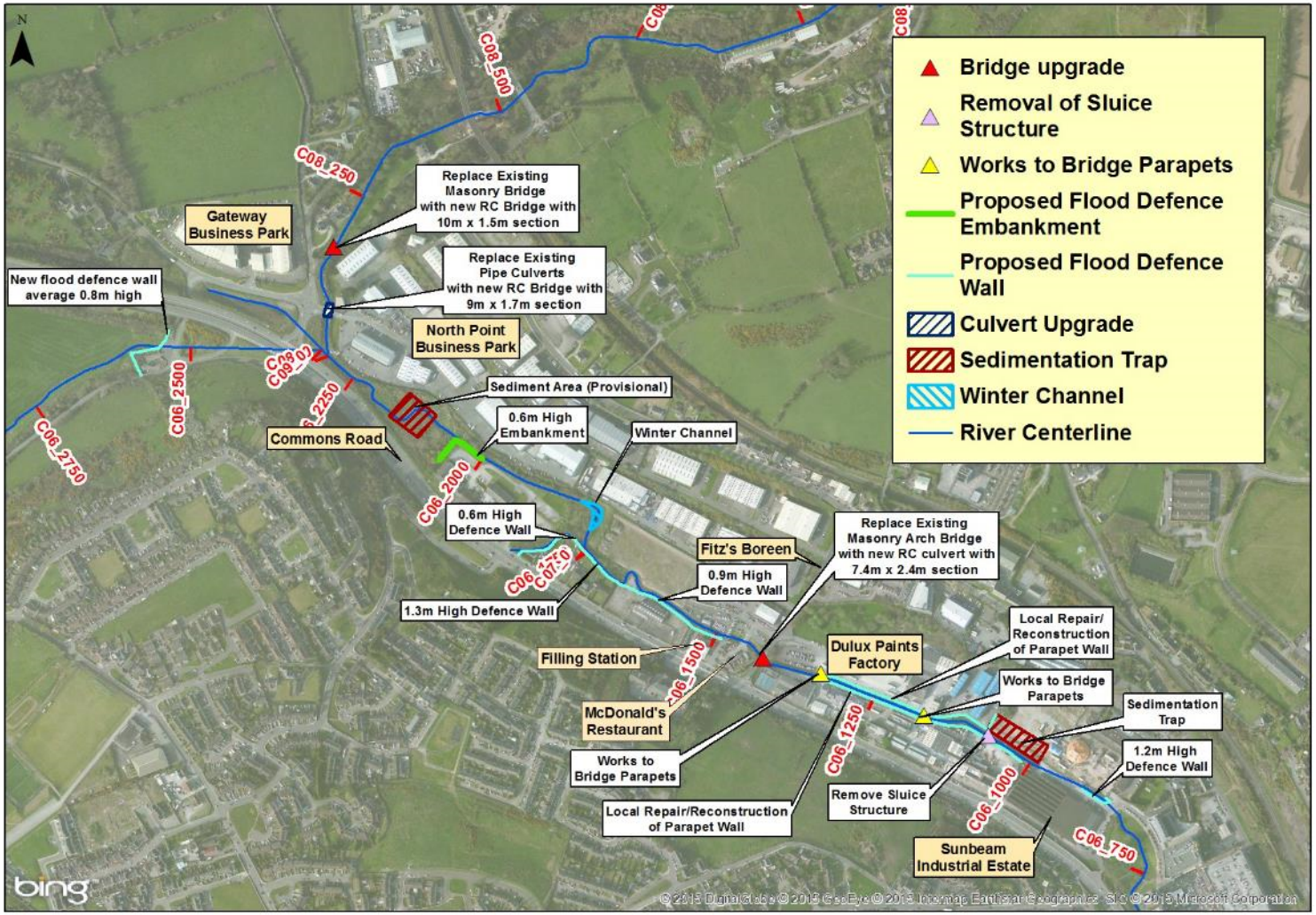


Figure 40 Option 5 – Common's Road

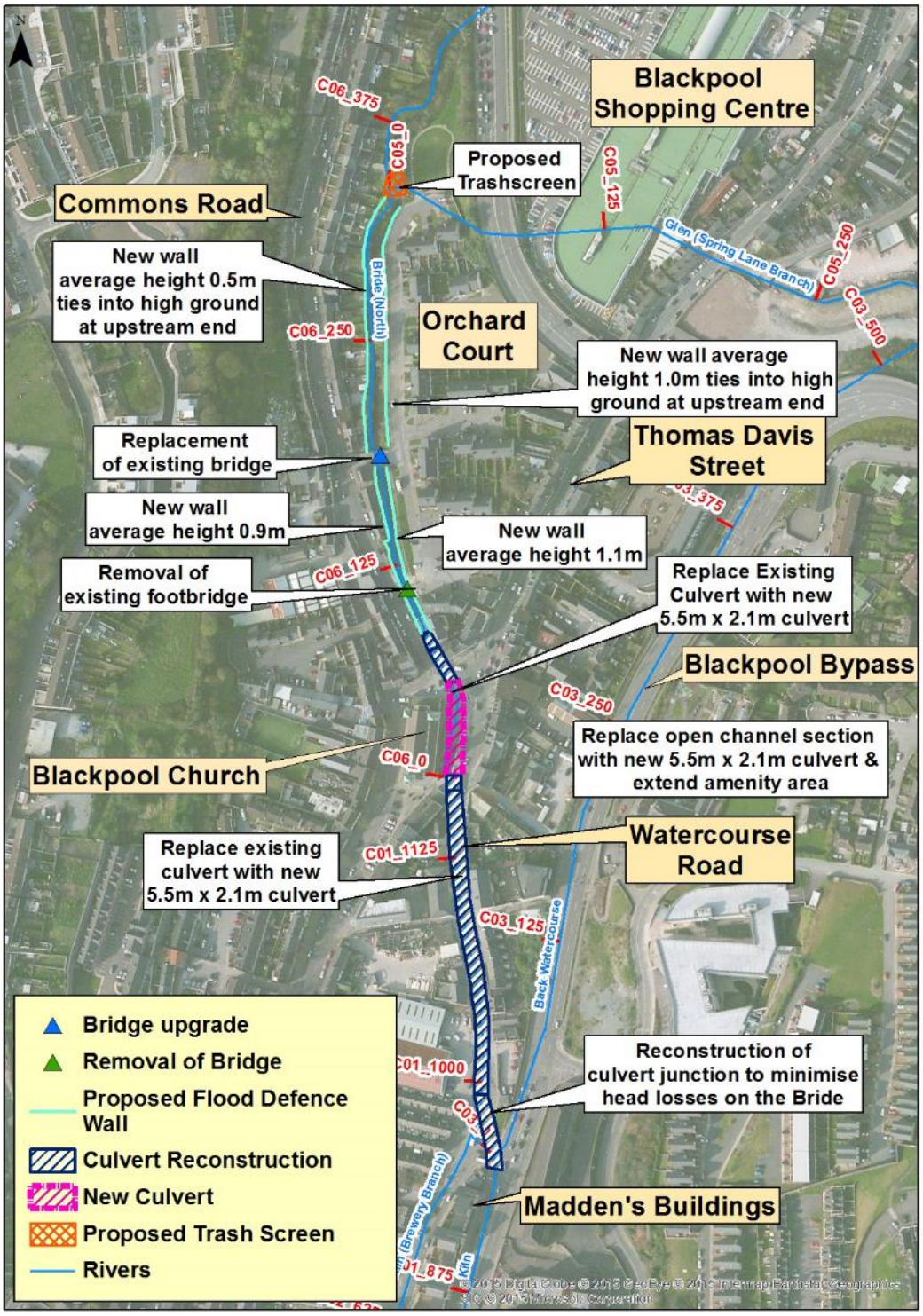


Figure 41 Option 5 – Blackpool

Table 6 Option 5 Conveyance Improvements & Direct Defences (culvert replacement from Orchard Court to Madden's Building) Summary

Area	Measure category	Chainage	Location (and Total Length of Channel Affected)	Description	Comments
All	Maintenance	C06_2306 to C06_0000, C01_1180 to C01_0000, C02_0824 to C02_0000	The Bride River from its confluence with the Glenamought River, downstream to its outfall to the River Lee (total length approximately 3470m). This measure also includes the Brewery Branch reach of the Kiln River (approximately 825m long)	Implementation of an organised channel maintenance programme throughout the reach with particular attention paid to locations where debris is likely to accumulate, such as at structures, sharp bends, culvert inlets etc. Programme to include checking and cleaning of culverted reaches.	
Commons Road Area	Defence Embankment	C06_2542 to C06_2590	Lower Kileens Road	New flood defence wall, approximately 110m long, average 0.8m high	Wall to tie into high ground at each end
	Conveyance Improvement	C08_0160	Upstream of North Point Business Park (Approximately 7m)	Replace existing masonry bridge with a new RC bridge, 10m wide x 1.5m high	Existing bridge provides access to a residential property. Alternative access to be provided during construction.
	Conveyance Improvement	C08_0000	North Point Business park (Approximately 20m)	Replace existing 3no pipe culverts with a new RC bridge 9m wide by 1.7m high	Existing bridge provides access to the business park. Alternative access to be provided during construction.
	Conveyance Improvement	C08_0000	North Point Business park (Approximately 20m)	Replace existing 3no pipe culverts with a new RC bridge 9m wide by 1.7m high	Existing bridge provides access to the business park. Alternative access to be provided during construction.
	Defence Embankment	C06_2053 to C06_2001	Commons Inn (upstream end of property) (Approximately 52m)	Construction of a new 0.6m high, 85m long flood defence embankment along right bank.	The embankment will be constructed along Commons Inn perimeter, away from any buildings.
	Sediment Management	C06_2150 to C06_2100	North Point Business park (Approximately 50m)	Provisional Natural Sediment Area	Consideration would only be given to this item if following implementation and monitoring of the scheme, it was considered necessary to supplement the function of the main sediment trap at Dulux

