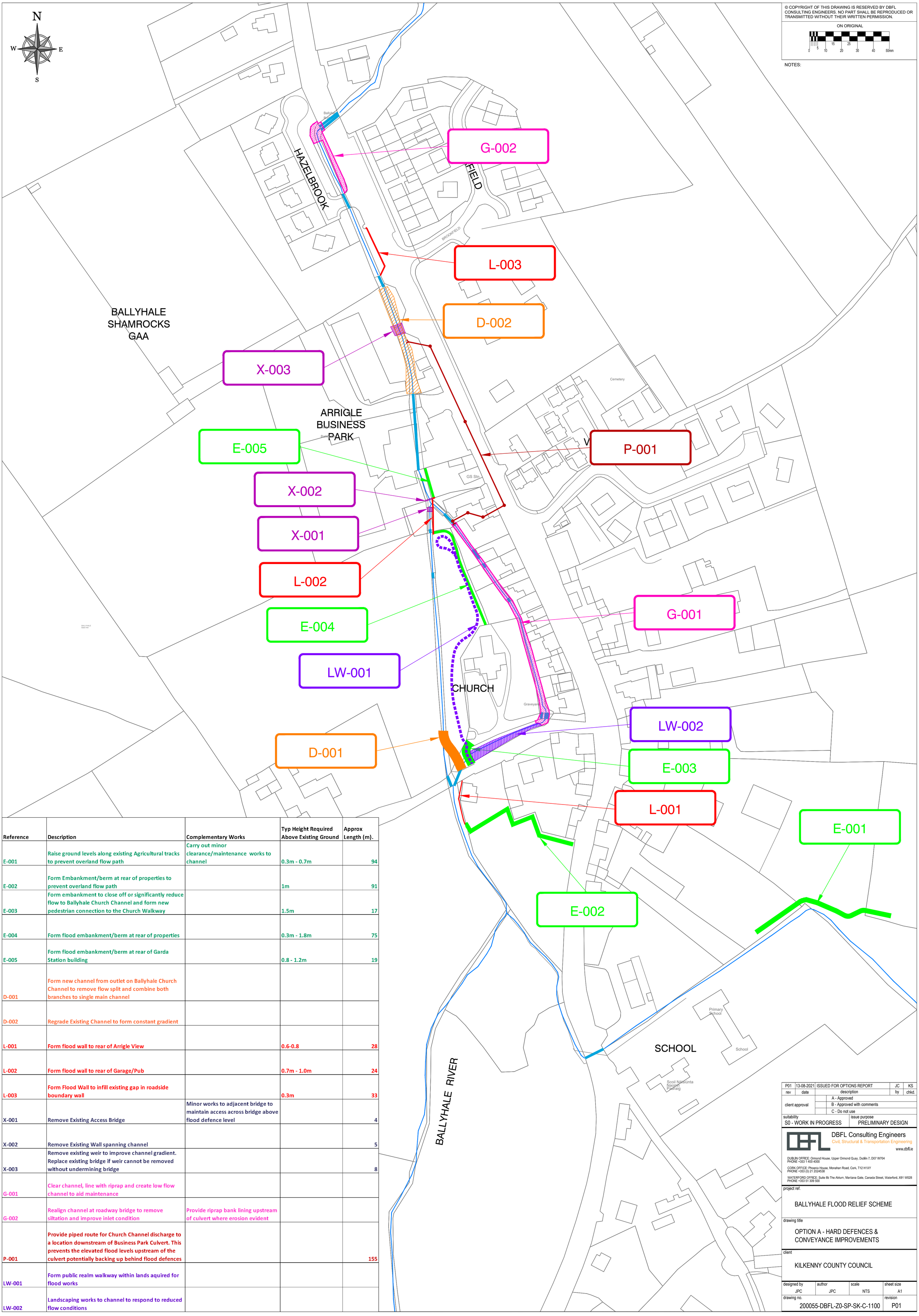
NOTES:



Reference	Description	Complementary Works	Typ Height Required Above Existing Ground	Approx Length (m).
E-001	Raise ground levels along existing Agricultural tracks to prevent overland flow path	Carry out minor clearance/maintenance works to channel	0.3m - 0.7m	94
E-002	Form Embankment/berm at rear of properties to prevent overland flow path		1m	91
E-003	Form embankment to close off or significantly reduce flow to Ballyhale Church Channel and form new pedestrian connection to the Church Walkway		1.5m	17
E-004	Form flood embankment/berm at rear of properties		0.3m - 1.8m	75
E-005	Form flood embankment/berm at rear of Garda Station building		0.8 - 1.2m	19
D-001	Form new channel from outlet on Ballyhale Church Channel to remove flow split and combine both branches to single main channel			
D-002	Regrade Existing Channel to form constant gradient			
L-001	Form flood wall to rear of Arrigle View		0.6-0.8	28
L-002	Form flood wall to rear of Garage/Pub		0.7m - 1.0m	24
L-003	Form Flood Wall to infill existing gap in roadside boundary wall		0.3m	33
X-001	Remove Existing Access Bridge	Minor works to adjacent bridge to maintain access across bridge above flood defence level		4
X-002	Remove Existing Wall spanning channel			5
X-003	Remove existing weir to improve channel gradient. Replace existing bridge if weir cannot be removed without undermining bridge			8
G-001	Clear channel, 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	Provide riprap bank lining upstream of culvert where erosion evident		
P-001	Provide piped route for Church Channel discharge to a location downstream of Business Park Culvert. This prevents the elevated flood levels upstream of the culvert potentially backing up behind flood defences			155
LW-001	Form public realm walkway within lands aquired for flood works			
LW-002	Landscaping works to channel to respond to reduced flow conditions			

rev	date	description	by	chkd.
P01	13-08-2021	ISSUED FOR OPTIONS REPORT	JC	KS

client approval
- A - Approved
- B - Approved with comments
- C - Do not use

suitability: S0 - WORK IN PROGRESS
issue purpose: PRELIMINARY DESIGN

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project ref.
BALLYHALE FLOOD RELIEF SCHEME

drawing title
OPTION A - HARD DEFENCES & CONVEYANCE IMPROVEMENTS

client
KILKENNY COUNTY COUNCIL

designed by	author	scale	sheet size
JPC	JPC	NTS	A1

drawing no.: 200055-DBFL-Z0-SP-SK-C-1100
revision: P01

ON ORIGINAL

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NOTES:

N W E S

LITTLE ARRIGLE RIVER

BALLYHALE RIVER

KILTORCAN BUSINESS PARK

DC-001

HAZELBROOK

BROOKFIELD

BALLYHALE SHAMROCKS GAA

ARRIGLE BUSINESS PARK

VICARS LANE

LW-001

L-001

CHURCH

C-001

E-002

E-001

FC-001

SCHOOL

BALLYHALE RIVER

Reference	Description	Typ min Height Required Above Existing Ground	Complementary Works	Approx Length (m).
E-001	Raise ground levels along existing Agricultural tracks to prevent overland flow path	0.3m - 0.7m	Carry out minor clearance/maintenance works to channel	94
E-002	Form Embankment/berm at rear of properties to prevent overland flow path	1m		91
L-001	Form flood wall to rear of Building Next to Bridge	0.6-0.8		17
DC-001	Creation of a new overflow diversion channel to connect into the Little Arrigle			900
FC-001	Creation of a flow control structure for the new diversion channel			
C-001	Installation of Culvert along section of roadway			12
LW-001	Form public realm walkway within lands aquired for flood works			200

rev	date	description	by	chkd.
P01	13-08-2021	ISSUED FOR OPTIONS REPORT	JC	KS

client approval
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project ref.