Table 6 (Continued) Option 5 Conveyance Improvements & Direct Defences (culvert replacement from Orchard Court to Madden's Building) Summary

Area	Measure category	Chainage	Location (and Total Length of Channel Affected)	Description	Comments
Commons Road Area	Conveyance Improvement	C06_1845 to C06_1785	Commons Inn (downstream end of property) (approximately 60m)	Creation of a compound "winter channel", facilitating higher flows to remain in bank. Measure involves reducing ground levels on the right bank by approximately 1.5m - 2m over a 60m length to create the enlarged compound channel section.	
	Defence Walls	C06_1855 to C06_1490	Upstream of Fitz's Boreen, to the rear of the properties which face out onto the N20 (approximately 270m on Bride, approximately 85m on side channel)	Construction of a new 1.3m high (maximum height), 355m long, RC defence wall along right bank of the Bride River and a side channel of the Bride.	The wall will be constructed to the rear of the residential & commercial properties. Works will be carried out from the watercourse side.
	Conveyance Improvement	C06_1425 to C06_1420	Fitz's Boreen Arch Bridge.	Replace existing 1m wide by 1.5m high twin masonry arch bridge with new RC rectangular bridge (cross section dimensions approximately 7.4m x 2.4m high)	Existing bridge provides access to the adjacent industrial park. Alternative temporary access route available.
	Defence Walls	C06_1327 to C06_1010	Dulux Paints Factory (Approximately 317m)	Existing channel walls are generally high enough to contain the 1 in 100 year event including 500mm freeboard. Local concrete repairs/joint sealing will be required over the full 317m length of the existing walls on both banks. Local reconstruction of the existing parapet wall may also be required over approximately 20% of the length.	Works will be carried out on an active industrial site.
	Defence Walls	C06_1340 to C06_1327	Dulux Paints Factory upstream bridge	Extend existing RC parapets by approximately 200mm	This measure will ensure that water does not overtop the bridge.
	Defence Walls	C06_1175 to C06_1167	Dulux Paints Factory downstream bridge	Extend existing RC parapets by approximately 300mm	This measure will ensure that water does not overtop the bridge.
	Conveyance Improvement	C06_1072	Sluice structure at Dulux Paints	Permanent removal of steel sluice structure	This measure will reduce blockage risk at this location. Existing structure appears to be abandoned and in disrepair.