BALLYHALE FLOOD RELIEF SCHEME

drawing title

OPTION B - HARD DEFENCES & FLOW DIVERSION TO LITTLE ARRIGLE

client

KILKENNY COUNTY COUNCIL

designed by	author	scale	sheet size
JPC	JPC	NTS	A1

drawing no. 200055-DBFL-Z0-SP-SK-C-1101

revision P01

ON ORIGINAL

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NOTES:

N W E S

C-002

DC-001

LW-001

L-001

E-002

E-001

C-001

FC-001

KILTORCAN BUSINESS PARK

BALLYHALE RIVER

HAZELBROOK

BROOKFIELD

BALLYHALE SHAMROCKS GAA

ARRIGLE BUSINESS PARK

VICARS LANE

CHURCH

SCHOOL

Reference	Description	Typ min Height Required Above Existing Ground	Complementary Works	Approx Length (m).
E-001	Raise ground levels along existing Agricultural tracks to prevent overland flow path	0.3m - 0.7m	Carry out minor clearance/maintenance works to channel	94
E-002	Form Embankment/berm at rear of properties to prevent overland flow path	1m		91
L-001	Form flood wall to rear of Building Next to Bridge	0.6-0.8		17
DC-001	Creation of a new overflow diversion channel to connect into the Little Arrigle			1400
FC-001	Creation of a flow control structure for the new diversion channel			
C-001	Installation of Culvert along section of roadway			12
C-002	Installation of Culvert along section of roadway			20
LW-001	Form public realm walkway within lands aquired for flood works			200

rev	date	description	by	chkd.
P01	13-08-2021	ISSUED FOR OPTIONS REPORT	JC	KS

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- C - Do not use

suitability: S0 - WORK IN PROGRESS

issue purpose: PRELIMINARY DESIGN

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project ref.

BALLYHALE FLOOD RELIEF SCHEME

drawing title

OPTION C - HARD DEFENCES & FLOW DIVERSION TO BALLYHALE RIVER

client

KILKENNY COUNTY COUNCIL

designed by	author	scale	sheet size
JPC	JPC	NTS	A1

drawing no.: 200055-DBFL-Z0-SP-SK-C-1102

revision: P01

ON ORIGINAL

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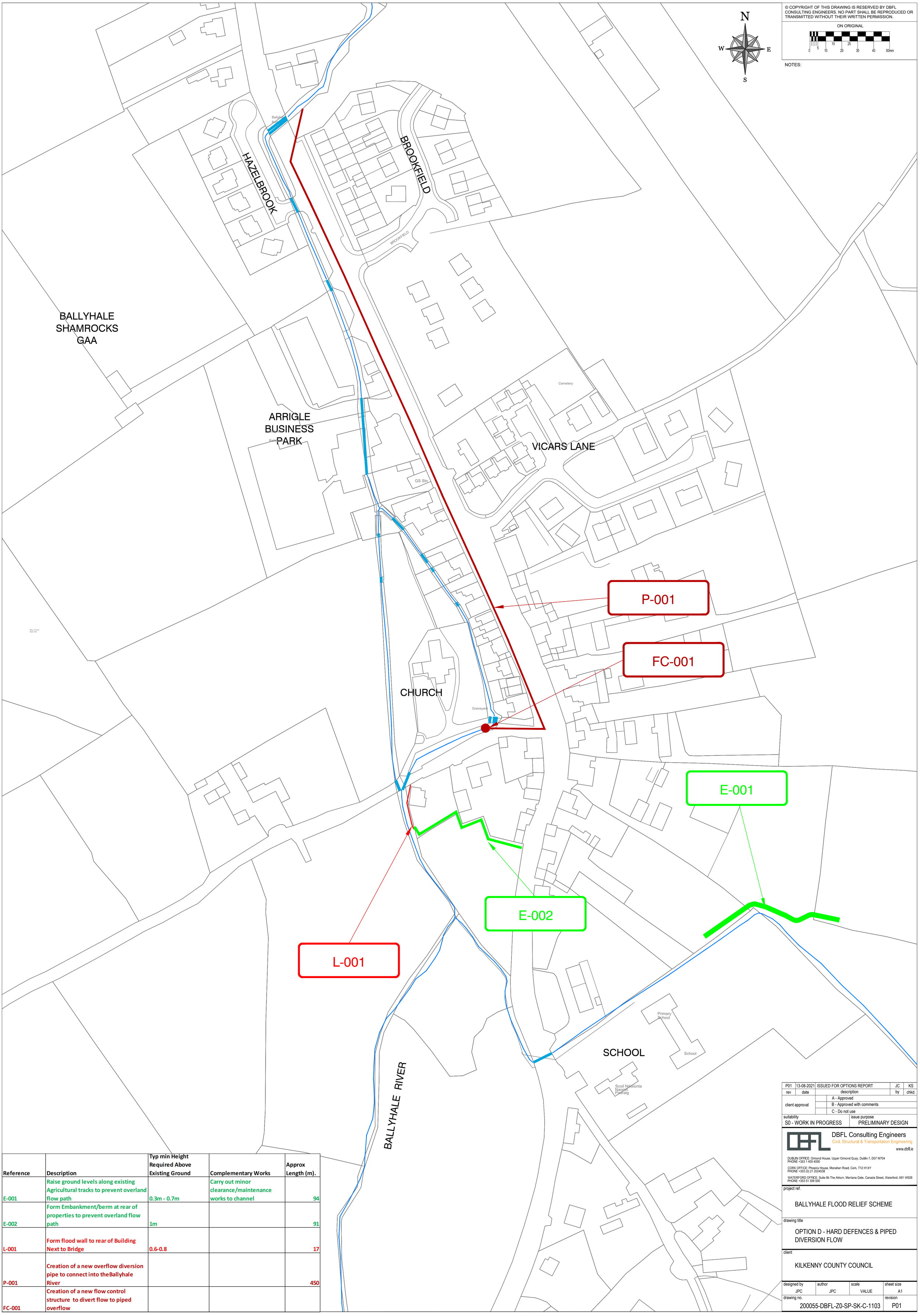
NOTES:

N W E S



Reference	Description	Typ min Height Required Above Existing Ground	Complementary Works	Approx Length (m).
E-001	Raise ground levels along existing Agricultural tracks to prevent overland flow path	0.3m - 0.7m	Carry out minor clearance/maintenance works to channel	94
E-002	Form Embankment/berm at rear of properties to prevent overland flow path	1m		91
L-001	Form flood wall to rear of Building Next to Bridge	0.6-0.8		17
P-001	Creation of a new overflow diversion pipe to connect into theBallyhale River			450
FC-001	Creation of a new flow control structure to divert flow to piped overflow			

rev	date	description	by	chkd.
P01	13-08-2021	ISSUED FOR OPTIONS REPORT	JC	KS

client approval: A - Approved; B - Approved with comments; C - Do not use

suitability: S0 - WORK IN PROGRESS

issue purpose: PRELIMINARY DESIGN

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project ref.

BALLYHALE FLOOD RELIEF SCHEME

drawing title

OPTION D - HARD DEFENCES & PIPED DIVERSION FLOW

client

KILKENNY COUNTY COUNCIL

designed by	author	scale	sheet size
JPC	JPC	VALUE	A1

drawing no. 200055-DBFL-Z0-SP-SK-C-1103

revision P01

Appendix B

MCA Scoring Summaries

Option A

Social Objectives

OBJECTIVE 1.A (i) **Minimise risk to human health and life – Residents**

	Weighting	Comment
Global	27	Set Nationally
Local	3.118	Sum of factored scores for all residential properties within the AFA for during the baseline scenario

OBJECTIVE 1.A (i)		**Option Scoring**
Residiual Risk Score	0	Sum of factored scores within the AFA for during the defended scenario
Option Score	5	Option Score = 5 X [(Local Weighting – Residual Risk Score) / Local Weighting]
Total Weighted Option Score	420.93	Global Weighting x Local Weighting x Total Option Score

OBJECTIVE 1.A (ii) **Minimise risk to human health and life – High vulnerability properties**

	Weighting	Comment
Global	17	Set Nationally
Local	2.5	Sum of factored scores for all High Vunerable properties within the AFA for during the baseline scenario

OBJECTIVE 1.A (ii)		**Option Scoring**
Residiual Risk Score	0	Sum of factored scores within the AFA for during the defended scenario
Option Score	5	Option Score = 5 X [(Local Weighting – Residual Risk Score) / Local Weighting]
Total Weighted Option Score	212.5	Global Weighting x Local Weighting x Total Option Score

OBJECTIVE 1.B (i) **Minimise risk to community – Social Infrastructure and Amenity**

	Weighting	Comment
Global	9	Set Nationally
Local	5	Based on calculated assessment, adjusted by professional judgement

OBJECTIVE 1.B (i)		**Option Scoring**
Residiual Risk Score	0	Sum of factored scores within the AFA for during the defended scenario
Option Score	5	Option Score = 5 X [(Local Weighting – Residual Risk Score) / Local Weighting]
Total Weighted Option Score	225	Global Weighting x Local Weighting x Total Option Score

OBJECTIVE 1.B (ii) **Minimise risk to community - Local Employment**

	Weighting	Comment
Global	7	Set Nationally
Local	1	Based on calculated assessment, adjusted by professional judgement

OBJECTIVE 1.B (ii)		**Option Scoring**
Residiual Risk Score	0	Sum of factored scores within the AFA for during the defended scenario
Option Score	5	Option Score = 5 X [(Local Weighting – Residual Risk Score) / Local Weighting]
Total Weighted Option Score	35	Global Weighting x Local Weighting x Total Option Score

Social Score	893.43

Economical Objectives

OBJECTIVE 2.A **Reduce Economic Damages**

	Weighting	Comment
Global	24	Set Nationally
Local	2.5575384	AAD for the SSA / €75,000

OBJECTIVE 2.A		**Option Scoring**
Reduced AAD	0	Defended Scenario
Option Score	5	Score = 0.05 X Percentage Reduction in AAD
Total Weighted Option Score	306.904608	Global Weighting x Local Weighting x Total Option Score

OBJECTIVE 2.B **Minimise risk to transport infrastructure**

	Weighting	Comment
Global	10	Set Nationally
Local	2.25	Based on calculated assessment, adjusted by professional judgement

OBJECTIVE 2.B		**Option Scoring**
Reduced AAD	0	Sum of factored scores for all transport infrastructure within the AFA for during the baseline scenario
Option Score	5	Option Score = 5 X [(Local Weighting – Residual Risk Score) / Local Weighting]
Total Weighted Option Score	112.5	Global Weighting x Local Weighting x Total Option Score

OBJECTIVE 2.C **Minimise risk to utility infrastructure**

	Weighting	Comment
Global	14	Set Nationally
Local	1	Based on calculated assessment, adjusted by professional judgement

OBJECTIVE 2.C		**Option Scoring**
Reduced AAD	0	Sum of factored scores for all Utility infrastructure within the AFA for during the baseline scenario
Option Score	5	Option Score = 5 X [(Local Weighting – Residual Risk Score) / Local Weighting]
Total Weighted Option Score	70	Global Weighting x Local Weighting x Total Option Score

OBJECTIVE 2.D **Manage risk to agriculture**

	Weighting	Comment
Global	12	Set Nationally
Local	3	Agricultural acivity in the area is mainly grazing on pasture land with smaller areas of crop production on arable land within the AFA

OBJECTIVE 2.D		**Option Scoring**
Option Score	0	Reduction in Agricultural Land Flooded
Total Weighted Option Score	0	Global Weighting x Local Weighting x Total Option Score

Economical Option Summary

Economical Score	489.404608

Envionmental Objectives

OBJECTIVE 3.A — **Support the objectives of the WFD**

	Weighting	Comment
Global	16	Set Nationally
Local	5	Constant from OPW Guidance

OBJECTIVE 3.A — **Option Scoring**

Option Score	-1	Intermittent positive impact wherby reduction in flood risk provides reduction in the pollution risk associated with flood events [+2] Short term negative impacts associated with instream works during construction phase (-2) Adjusted by additional -1 to reflect greater level of instream works relative to other options [-3]
Total Weighted Option Score	-80	Global Weighting x Local Weighting x Total Option Score

OBJECTIVE 3.B — **Support the objectives of the Habitats and Birds Directives**

	Weighting	Comment
Global	10	Set Nationally
Local	5	The proposed works are proximate to and potentially within designated sites including Natura 2000 sites of international importance. The primary designated site proximate to/within or downstream of the proposed works is the River Barrow and River Nore SAC and there is a direct hydrological connection to this SAC. In addition, the River Nore SPA is 5km downstream of all instream works.

OBJECTIVE 3.B — **Option Scoring**

Option Score	-1	Risk of short term negative impacts associated with instream works directly upstream of SAC during construction phase [-1]
Total Weighted Option Score	-50	Global Weighting x Local Weighting x Total Option Score

OBJECTIVE 3.C — **Avoid damage to, and where possible enhance, the flora and fauna of the catchment**

	Weighting	Comment
Global	5	Set Nationally
Local	3	The proposed works are proximate to and potentially within designated sites including Natura 2000 sites of international importance. The primary designated site proximate to/within or downstream of the proposed works is the River Barrow and River Nore SAC and there is a direct hydrological connection to this SAC. In addition, the River Nore SPA is 5km downstream of all instream works.

OBJECTIVE 3.C — **Option Scoring**

Option Score	1	Potential for local improvement of flora/fauna due to improvement in channel conditions. Benifits achieved through weir removal, removing of flow split, and directing from from heavily modified channel to open channel [+1]
Total Weighted Option Score	15	Global Weighting x Local Weighting x Total Option Score

OBJECTIVE 3.D — **Protect and where possible enhance fisheries resource within the catchment**

	Weighting	Comment
Global	13	Set Nationally
Local	4	The proposed works are proximate to and potentially within designated sites including Natura 2000 sites of international importance. The primary designated site proximate to/within or downstream of the proposed works is the River Barrow and River Nore SAC and there is a direct hydrological connection to this SAC. In addition, the River Nore SPA is 5km downstream of all instream works.