Table 6 (Continued) Option 5 Conveyance Improvements & Direct Defences (culvert replacement from Orchard Court to Madden's Building) Summary

Area	Measure category	Chainage	Location (and Total Length of Channel Affected)	Description	Comments
Commons Road Area	Conveyance Improvement	C06_1072	Sluice structure at Dulux Paints	Permanent removal of steel sluice structure	This measure will reduce blockage risk at this location. Existing structure appears to be abandoned and in disrepair.
	Sediment Management	C06_1077 to C06_0989	Dulux Paints Factory (Approximately 88m)	Creation of a sedimentation trap, on the left bank of the Bride River immediately upstream of Sunbeam Industrial Estate	
	Defence Walls	C06_0916 to C06_0875	Sunbeam Industrial Estate (approximately 30m)	Construction of a new 0.6m high solid RC defence wall along both banks of the Bride adjacent to Sunbeam Industrial Estate. Length of new wall to be approximately 60m	The wall will be constructed to the rear of an industrial property on the right bank and along an internal access road on the left bank.
Blackpool	Defence Walls	C06_0360 to C06_0093	Orchard Court (full length, both banks) (Approximately 267m)	Construction of a new, stone clad solid RC wall on both banks with an average height of 1.1m above ground level. Total length of wall approximately 500m.	Construction of the defence on the right bank will be along the rear of residential properties, with construction to be mainly carried out from the watercourse side. A significant amount of Japanese knotweed is present along the channel in this reach.
	Debris Control	C06_0330	Orchard Court (northern end, in-channel) (approximately 15m)	New trashscreen structure to be constructed in the channel	
	Conveyance Improvement	C06_0190 to C06_0180	Orchard Court vehicular bridge (Approximately 10m)	Orchard Court vehicular access bridge to be replaced with a new bridge with an approximately 170mm higher soffit than existing. New bridge to be approximately 8m x 10m on plan.	The road bridge is the only vehicular access to Orchard Court. Temporary vehicular access arrangements to be provided during construction. Local amendments to road levels will be required on either side of the bridge to tie into the new bridge levels.

Table 6 (Continued) Option 5 Conveyance Improvements & Direct Defences (culvert replacement from Orchard Court to Madden's Building) Summary

Area	Measure category	Chainage	Location (and Total Length of Channel Affected)	Description	Comments
Blackpool	Conveyance Improvement	C06_0115 to C06_0110	Orchard Court pedestrian bridge (Approximately 5m)	Permanent removal of Orchard Court pedestrian bridge	The existing bridge causes significant heading up of water levels during flood events. Alternative pedestrian access to Orchard Court is available.
	Conveyance Improvement	C06_0093 to C06_0084	Orchard Court Culvert inlet (Approximately 9m)	Reconstruction of the existing culvert inlet to remove flow constriction on the Bride. New inlet to be 5.5m x 2.1m.	This measure involves the removal of existing precast cover slab, steel support beams and concrete channel walls to install new culvert inlet. This measure will require works in close proximity to the existing domestic property. Temporary works may be required to secure the property during construction. Access to the residence will be affected during construction.
	Conveyance Improvement	C06_0084 to C06_0055	Orchard Court Culvert (Approximately 29m)	Removal of the existing culvert and installation of a new 5.5m x 2.1m culvert.	Significant traffic management required during construction. Majority of existing services on Watercourse Road can be maintained/upheld during construction.
	Conveyance Improvement	C06_0055 to C06_0000	Blackpool Church (Approximately 55m)	Installation of a new 5.5m x 2.1m RC culvert section to replace existing open channel adjacent to Church.	
	Conveyance Improvement	C01_1171 to C01_0960	Blackpool Church Culvert (Approximately 211m)	Removal of the existing 4.8m x 1.6m culvert and installation of a new 5.5m x 2.1m culvert.	Significant traffic management required during construction. Existing services on Watercourse Road can be maintained/upheld during construction. A new 2x300mm diameter foul drainage siphon would need to be constructed crossing the new culvert at approximately chainage C06_1091.
	Conveyance Improvement	C01_0960 to C01_0900	Madden's Buildings (Approximately 60m)	Reconstruction of the existing culvert junction to minimise head losses for the Bride flow passing through the junction into the Kiln culvert.	Significant traffic disruption during construction. Significant number of services will need to be diverted to facilitate construction.

6 Economic Assessment of Shortlisted Options

6.1 Cost Estimate of Shortlisted Options

6.1.1 Methodology

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

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

The following costs were excluded:

- Value Added Tax.
- Cost of OPW/Cork City Council staff time on the project

6.1.2 Construction Costing Method

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

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

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

- Normal working week for construction personnel and plant.
- No exceptional adverse weather.

6.1.3 Environmental/Archaeological Monitoring, Mitigation Works and Improvement Works

Environmental and archaeological monitoring will be required during the construction of the works. It is also likely that some environmental mitigation and improvement works will be necessary. A provisional allowance of 10% of the base construction cost estimate has been included in the cost estimate.