OBJECTIVE 3.D — **Option Scoring**

Option Score	0	Potential for local improvement of fisheries due to improvement in channel conditions. Benifits achieved through weir removal, removing of flow split, and directing from from heavily modified channel to open channel [+2] Short term negative impacts associated with instream works during construction phase [-2]
Total Weighted Option Score	0	Global Weighting x Local Weighting x Total Option Score

OBJECTIVE 3.E	Protect, and where possible enhance, landscape character and visual amenity within the zone of influence.	
	Weighting	Comment
Global	8	Set Nationally
Local	1	Ballyhale is located in an area outlined as a Transitional Area, which lies between the south western uplands (Landscape Character Type C) and the lower lying lands to the north(Landscape Character Area F, Kilkenny Western Basin. The landscape character of this area is defined by a smooth terrain, allowing views over long distances, and vegetation is predominantly low. Land use comprises pasturelands and tree plantations, the area is described as a rural area with scattered, low density settlement patterns.

OBJECTIVE 3.E		Option Scoring
Option Score	0	Potential for local improvement of fisheries due to improvement in channel conditions. Benifits achieved through weir removal, removing of flow split, and directing from from heavily modified channel to open channel [+2] Short term negative impacts associated with instream works during construction phase [-2]
Total Weighted Option Score	0	Global Weighting x Local Weighting x Total Option Score

OBJECTIVE 3.F.i	Avoid damage to or loss of features, institutions and collections of cultural heritage importance and their setting, and improve their protection from extreme floods.	
	Weighting	Comment
Global	4	Set Nationally
Local	2	A number of sites/features listed on the Record of Protected Structures and/or Recorded by NIAH are present and potentially affected with a moderate to low vulnerability.

OBJECTIVE 3.F.i		Option Scoring
Option Score	1	Increase in the level of protection for architectural features (Record of Protected Structures and NIAH) from extreme flooding, such that it is less vulnerable to flood damage.
Total Weighted Option Score	8	Global Weighting x Local Weighting x Total Option Score

OBJECTIVE 3.F.ii	Avoid damage to or loss of features, institutions and collections of cultural heritage importance and their setting, and improve their protection from extreme floods.	
	Weighting	Comment
Global	4	Set Nationally
Local	2	A number of sites listed on the RMP/RPS present and potentially affected. (moderate to low vulnerability)

OBJECTIVE 3.F.ii		Option Scoring
Option Score	1	Increase in the level of protection for archaeological features (Recorded Monuments) from extreme flooding, such that it is less vulnerable to flood damage.
Total Weighted Option Score	8	Global Weighting x Local Weighting x Total Option Score

Environmental Option Summary

Environmental Score	-99

Technical Objectives

OBJECTIVE 4.A **Ensure flood risk management options are operationally robust**

	Weighting	Comment
Global	20	Set Nationally
Local	5	Constant from OPW Guidance

OBJECTIVE 4.A **Option Scoring**

Option Score	4	Negligible operational risk, i.e., no reliance on systems or intervention, with more regular monitoring and intermittent, but potentially substantial, maintenance requirements. Fixed flood defence embankments, Uncontrolled storage, Increased conveyance measures (incl. diversion channels) where maintenance required
Adjustment Factor	0	No Adjustment
Total Weighted Option Score	400	Global Weighting x Local Weighting x Total Option Score

OBJECTIVE 4.B **Minimise health and safety risk in construction, maintenance and operation of the flood risk management option**

	Weighting	Comment
Global	20	Set Nationally
Local	5	Constant from OPW Guidance

OBJECTIVE 4.B **Option Scoring**

Option Score	3	The following Hazards have been identified: working near water and working with heavy plant machinery
Adjustment Factor	0	No Adjustment
Total Weighted Option Score	300	Global Weighting x Local Weighting x Total Option Score

OBJECTIVE 4.C **Ensure flood risk can be managed effectively and sustainably into the future, and the potential impacts of climate change**

	Weighting	Comment
Global	20	Set Nationally
Local	5	Constant from OPW Guidance

OBJECTIVE 4.C **Option Scoring**

Option Score	3	Option is adaptable at moderate cost, difficulty and impact, and provides no impediment to future interventions to address new potential future risk areas
Total Weighted Option Score	300	Global Weighting x Local Weighting x Total Option Score

Technical Option Summary

Technical Score	1000

Option B

Social Objectives

OBJECTIVE 1.A (i) **Minimise risk to human health and life – Residents**

	Weighting	Comment
Global	27	Set Nationally
Local	3.118	Sum of factored scores for all residential properties within the AFA for during the baseline scenario

OBJECTIVE 1.A (i)		**Option Scoring**
Residiual Risk Score	0	Sum of factored scores for all residential properties within the AFA for during the defended scenario
Option Score	5	Option Score = 5 X [(Local Weighting – Residual Risk Score) / Local Weighting]
Total Weighted Option Score	420.93	Global Weighting x Local Weighting x Total Option Score

OBJECTIVE 1.A (ii) **Minimise risk to human health and life – High vulnerability properties**

	Weighting	Comment
Global	17	Set Nationally
Local	2.5	Sum of factored scores for all High Vulnerability properties within the AFA for during the baseline scenario

OBJECTIVE 1.A (ii)		**Option Scoring**
Residiual Risk Score	0	Sum of factored scores for all High Vulnerability properties within the AFA for during the defended scenario
Option Score	5	Option Score = 5 X [(Local Weighting – Residual Risk Score) / Local Weighting]
Total Weighted Option Score	212.5	Global Weighting x Local Weighting x Total Option Score

OBJECTIVE 1.B (i) **Minimise risk to community – Social Infrastructure and Amenity**

	Weighting	Comment
Global	9	Set Nationally
Local	5	Based on calculated assessment, adjusted by professional judgement

OBJECTIVE 1.B (i)		**Option Scoring**
Residiual Risk Score	0	Sum of factored scores within the AFA for during the defended scenario
Option Score	5	Option Score = 5 X [(Local Weighting – Residual Risk Score) / Local Weighting]
Total Weighted Option Score	225	Global Weighting x Local Weighting x Total Option Score

OBJECTIVE 1.B (ii) **Minimise risk to community - Local Employment**

	Weighting	Comment
Global	7	Set Nationally
Local	1	Based on calculated assessment, adjusted by professional judgement

OBJECTIVE 1.B (ii)		**Option Scoring**
Residiual Risk Score	0	Sum of factored scores for all residential properties within the AFA for during the defended scenario
Option Score	5	Option Score = 5 X [(Local Weighting – Residual Risk Score) / Local Weighting]
Total Weighted Option Score	35	Global Weighting x Local Weighting x Total Option Score

Social Score	893.43

Economical Objectives

OBJECTIVE 2.A **Reduce Economic Damages**

	Weighting	Comment
Global	24	Set Nationally
Local	2.5575384	AAD for the SSA / €75,000

OBJECTIVE 2.A **Option Scoring**

Reduced AAD	0	Defended Scenario
Option Score	5	Score = 0.05 X Percentage Reduction in AAD
Total Weighted Option Score	306.904608	Global Weighting x Local Weighting x Total Option Score

OBJECTIVE 2.B **Minimise risk to transport infrastructure**

	Weighting	Comment
Global	10	Set Nationally
Local	2.25	Based on calculated assessment, adjusted by professional judgement

OBJECTIVE 2.B **Option Scoring**

Reduced AAD	0	Sum of factored scores for all transport infrastructure within the AFA for during the defended scenario
Option Score	5	Option Score = 5 X [(Local Weighting – Residual Risk Score) / Local Weighting]
Total Weighted Option Score	112.5	Global Weighting x Local Weighting x Total Option Score

OBJECTIVE 2.C **Minimise risk to utility infrastructure**

	Weighting	Comment
Global	14	Set Nationally
Local	1	Based on calculated assessment, adjusted by professional judgement

OBJECTIVE 2.C **Option Scoring**

Reduced AAD	0	Sum of factored scores for all Utility Infrastructure within the AFA for during the defended scenario
Option Score	5	Option Score = 5 X [(Local Weighting – Residual Risk Score) / Local Weighting]
Total Weighted Option Score	70	Global Weighting x Local Weighting x Total Option Score

OBJECTIVE 2.D **Manage risk to agriculture**

	Weighting	Comment
Global	12	Set Nationally
Local	3	Agricultural acivity in the area is mainly grazing on pasture land with smaller areas of crop production on arable land within the AFA

OBJECTIVE 2.D **Option Scoring**

Option Score	0	Reduction in Agricultural Land Flooded
Total Weighted Option Score	0	Global Weighting x Local Weighting x Total Option Score

Economical Option Summary

Economical Score	489.404608

Envionmental Objectives

OBJECTIVE 3.A	Support the objectives of the WFD	
	Weighting	Comment
Global	16	Set Nationally
Local	5	Constant from OPW Guidance

OBJECTIVE 3.A		Option Scoring
Option Score	-3	'Positive impact wherby reduction in flood risk provides reduction in the pollution risk associated with flood events [+2] Long Term negative impacts associated with flow diversion to a different river [-5]
Total Weighted Option Score	-240	Global Weighting x Local Weighting x Total Option Score

OBJECTIVE 3.B	Support the objectives of the Habitats and Birds Directives	
	Weighting	Comment
Global	10	Set Nationally
Local	5	The proposed works are proximate to and potentially within designated sites including Natura 2000 sites of international importance. The primary designated site proximate to/within or downstream of the proposed works is the River Barrow and River Nore SAC and there is a direct hydrological connection to this SAC. In addition, the River Nore SPA is 5km downstream of all instream works.

OBJECTIVE 3.B		Option Scoring
Option Score	-3	Risk of long term negative impacts associated with instream works within SAC boundary and changes to hydrology and morphology assosicated with flow diverion from different river into SAC [-3]
Total Weighted Option Score	-150	Global Weighting x Local Weighting x Total Option Score

OBJECTIVE 3.C	Avoid damage to, and where possible enhance, the flora and fauna of the catchment	
	Weighting	Comment
Global	5	Set Nationally
Local	3	The proposed works are proximate to and potentially within designated sites including Natura 2000 sites of international importance. The primary designated site proximate to/within or downstream of the proposed works is the River Barrow and River Nore SAC and there is a direct hydrological connection to this SAC. In addition, the River Nore SPA is 5km downstream of all instream works.

OBJECTIVE 3.C		Option Scoring
Option Score	-4	Potential localised loss of or disturbance to flora/fauna resulting from construction of hard defences and diversion channel . Significant land take and tree/hedgerow impact associated with diversion channel. Adjusted due to additional risk to flora and fauna as a result of flow diversion to a different watercourse [-4]
Total Weighted Option Score	-60	Global Weighting x Local Weighting x Total Option Score

OBJECTIVE 3.D	Protect and where possible enhance fisheries resource within the catchment	
	Weighting	Comment
Global	13	Set Nationally
Local	4	The proposed works are proximate to and potentially within designated sites including Natura 2000 sites of international importance. The primary designated site proximate to/within or downstream of the proposed works is the River Barrow and River Nore SAC and there is a direct hydrological connection to this SAC. In addition, the River Nore SPA is 5km downstream of all instream works.

OBJECTIVE 3.D		Option Scoring
Option Score	-4	Short Term Construction Phase Impacts and Permenant impacts from diversion channel to different stream
Total Weighted Option Score	-208	Global Weighting x Local Weighting x Total Option Score

OBJECTIVE 3.E **Protect, and where possible enhance, landscape character and visual amenity within the zone of influence.**

	Weighting	Comment
Global	8	Set Nationally
Local	1	Ballyhale is located in an area outlined as a Transitional Area, which lies between the south western uplands (Landscape Character Type C) and the lower lying lands to the north(Landscape Character Area F, Kilkenny Western Basin. The landscape character of this area is defined by a smooth terrain, allowing views over long distances, and vegetation is predominantly low. Land use comprises pasturelands and tree plantations, the area is described as a rural area with scattered, low density settlement patterns.

OBJECTIVE 3.E		**Option Scoring**
Option Score	-4	Negative Short term impacts due to construction stage disturbance. Long term negative impact due to major earthworks cuttings associated with diversion channel and associated loss of trees and hedgerows [-4]
Total Weighted Option Score	-32	Global Weighting x Local Weighting x Total Option Score

OBJECTIVE 3.F.i **Avoid damage to or loss of features, institutions and collections of cultural heritage importance and their setting, and improve their protection from extreme floods.**

	Weighting	Comment
Global	4	Set Nationally
Local	2	A number of sites/features listed on the Record of Protected Structures and/or Recorded by NIAH are present and potentially affected with a moderate to low vulnerability.

OBJECTIVE 3.F.i		**Option Scoring**
Option Score	1	Increase in the level of protection for architectural features (Record of Protected Structures and NIAH) from extreme flooding, such that it is less vulnerable to flood damage.
Total Weighted Option Score	8	Global Weighting x Local Weighting x Total Option Score

OBJECTIVE 3.F.ii **Avoid damage to or loss of features, institutions and collections of cultural heritage importance and their setting, and improve their protection from extreme floods.**

	Weighting	Comment
Global	4	Set Nationally
Local	2	A number of sites listed on the RMP/RPS present and potentially affected. (moderate to low vulnerability)

OBJECTIVE 3.F.ii		**Option Scoring**
Option Score	1	Increase in the level of protection for archaeological features (Recorded Monuments) from extreme flooding, such that it is less vulnerable to flood damage.
Total Weighted Option Score	8	Global Weighting x Local Weighting x Total Option Score

Environmental Option Summary

Environmental Score	-674

Technical Objectives

OBJECTIVE 4.A **Ensure flood risk management options are operationally robust**

	Weighting	Comment
Global	20	Set Nationally
Local	5	Constant from OPW Guidance

OBJECTIVE 4.A		**Option Scoring**
Option Score	5	No operational risk, i.e., no reliance on systems or intervention, with limited monitoring / maintenance requirements Fixed flood defence walls, Increased conveyance in self-cleansing rivers or diversion channels, Relocation
Adjustment Factor	0	No Adjustment
Total Weighted Option Score	500	Global Weighting x Local Weighting x Total Option Score

OBJECTIVE 4.B **Minimise health and safety risk in construction, maintenance and operation of the flood risk management option**

	Weighting	Comment
Global	20	Set Nationally
Local	5	Constant from OPW Guidance

OBJECTIVE 4.B		**Option Scoring**
Option Score	2	The following Hazards have been identified: working near water, working with heavy plant machinery and deep excavations
Adjustment Factor	0	No Adjustment
Total Weighted Option Score	200	Global Weighting x Local Weighting x Total Option Score

OBJECTIVE 4.C **Ensure flood risk can be managed effectively and sustainably into the future, and the potential impacts of climate change**