6.1.4 Site Investigation and other Surveys

A site investigation, topographic survey, archaeological survey and CCTV drainage survey will all need to be carried out for the scheme. The total cost of these investigation and surveys is estimated to be approximately €150,000 and has been included in the cost estimate.

6.1.5 Design and Site Supervision Costs

An allowance of 10% of the construction cost has been made for design and site supervision costs.

6.1.6 Land Purchase and Compensation

OPW advised that 10% should generally be added to the construction cost of the scheme to allow for:

- Land purchases and compensation.
- Planning, highway and other third party costs.
- Administration and legal costs associated with land exchanges, statutory approvals, planning applications, service diversions, highway adoptions etc.

Contrary to the above, a higher allowance for land acquisition of 22.5% was deemed to be appropriate for the option of upstream storage option due to the likely lower capital cost but large land take required.

6.1.7 Maintenance Works Costs

The maintenance regime has anticipated costs associated with the following items:

Table 7 Scheme Maintenance Items Cost

Element	Maintenance Task	Predicted Average Frequency
Embankments	Mowing	6 months
Floodwalls	Sealant replacement	5 years
	Repointing mortar joints in cladding (say 25% of area)	25 years
Filter drains	Visual Inspection	5 years
	CCTV survey	10 years
	Granular Fill Replacement	20 years
Flap Valves	Inspection	5 years
	Replacement	25 years
Pumping Stations	Inspections, condition assessments, repairs and replacement of parts, removal of blockages and telemetry checks	5 years
	Electrical Works Replacement	20 years
	Running costs (electricity)	Annual
Sealed service ducts	Inspection	5 years

Element	Maintenance Task	Predicted Average Frequency
	Replacement	5 years
Culverts	Clearing of silt	10 years
	Full CCTV survey	10 years
Whole of the scheme	Full visual inspection	10 years
Trash screens	Cleaning of Debris	Every 2 months
Sedimentation trap	Cleaning of Debris	Annual
Flood storage reservoir	Trash screen cleaning	Every 2 months
	Maintenance of CCTV camera system	Annual
	Maintenance of Telemetry system	Annual
	Embankment mowing	6 months
	Full visual inspection	6 months
	Inspection by Supervising Engineer	6 months
	Inspection by Inspecting Engineer	10 years
	Replacement of Hydrobrake	20 years

Maintenance Costs were estimated in two ways as follows:

1. Building up the estimated costs using an estimated cost for each of the above items particular to the proposed scheme multiplied by the annual frequency of occurrence.

2. Assuming an annual maintenance cost of 1% of the Construction Cost

The latter generally resulted in the higher figure and has therefore conservatively been used.

6.1.8 Project Contingency / Optimism Bias

There is a tendency for budget cost estimates for flood defence schemes to be overly optimistic. In a project of this nature where access for labour, plant and materials will be difficult, including a robust contingency in the cost estimate is essential.

A project contingency / optimism bias of 20% has been included in the cost estimate. (This is additional to the normal construction cost contingency)

6.1.9 Allowance for Art

The “per cent for art” scheme is compulsory for all major public works contracts. For this size of project, the required allowance for art is 1% of the capital cost up to a maximum of €38,000. As all of the options considered have a value greater than €3.8m, the maximum allowance of €38,000 has been included in the cost estimate for all options.

6.2 Summary of Costs

Detailed cost build-ups for all options are contained in Appendix A.

Table 8 below summarises the total costs for each of the viable options.

Table 8 Summary of Cost

	Option 2 - Upstream Storage	Option 3 - High Walls in Orchard Court	Option 4 - Culvert in Orchard Court	Option 5 - Replace Existing Culvert to Maddens Buildings
	€	€	€	€
Construction Contract				
Construction Cost Estimate of Proposed Measures	€3,659,559	€4,641,087	€4,694,621	€5,546,469
Prelims 15%	€548,934	€696,163	€704,193	€831,970
Risks and Unmeasured Items 20%	€731,912	€928,217	€938,924	€1,109,294
Construction Archaeology & Environmental Mitigation 10%	€494,040	€626,547	€633,774	€748,773
Subtotal for Construction Cost	**€5,434,445**	**€6,892,015**	**€6,971,512**	**€8,236,506**
Add Other Related Costs				
Land Acquisition 15%	€1,222,750	€1,033,802	€1,045,727	€1,235,476
Fees and Supervision 10%	€543,445	€689,201	€697,151	€823,651
Art	€38,000	€38,000	€38,000	€38,000
Site Investigation & Surveys	€150,000	€150,000	€150,000	€150,000
Subtotal	**€7,388,640**	**€8,803,019**	**€8,902,390**	**€10,483,633**
Optimism Bias				
Optimism Bias 20%	€1,477,728	€1,760,604	€1,780,478	€2,096,727
Capital Cost Total	**€8,866,368**	**€10,563,622**	**€10,682,868**	**€12,580,359**
Maintenance Costs				
Maintenance including 20% Optimism Bias (NPV)	€1,591,798	€1,345,823	€1,361,346	€1,608,365
Total Cost Estimate				
Project Cost Total	**€10,458,166**	**€11,909,445**	**€12,044,214**	**€14,188,724**

*A higher allowance for land acquisition of 22.5% was made in the upstream storage option. This is due to the likely additional compensation costs associated with the land within the storage area.

It is noted that the most expensive option is only 30% more expensive that the cheapest option. Given the small differential in cost, and the inherent inaccuracy of budgeting at this level of detail, it should be recognised that subject to the preferred option being satisfactorily cost beneficial and offering value for money, care should be taken in not giving undue weighting to cost in selecting the preferred scheme.

6.3 Flood Damages Assessment

6.3.1 Overview

The benefit to be derived from the flood protection works is the reduction in risk of flooding to property. This risk is quantified as the expected damage to property that would occur over the lifetime of the scheme.