	Weighting	Comment
Global	20	Set Nationally
Local	5	Constant from OPW Guidance

OBJECTIVE 4.C		**Option Scoring**
Option Score	4	Option is readily adaptable at limited cost, difficulty and impact, and provides no impediment to future interventions to address new potential future risk areas
Total Weighted Option Score	400	Global Weighting x Local Weighting x Total Option Score

Technical Option Summary

Technical Score	1100

Option C

Social Objectives

OBJECTIVE 1.A (i)	Minimise risk to human health and life – Residents	
	Weighting	Comment
Global	27	Set Nationally
Local	3.118	Sum of factored scores for all residential properties within the AFA for during the baseline scenario

OBJECTIVE 1.A (i)	Option Scoring	
Residiual Risk Score	0	Sum of factored scores for all residential properties within the AFA for during the defended scenario
Option Score	5	Option Score = 5 X [(Local Weighting – Residual Risk Score) / Local Weighting]
Total Weighted Option Score	420.93	Global Weighting x Local Weighting x Total Option Score

OBJECTIVE 1.A (ii)	Minimise risk to human health and life – High vulnerability properties	
	Weighting	Comment
Global	17	Set Nationally
Local	2.5	Sum of factored scores for all High Vulnerability within the AFA for during the baseline scenario

OBJECTIVE 1.A (ii)	Option Scoring	
Residiual Risk Score	0	Sum of factored scores for all High Vulnerability within the AFA for during the defended scenario
Option Score	5	Option Score = 5 X [(Local Weighting – Residual Risk Score) / Local Weighting]
Total Weighted Option Score	212.5	Global Weighting x Local Weighting x Total Option Score

OBJECTIVE 1.B (i)	Minimise risk to community – Social Infrastructure and Amenity	
	Weighting	Comment
Global	9	Set Nationally
Local	5	Based on calculated assessment, adjusted by professional judgement

OBJECTIVE 1.B (i)	Option Scoring	
Residiual Risk Score	0	Sum of factored scores within the AFA for during the defended scenario
Option Score	5	Option Score = 5 X [(Local Weighting – Residual Risk Score) / Local Weighting]
Total Weighted Option Score	225	Global Weighting x Local Weighting x Total Option Score

OBJECTIVE 1.B (ii)	Minimise risk to community - Local Employment	
	Weighting	Comment
Global	7	Set Nationally
Local	1	Based on calculated assessment, adjusted by professional judgement

OBJECTIVE 1.B (ii)	Option Scoring	
Residiual Risk Score	0	Sum of factored scores within the AFA for during the defended scenario
Option Score	5	Option Score = 5 X [(Local Weighting – Residual Risk Score) / Local Weighting]
Total Weighted Option Score	35	Global Weighting x Local Weighting x Total Option Score

Social Score	893.43

Economical Objectives

OBJECTIVE 2.A **Reduce Economic Damages**

	Weighting	Comment
Global	24	Set Nationally
Local	2.5575384	AAD for the SSA / €75,000

OBJECTIVE 2.A **Option Scoring**

Reduced AAD	0	Defended Scenario
Option Score	5	Score = 0.05 X Percentage Reduction in AAD
Total Weighted Option Score	306.904608	Global Weighting x Local Weighting x Total Option Score

OBJECTIVE 2.B **Minimise risk to transport infrastructure**

	Weighting	Comment
Global	10	Set Nationally
Local	2.25	Based on calculated assessment, adjusted by professional judgement

OBJECTIVE 2.B **Option Scoring**

Reduced AAD	0	Sum of factored scores for all transport infrastructure within the AFA for during the defended scenario
Option Score	5	Option Score = 5 X [(Local Weighting – Residual Risk Score) / Local Weighting]
Total Weighted Option Score	112.5	Global Weighting x Local Weighting x Total Option Score

OBJECTIVE 2.C **Minimise risk to utility infrastructure**

	Weighting	Comment
Global	14	Set Nationally
Local	1	Based on calculated assessment, adjusted by professional judgement

OBJECTIVE 2.C **Option Scoring**

Reduced AAD	0	Sum of factored scores for all utility infrastructure within the AFA for during the defended scenario
Option Score	5	Option Score = 5 X [(Local Weighting – Residual Risk Score) / Local Weighting]
Total Weighted Option Score	70	Global Weighting x Local Weighting x Total Option Score

OBJECTIVE 2.D **Manage risk to agriculture**

	Weighting	Comment
Global	12	Set Nationally
Local	3	Agricultural acivity in the area is mainly grazing on pasture land with smaller areas of crop production on arable land within the AFA

OBJECTIVE 2.D **Option Scoring**

Option Score	0	Reduction in Agricultural Land Flooded
Total Weighted Option Score	0	Global Weighting x Local Weighting x Total Option Score

Economical Option Summary

Economical Score	489.404608

Envionmental Objectives

OBJECTIVE 3.A	Support the objectives of the WFD	
	Weighting	Comment
Global	16	Set Nationally
Local	5	Constant from OPW Guidance

OBJECTIVE 3.A		Option Scoring
Option Score	-2	'Positive impact wherby reduction in flood risk provides reduction in the pollution risk associated with flood events [+2] Long Term negative impacts associated with flow diversion to the same river [-4]
Total Weighted Option Score	-160	Global Weighting x Local Weighting x Total Option Score

OBJECTIVE 3.B	Support the objectives of the Habitats and Birds Directives	
	Weighting	Comment
Global	10	Set Nationally
Local	5	The proposed works are proximate to and potentially within designated sites including Natura 2000 sites of international importance. The primary designated site proximate to/within or downstream of the proposed works is the River Barrow and River Nore SAC and there is a direct hydrological connection to this SAC. In addition, the River Nore SPA is 5km downstream of all instream works.

OBJECTIVE 3.B		Option Scoring
Option Score	-3	Risk of long term negative impacts associated with instream works within SAC boundary. Risk of pollutant flush from open diversion channel into SAC during flood events [-3]
Total Weighted Option Score	-150	Global Weighting x Local Weighting x Total Option Score

OBJECTIVE 3.C	Avoid damage to, and where possible enhance, the flora and fauna of the catchment	
	Weighting	Comment
Global	5	Set Nationally
Local	3	The proposed works are proximate to and potentially within designated sites including Natura 2000 sites of international importance. The primary designated site proximate to/within or downstream of the proposed works is the River Barrow and River Nore SAC and there is a direct hydrological connection to this SAC. In addition, the River Nore SPA is 5km downstream of all instream works.

OBJECTIVE 3.C		Option Scoring
Option Score	-3	Potential localised loss of or disturbance to flora/fauna resulting from construction of hard defences and diversion channel. Significant land take and tree/hedgerow impact associated with diversion channel [-3]
Total Weighted Option Score	-45	Global Weighting x Local Weighting x Total Option Score

OBJECTIVE 3.D	Protect and where possible enhance fisheries resource within the catchment	
	Weighting	Comment
Global	13	Set Nationally
Local	4	The proposed works are proximate to and potentially within designated sites including Natura 2000 sites of international importance. The primary designated site proximate to/within or downstream of the proposed works is the River Barrow and River Nore SAC and there is a direct hydrological connection to this SAC. In addition, the River Nore SPA is 5km downstream of all instream works.