6.3.2 General Approach

The adopted approach assesses the damages for the Blackpool study area as a whole. It is recognised that individual properties and areas may have a positive or negative impact on the overall scheme based on their individual valuation of benefit and the cost. These differences are spread across the scheme to give a comprehensive assessment.

The damages assessment has not made allowance for the additional depths of flooding caused by climate change.

6.3.3 Guidance

The analysis has been carried out in accordance with the OPW guidance document "Lower Lee, Douglas and Glashaboy Flood Relief Schemes: Economic Damage Assessment and Cost Benefit Analysis (Rev B)". This guidance document sets out a common approach to the calculation of monetised economic flood damages and the economic benefits of flood risk management options, and for undertaking a cost-benefit analysis.

Flood damage data has been assessed from the "The Benefits of Flood and Coastal Risk Management: A Manual of Assessment Techniques (2014)" published by the Flood Hazards Research Centre at Middlesex University. This document is often referred to as the "Multi-coloured Manual" (MCM)

6.3.4 Assumptions

6.3.4.1 Damage Allowances

The calculation of flood damage for both residential and commercial properties can be classified into two broad categories:

Tangible Damages

These can be quantified in monetary terms, such as the reduction in flood damage costs from improvements in the standards of flood protection. Tangible damages are divided into the direct and indirect.

Direct tangible damages result from the physical contact of flood water with property. The damage magnitude may be taken as the cost of the property restoration to its condition prior the flood event, or its loss in market value if restoration is not worthwhile. Direct damages are a function of many variables including the physical make-up of the property and the characteristics of the flood event, including the depth and duration of flooding.

The unit damages for residential properties used the MCM "initial appraisal" approach. This is because the MCM 2014 "full-scale appraisal" only includes damages broken down by social class. As per OPW guidance, social class is to be excluded from the damages assessment for this project.

The unit damages for non-residential properties used the standard depth/damage curves from chapter 5 of the MCM 2014.

Indirect tangible damages are losses caused by disruption of physical and economic linkages to the local/national economy. Examples include the costs of emergency services of a flood event, and the interruption of traffic flows. MCM 2014 estimates the cost of emergency services as between 5.6% and 10.7% of the direct tangible damages (direct tangible damages are referred to as the "Principal Direct Damages" (PDD) in the OPW guidance note). OPW guidance directs that an allowance of 8.1% of the PDD be included in the damages assessment to account for emergency services. OPW guidance states that this allowance is deemed to include evacuation costs.

An allowance of 20% of the PDD has been included to account for damage to infrastructural utility assets.

The cost of interruption of traffic flows is more difficult to determine, therefore as a conservative assumption this element of the indirect tangible damages has been ignored.

As per OPW guidance, loss of business costs for commercial properties, damage to roads, damage to parked cars, environmental damage, personal evacuation costs, temporary accommodation and extra heating costs have also been ignored.

The damage costs associated with risk to life have also been excluded as per OPW guidance. This has been excluded as loss of life due to flood events is very rare in Ireland.

Intangible Damages

These are difficult to quantify in monetary terms as they include human stress and anxiety, inconvenience and ill health associated with frequent, repeat flooding.

In accordance with OPW guidance, the flood damage assessment undertaken for the scheme has used the PDD as a guide to estimating the Intangible Damages. The guidance distinguishes between residential and non-residential properties:

- For residential properties the intangible flood damages are set equal to the total direct property damage;
- For commercial premises that are not family owned such as office spaces, retail outlets and chain stores, the intangible flood damages have been taken as zero as a conservative approach. In the context of Blackpool, this category includes Dulux, Blackpool Retail Park, Blackpool Shopping centre and Heineken Brewery.
- For small family owned business, the intangible flood damages are set equal to the total direct property damage. In Blackpool, this includes the majority of local businesses downstream of Orchard Court in Blackpool village itself. (With the exception of Heineken). This reflects and recognises the well documented significant negative impact on the local business community in Blackpool over the last few decades.

6.3.4.2 Thresholds of Flooding

The threshold of flooding is that level at which flooding will start to occur. For this scheme, the threshold of flooding for each property is determined based on the 2D hydraulic model results, and the assumed / surveyed floor level for each property. Note that where no threshold survey information was available, it was assumed that the ground floor level of each property is 150mm above the Lidar ground level.

6.3.5 Damages Assessment GIS Tool

Arup has developed an in-house GIS tool which was used to support the calculation of flood damages for the study area. The tool creates a single dataset of all the residential and commercial properties in the study area and estimates the flood depths for the various return period at each property using the 2D hydraulic model results. The tool then assigns flood damages to each property using the flood damage data in the MCM.

The datasets used by the tool are as follows:

- **Geodirectory dataset** – for determining the building type and use. In Geodirectory, the economic activity associated with each property is held as a NACE code (Nomenclature of Economic Activities). NACE is the European statistical classification of economic activities. Where discrepancies were found, the properties were inspected on site or through use of "street view" imagery freely available online, and amended accordingly;
- **OSi NTF dataset** – for calculating the area of the commercial properties;
- **2D hydraulic modelling results** – water levels to OD Malin for eight separate return period events are used by the tool to determine the extent and level of flooding in Blackpool. Subtraction of the property threshold level from the water level yields the depth of flooding at each property for all return period events;
- **Lidar data** – for estimating the ground level of all the properties in Blackpool. It has been assumed that the threshold level of all the properties is 150mm above the Lidar ground level.

It was noted that some discrepancies exist between the Geodirectory and NTF datasets. The property dataset therefore required some manual editing to ensure it correctly represented the properties in Blackpool.

The FHRC damage figures have been converted from UK Sterling to Euro by means of Purchasing Power Parity (PPP) as per OPW guidance. As the damages data in the MCM is dated 2014, it was deemed to be unnecessary to adjust for inflation.

Capping values for both residential and commercial properties were determined using the residential property price register and commercial leases register. Following OPW guidance the commercial capping values were calculated as ten times the current rateable value of the property.