OBJECTIVE 3.D		Option Scoring
Option Score	-3	Short Term Construction Phase Impacts and Permanent impacts from diversion channel within the same stream
Total Weighted Option Score	-156	Global Weighting x Local Weighting x Total Option Score

OBJECTIVE 3.E	Protect, and where possible enhance, landscape character and visual amenity within the zone of influence.	
	Weighting	Comment
Global	8	Set Nationally
Local	1	Ballyhale is located in an area outlined as a Transitional Area, which lies between the south western uplands (Landscape Character Type C) and the lower lying lands to the north(Landscape Character Area F, Kilkenny Western Basin. The landscape character of this area is defined by a smooth terrain, allowing views over long distances, and vegetation is predominantly low. Land use comprises pasturelands and tree plantations, the area is described as a rural area with scattered, low density settlement patterns.

OBJECTIVE 3.E		Option Scoring
Option Score	-4	Negative Short term impacts due to construction stage disturbance. Long term negative impact due to major earthworks cuttings associated with diversion channel and associated loss of trees and hedgerows [-4]
Total Weighted Option Score	-32	Global Weighting x Local Weighting x Total Option Score

OBJECTIVE 3.F.i	Avoid damage to or loss of features, institutions and collections of cultural heritage importance and their setting, and improve their protection from extreme floods.	
	Weighting	Comment
Global	4	Set Nationally
Local	2	A number of sites/features listed on the Record of Protected Structures and/or Recorded by NIAH are present and potentially affected with a moderate to low vulnerability.

OBJECTIVE 3.F.i		Option Scoring
Option Score	1	Increase in the level of protection for architectural features (Record of Protected Structures and NIAH) from extreme flooding, such that it is less vulnerable to flood damage.
Total Weighted Option Score	8	Global Weighting x Local Weighting x Total Option Score

OBJECTIVE 3.F.ii	Avoid damage to or loss of features, institutions and collections of cultural heritage importance and their setting, and improve their protection from extreme floods.	
	Weighting	Comment
Global	4	Set Nationally
Local	2	A number of sites listed on the RMP/RPS present and potentially affected. (moderate to low vulnerability)

OBJECTIVE 3.F.ii		Option Scoring
Option Score	1	Increase in the level of protection for archaeological features (Recorded Monuments) from extreme flooding, such that it is less vulnerable to flood damage.
Total Weighted Option Score	8	Global Weighting x Local Weighting x Total Option Score

Environmental Option Summary

Environmental Score	-527

Technical Objectives

OBJECTIVE 4.A **Ensure flood risk management options are operationally robust**

	Weighting	Comment
Global	20	Set Nationally
Local	5	Constant from OPW Guidance

OBJECTIVE 4.A		**Option Scoring**
Option Score	5	No operational risk, i.e., no reliance on systems or intervention, with limited monitoring / maintenance requirements Fixed flood defence walls, Increased conveyance in self-cleansing rivers or diversion channels, Relocation
Adjustment Factor	0	No Adjustment
Total Weighted Option Score	500	Global Weighting x Local Weighting x Total Option Score

OBJECTIVE 4.B **Minimise health and safety risk in construction, maintenance and operation of the flood risk management option**

	Weighting	Comment
Global	20	Set Nationally
Local	5	Constant from OPW Guidance

OBJECTIVE 4.B		**Option Scoring**
Option Score	2	The following Hazards have been identified: working near water, working with heavy plant machinery and deep excavations
Adjustment Factor	0	No Adjustment
Total Weighted Option Score	200	Global Weighting x Local Weighting x Total Option Score

OBJECTIVE 4.C **Ensure flood risk can be managed effectively and sustainably into the future, and the potential impacts of climate change**

	Weighting	Comment
Global	20	Set Nationally
Local	5	Constant from OPW Guidance

OBJECTIVE 4.C		**Option Scoring**
Option Score	4	Option is readily adaptable at limited cost, difficulty and impact, and provides no impediment to future interventions to address new potential future risk areas
Total Weighted Option Score	400	Global Weighting x Local Weighting x Total Option Score

Technical Option Summary

Technical Score	1100

Option D

Social Objectives

OBJECTIVE 1.A (i) **Minimise risk to human health and life – Residents**

	Weighting	Comment
Global	27	Set Nationally
Local	3.118	Sum of factored scores for all residential properties within the AFA for during the baseline scenario

OBJECTIVE 1.A (i) **Option Scoring**

Residiual Risk Score	0	Sum of factored scores for all residential properties within the AFA for during the defended scenario
Option Score	5	Option Score = 5 X [(Local Weighting – Residual Risk Score) / Local Weighting]
Total Weighted Option Score	420.93	Global Weighting x Local Weighting x Total Option Score

OBJECTIVE 1.A (ii) **Minimise risk to human health and life – High vulnerability properties**

	Weighting	Comment
Global	17	Set Nationally
Local	2.5	Sum of factored scores for all high vulnerability properties within the AFA for during the baseline scenario

OBJECTIVE 1.A (ii) **Option Scoring**

Residiual Risk Score	0	Sum of factored scores for all high vulnerability properties within the AFA for during the defended scenario
Option Score	5	Option Score = 5 X [(Local Weighting – Residual Risk Score) / Local Weighting]
Total Weighted Option Score	212.5	Global Weighting x Local Weighting x Total Option Score

OBJECTIVE 1.B (i) **Minimise risk to community – Social Infrastructure and Amenity**

	Weighting	Comment
Global	9	Set Nationally
Local	5	Based on calculated assessment, adjusted by professional judgement

OBJECTIVE 1.B (i) **Option Scoring**

Residiual Risk Score	0	Sum of factored scores for all social infrastructure within the AFA for during the defended scenario
Option Score	5	Option Score = 5 X [(Local Weighting – Residual Risk Score) / Local Weighting]
Total Weighted Option Score	225	Global Weighting x Local Weighting x Total Option Score

OBJECTIVE 1.B (ii) **Minimise risk to community - Local Employment**

	Weighting	Comment
Global	7	Set Nationally
Local	1	Based on calculated assessment, adjusted by professional judgement

OBJECTIVE 1.B (ii) **Option Scoring**

Residiual Risk Score	0	Sum of factored scores within the AFA for during the defended scenario
Option Score	5	Option Score = 5 X [(Local Weighting – Residual Risk Score) / Local Weighting]
Total Weighted Option Score	35	Global Weighting x Local Weighting x Total Option Score

Social Score	893.43

Economical Objectives

OBJECTIVE 2.A **Reduce Economic Damages**

	Weighting	Comment
Global	24	Set Nationally
Local	2.5575384	AAD for the SSA / €75,000

OBJECTIVE 2.A **Option Scoring**

Reduced AAD	0	Defended Scenario
Option Score	5	Score = 0.05 X Percentage Reduction in AAD
Total Weighted Option Score	306.904608	Global Weighting x Local Weighting x Total Option Score

OBJECTIVE 2.B **Minimise risk to transport infrastructure**

	Weighting	Comment
Global	10	Set Nationally
Local	2.25	Based on calculated assessment, adjusted by professional judgement

OBJECTIVE 2.B **Option Scoring**

Reduced AAD	0	Sum of factored scores for all transport infrastructure within the AFA for during the defended scenario
Option Score	5	Option Score = 5 X [(Local Weighting – Residual Risk Score) / Local Weighting]
Total Weighted Option Score	112.5	Global Weighting x Local Weighting x Total Option Score

OBJECTIVE 2.C **Minimise risk to utility infrastructure**

	Weighting	Comment
Global	14	Set Nationally
Local	1	Based on calculated assessment, adjusted by professional judgement

OBJECTIVE 2.C **Option Scoring**

Reduced AAD	0	Sum of factored scores for all utility infrastructure within the AFA for during the defended scenario
Option Score	5	Option Score = 5 X [(Local Weighting – Residual Risk Score) / Local Weighting]
Total Weighted Option Score	70	Global Weighting x Local Weighting x Total Option Score

OBJECTIVE 2.D **Manage risk to agriculture**

	Weighting	Comment
Global	12	Set Nationally
Local	3	Agricultural acivity in the area is mainly grazing on pasture land with smaller areas of crop production on arable land within the AFA

OBJECTIVE 2.D **Option Scoring**

Option Score	0	Reduction in Agricultural Land Flooded
Total Weighted Option Score	0	Global Weighting x Local Weighting x Total Option Score

Economical Option Summary

Economical Score	489.404608

Envionmental Objectives

OBJECTIVE 3.A **Support the objectives of the WFD**

	Weighting	Comment
Global	16	Set Nationally
Local	5	Constant from OPW Guidance

OBJECTIVE 3.A **Option Scoring**

Option Score	-2	Positive impact wherby reduction in flood risk provides reduction in the pollution risk associated with flood events [+2] Long Term negative impacts associated with flow diversion to the same river and culverting [-4]
Total Weighted Option Score	-160	Global Weighting x Local Weighting x Total Option Score

OBJECTIVE 3.B **Support the objectives of the Habitats and Birds Directives**

	Weighting	Comment
Global	10	Set Nationally
Local	5	The proposed works are proximate to and potentially within designated sites including Natura 2000 sites of international importance. The primary designated site proximate to/within or downstream of the proposed works is the River Barrow and River Nore SAC and there is a direct hydrological connection to this SAC. In addition, the River Nore SPA is 5km downstream of all instream works.

OBJECTIVE 3.B **Option Scoring**

Option Score	-2	Risk of long term negative impacts associated with instream works within SAC boundary. Adjusted to relect lesser impact relative to other options [-2]
Total Weighted Option Score	-100	Global Weighting x Local Weighting x Total Option Score

OBJECTIVE 3.C **Avoid damage to, and where possible enhance, the flora and fauna of the catchment**

	Weighting	Comment
Global	5	Set Nationally
Local	3	The proposed works are proximate to and potentially within designated sites including Natura 2000 sites of international importance. The primary designated site proximate to/within or downstream of the proposed works is the River Barrow and River Nore SAC and there is a direct hydrological connection to this SAC. In addition, the River Nore SPA is 5km downstream of all instream works.

OBJECTIVE 3.C **Option Scoring**

Option Score	-1	Potential localised loss of or disturbance to flora/fauna resulting from construction of hard dences and piped outlet. Limited by extents and nature of works area
Total Weighted Option Score	-15	Global Weighting x Local Weighting x Total Option Score

OBJECTIVE 3.D **Protect and where possible enhance fisheries resource within the catchment**

	Weighting	Comment
Global	13	Set Nationally
Local	4	The proposed works are proximate to and potentially within designated sites including Natura 2000 sites of international importance. The primary designated site proximate to/within or downstream of the proposed works is the River Barrow and River Nore SAC and there is a direct hydrological connection to this SAC. In addition, the River Nore SPA is 5km downstream of all instream works.

OBJECTIVE 3.D		Option Scoring
Option Score	-4	Short Term Construction Phase Impacts and Permenant impacts from diversion channel within the same stream
Total Weighted Option Score	-208	Global Weighting x Local Weighting x Total Option Score

OBJECTIVE 3.E	Protect, and where possible enhance, landscape character and visual amenity within the zone of influence.	
	Weighting	Comment
Global	8	Set Nationally
Local	1	Ballyhale is located in an area outlined as a Transitional Area, which lies between the south western uplands (Landscape Character Type C) and the lower lying lands to the north(Landscape Character Area F, Kilkenny Western Basin. The landscape character of this area is defined by a smooth terrain, allowing views over long distances, and vegetation is predominantly low. Land use comprises pasturelands and tree plantations, the area is described as a rural area with scattered, low density settlement patterns.

OBJECTIVE 3.E		Option Scoring
Option Score	-1	Negative Short term impacts in the zone of visibility of the measure due to construction stage disturbance [-1]
Total Weighted Option Score	-8	Global Weighting x Local Weighting x Total Option Score

OBJECTIVE 3.F.i	Avoid damage to or loss of features, institutions and collections of cultural heritage importance and their setting, and improve their protection from extreme floods.	
	Weighting	Comment
Global	4	Set Nationally
Local	2	A number of sites/features listed on the Record of Protected Structures and/or Recorded by NIAH are present and potentially affected with a moderate to low vulnerability.

OBJECTIVE 3.F.i		Option Scoring
Option Score	1	Increase in the level of protection for architectural features (Record of Protected Structures and NIAH) from extreme flooding, such that it is less vulnerable to flood damage.
Total Weighted Option Score	8	Global Weighting x Local Weighting x Total Option Score

OBJECTIVE 3.F.ii	Avoid damage to or loss of features, institutions and collections of cultural heritage importance and their setting, and improve their protection from extreme floods.	
	Weighting	Comment
Global	4	Set Nationally
Local	2	A number of sites listed on the RMP/RPS present and potentially affected. (moderate to low vulnerability)

OBJECTIVE 3.F.ii		Option Scoring
Option Score	1	Increase in the level of protection for archaeological features (Recorded Monuments) from extreme flooding, such that it is less vulnerable to flood damage.
Total Weighted Option Score	8	Global Weighting x Local Weighting x Total Option Score

Environmental Option Summary

Environmental Score	-475

Technical Objectives

OBJECTIVE 4.A **Ensure flood risk management options are operationally robust**

	Weighting	Comment
Global	20	Set Nationally
Local	5	Constant from OPW Guidance

OBJECTIVE 4.A **Option Scoring**

Option Score	3	Negligible operational risk, i.e., no reliance on systems or intervention, with more regular monitoring and intermittent, but potentially substantial, maintenance requirements. Fixed flood defence embankments, Uncontrolled storage, Increased conveyance measures (incl. diversion channels) where maintenance required
Adjustment Factor	0	No Adjustment
Total Weighted Option Score	300	Global Weighting x Local Weighting x Total Option Score

OBJECTIVE 4.B **Minimise health and safety risk in construction, maintenance and operation of the flood risk management option**

	Weighting	Comment
Global	20	Set Nationally
Local	5	Constant from OPW Guidance

OBJECTIVE 4.B **Option Scoring**

Option Score	2	The following Hazards have been identified: working near water, working with heavy plant machinery and deep excavations
Adjustment Factor	0	No Adjustment
Total Weighted Option Score	200	Global Weighting x Local Weighting x Total Option Score

OBJECTIVE 4.C **Ensure flood risk can be managed effectively and sustainably into the future, and the potential impacts of climate change**

	Weighting	Comment
Global	20	Set Nationally
Local	5	Constant from OPW Guidance

OBJECTIVE 4.C **Option Scoring**

Option Score	0	Option is readily adaptable at limited cost to increase heights of Flood walls [E-001, E-002,], Embankments [L-001,], however the flow diversion pipe is not adaptable but wouldn't impede future flood defence measures Piped Diversion Channel [P-001]
Total Weighted Option Score	0	Global Weighting x Local Weighting x Total Option Score

Technical Option Summary

Technical Score	500