6.3.6 Damage Analysis Results

Estimated damages versus frequency is assessed for each return period with increasing numbers of properties affected and properties affected to a greater extent for higher return periods. Figure 42shows the damage-frequency graph for Blackpool. The Present Value Damage is equal to the area beneath the curve.

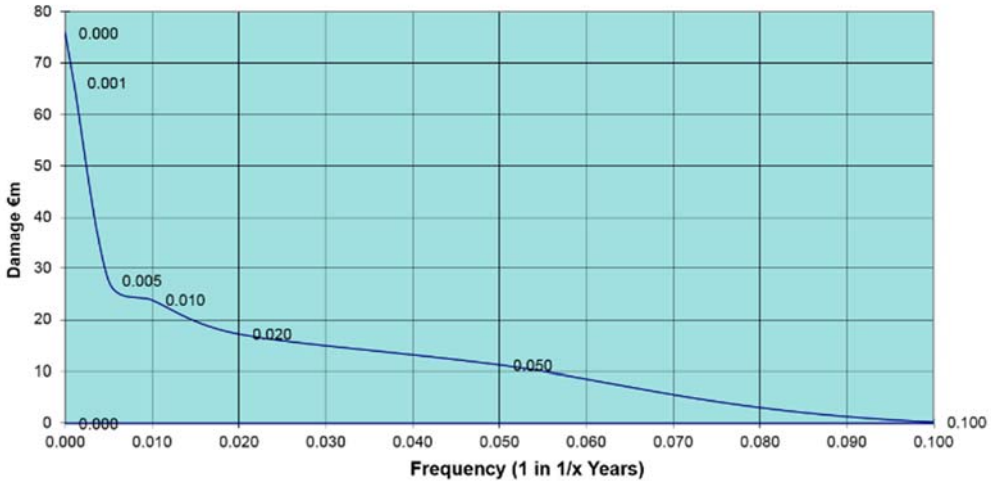


Figure 42 Damage-Frequency graph for Blackpool

The various elements of the flood damages are shown in Table 9.

Table 9 Summary of Flood Damages

Category	Damage for 1%AEP Fluvial Event (€m)	Annual Average Damage (€m)	Present Value Damage (50 year time horizon) (€m)
Direct Residential	3.67	0.2	4.38
Direct Non-Residential	8.07	0.46	10.28
Principal Direct Damages	**11.74**	**0.66**	**14.66**
Intangible (Residential)	3.67	0.2	4.38
Intangible (Non - Residential)	5.08	0.27	6.01
Emergency Services	0.95	0.05	1.19
Utilities	2.35	0.13	2.93
Total	**23.78**	**1.31**	**29.17**

6.4 Cost Benefit Analysis of the Options

6.4.1 Costs

6.4.1.1 Present Value Costs

The Present Value Costs provide an indication of the cost today of the works over their lifetime.

6.4.1.2 Capital Works Costs

The present value of costs is based on a 50-year design life for each option or scheme that is capable of protecting against a 1 in 100 year flood event. The Capital Works Costs have been calculated as described in Section 6.1.

Capital costs taken from above are added into the Cost Benefit Analysis (CBA) on the basis that one quarter will be expended in 2016 (Year 0), one half in 2017 (Year 1), and one quarter in 2018 (Year 2).

6.4.1.3 Maintenance Costs

The maintenance cost has been spread over the 50 year life span of the scheme, starting in year 4 (2019) coinciding with the completion of the scheme.

6.4.2 Economic Comparison

OPW has advised that the appropriate discount rate to be applied should be 4%.

6.4.3 Cost Benefit Analysis Summary

Detailed cost-benefit calculations are contained in Appendix A.

Table 10 represents the Cost Benefit Analysis based on Discount Rate of 4% which is the rate recommended by OPW following previous studies.

Table 10 Cost Benefit Analysis Summary

	Option 1	Option 2	Option 3	Option 4	Option 5
Present Value Costs (PVc)	€0.503m	€10.12m	€11.51m	€11.64m	€13.71m
Residual damages (100 year scheme) (PVd)	€29.17m	€10.53m	€10.53m	€10.53m	€10.53m
Present Value Benefit (PVb)	-	€18.65m	€18.65m	€18.65m	€18.65m
Net Present Value (NPV)	-	€8.53m	€7.14m	€7.01m	€4.93m
Benefit Cost Ratio (BCR)	-	1.84	1.62	1.60	1.36

6.4.4 Sensitivity Analysis

The control of all risks is impossible and therefore the economic robustness of the scheme has been investigated using sensitivity analysis. In order to investigate the least credible level of benefits, sensitivity analyses were carried out for the following alternative scenarios:-

- 5% reduction in flood damage benefits
- 3% discount rate
- 5% discount rate

Table 11 Sensitivity Analysis for 5% Reduction in Benefit

	Option 1	**Option 2**	**Option 3**	**Option 4**	**Option 5**
Present Value Costs (PVc)	€0.503m	€10.12m	€11.51m	€11.64m	€13.71m
Present Value Benefit (PVb)	-	€17.71m	€17.71m	€17.71m	€17.71m
Net Present Value (NPV)	-	€7.59m	€6.21m	€6.08m	€4.00m
Benefit Cost Ratio (BCR)	-	1.75	1.54	1.52	1.29

Table 12 Sensitivity Analysis for 3% Discount Rate

	Option 1	**Option 2**	**Option 3**	**Option 4**	**Option 5**
Present Value Costs (PVc)	€0.60m	€10.20m	€11.60m	€11.73m	€13.83m
Present Value Benefit (PVb)	-	€22.07m	€22.07m	€22.07m	€22.07m
Net Present Value (NPV)	-	€11.87m	€10.46m	€10.33m	€8.24m
Benefit Cost Ratio (BCR)	-	2.16	1.90	1.88	1.60

Table 13 Sensitivity Analysis for 5% Discount Rate

6.4.5 Conclusion of Benefit Cost Analysis

Benefits and costs for all options were compared with those of the "Do Minimum" case to provide a convenient common baseline against which the proposed scheme can be assessed.

The Cost Benefit Analysis was tested for sensitivity versus a 5% reduction in benefit, and also a varied discount rate.

Sensitivity analysis was not undertaken for cost underestimation as the cost estimate used already includes for Optimism Bias.

The Cost Benefit Analysis shows that all options are cost-beneficial (excluding do-minimum). The options are listed below in order of strongest to weakest cost-benefit ratios.

1. Option 2 – Ballincrokig flood storage, combined with conveyance improvements and direct defences in Common's Road/Blackpool
2. Option 3 – Conveyance improvements and direct defences (with high walls in Orchard Court).
3. Option 4 – Conveyance improvements and direct defences (with culvert through Orchard Court). (Note that difference with Option 3 is marginal)
4. Option 5 – Conveyance improvements & direct defences (culvert replacement from Orchard Court to Madden's Building).

7 Environmental Assessment of the Shortlisted Options

An Environmental Assessment of the shortlisted options was undertaken by the Project Environmental Consultants and is reported in separately in the Environmental Impact Statement[4].

The findings of environmental assessment were incorporated into the scoring of the relevant sections of the Multi Criteria Analysis which is summarised in the following section of this report.

[4] The EIS can be downloaded from the project website at www.lowerleefrs.ie

8 Climate Change Adaptability

In considering the merits of the potential options, it is important that the short term proposals are considered in the context of a longer term strategy which is flexible and adaptive to changes in the climate and its potential impact on flood risk.

The Bride System through Blackpool is predominantly a constrained canalised system in a heavily urbanised environment. This severely constrains the available options both in the short and the long term.

The existing system has insufficient in-bank conveyance capacity both in the short and longer term.

The options considered in terms of both the short term scheme and the long term strategy can be categorised as variations of the following approaches:

1. Reduce peak flows through the at-risk areas through upstream storage.
2. Increase conveyance by replacement of existing restrictions through the at-risk area.
3. Direct Defences to protect property in the at-risk area against out of bank flooding.

Figure 43 presents the Climate Change Adaption Strategy options for Blackpool in the context of each option considered for the present day scheme.

The adaptability of the various options is discussed in further detail in the following sections.

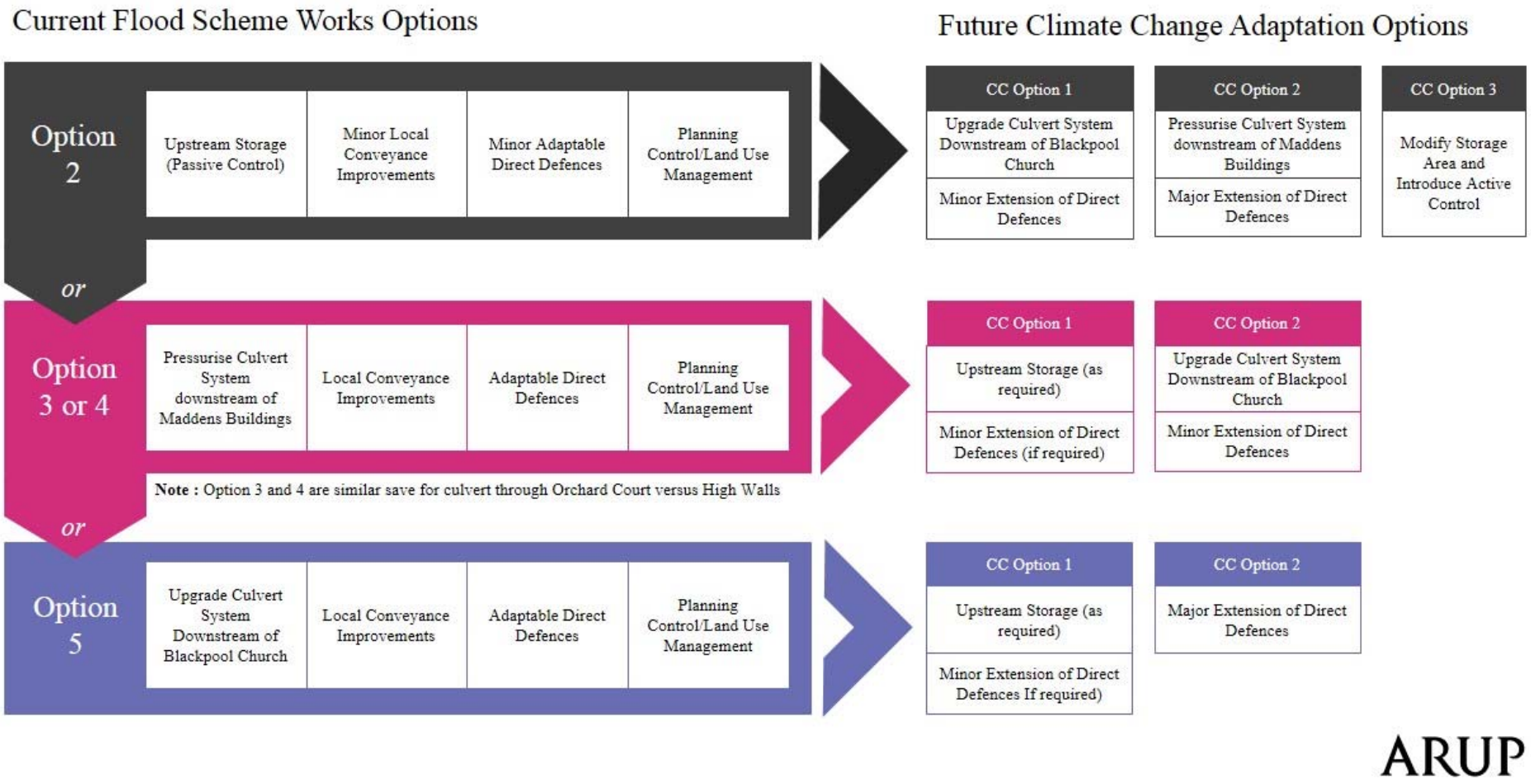


Figure 43 Climate Change Adaptation Strategy Options

8.1 Upstream Storage

The storage area on the Glenamought at Ballincrokig has the potential to significantly reduce peak flows on the Bride and is something which could be considered either in the short term or as part of a longer term strategy for climate change adaptation.

Because there is a large proportion of the catchment downstream of the storage area, from which run off will increase in the climate change scenario, the potential benefit of the storage area in reducing peak flows at Blackpool will diminish as climate change takes hold. This means that it is unlikely to be a long term solution in itself and will likely have to be undertaken in parallel with either direct defences and/or conveyance improvements in the long term. It also means that any storage area would likely need to be operated in a more dynamic and targeted way to maximise its potential benefit.

If storage is not chosen as the preferred option for the current scheme, we would recommend that the following be considered as part of the ongoing flood risk management strategy for the catchment to facilitate a potential future storage area at Ballincrokig and/or potential on the Glen upstream of the Blackpool Bypass,:

1. Planning Control – Liaise with Cork County Council to ensure appropriate zoning of potential storage areas (such as the potential Ballincrokig storage area or the Glen Storage area) and the related downstream at-risk area (area potentially affected by a breach of any future storage area) to ensure that any future development does not diminish the potential for a storage area at this location in the future.
2. Planning Control – Liaise with Cork County Council to ensure that planning policy in the Bride/Kiln Catchment (including Glenamought and Glen subcatchments) requires that any new development (or redevelopment) incorporates attenuation and SuDS to attenuate peak run off in the 1% AEP event to Greenfield runoff rates (so as not to erode the standard of defence of the current scheme)
3. Consider the installation of permanent rain gauges at suitable locations which will complement the existing flow gauge network recently installed to provide good quality rainfall data which will allow a greater understanding of spatial variation in rainfall within the catchment in the medium term and inform any future hydrological assessment of the catchment. Such gauges could also be integrated into any telemetered flood forecasting/operational system which might be considered in the future to actively manage peak flows from the various sub-catchments.

As the information to be gathered from item 3 above, would by necessity take a considerable period of time, it appears that this solution may be more suited as a solution which would be implemented as part of a future climate change adaptation of a flood relief scheme, rather than being undertaken now.

8.2 Conveyance Improvements

As noted above, the existing Bride system is heavily constrained through the urban areas of Blackpool and Cork City.

To increase the capacity of the system to pass larger flows, local conveyance measures should be undertaken at the various throttles in the system. This could be done on a phased basis with priority given to replacing those structures which limit conveyance the most and which can be practically undertaken at reasonable cost in the shorter term.

In terms of the Blackpool area, the significant throttles at Fitz' Boreen and Sunbeam can reasonably be replaced and enlarged in the short term.

However, the replacement of the under capacity culvert between Blackpool Church and Madden's Buildings is more problematic. Because of the geometry and structure of the previous culvert installation, the narrowness of the street and the proximity of the old adjoining terraced housing, its replacement with a suitably sized larger culvert in the short term would prove very difficult, be very expensive and comes with a high risk of adjoining property damage. For this reason, it may be that holding this option in reserve for climate change adaptation may prove a more viable options.

If it is decided to not upgrade the culvert in the short term, we would recommend that the following be considered as part of the ongoing flood risk management for the catchment to facilitate a potential future upgrading of the culvert between Blackpool Church and Madden's Buildings, we would:

- Planning Control – Liaise with Cork City Council to ensure that any future development along Watercourse Road between Blackpool Church and Madden's Buildings be required to take account of, or facilitate, the potential future widening of Watercourse Road to facilitate a future installation of a larger replacement culvert.

It should also be noted that the Brewery Branch is a fundamental part of the system in conveying the combined flow from the Bride and the Glen as far as the River Lee. In the climate change scenario, the combined capacity of both culverts will be insufficient to cater for any increased flow, meaning that unless upstream storage is utilised to decrease peak flows, one or both culverts will need upgrading. As the new Kiln Culvert is the newer and larger of the two, and located under the primary road artery into the city from Limerick, it appears prudent to plan for the upgrade/replacement of the old Brewery Branch. Some sections of the Brewery Branch will have sufficient capacity but others will need upgrading. This could be done in a piecemeal fashion as the various land holdings are developed.

To facilitate a potential future upgrading of the Brewery Branch between Madden's Buildings and the River Lee, we would recommend that the following be considered as part of the ongoing flood risk management for the catchment:

- Planning Control – Liaise with Cork City Council to ensure that a potential future corridor for a replacement/relocated Brewery Branch is identified and ensure that any future development along or in the vicinity of this corridor be required to take account of the potential future requirement to install a larger replacement culvert along its route.

8.3 Direct Defences

The scale of flood defences to be constructed depends on both the design flow and any restriction in conveyance along the affected length.

Therefore, the heights of flood defences required to be constructed as part of a proposed scheme to address the current flood risk would decrease across the entire scheme if the flood storage option was implemented as part the current scheme.

Flood defence heights at the lower end of the system would similarly be reduced if the culvert downstream of Blackpool Church was upgraded as part of the scheme.

In the absence of either upstream storage or culvert replacement downstream of the Church, the required heights of flood defences would generally be acceptable, with the exception of Orchard Court. As such, there is no major impediment to construction of defence walls as a primary element of a scheme at present.

Normally, in OPW flood defence schemes, defence walls are designed so that they can be extended in the future to take account of the potential effects of climate change.

In this particular scheme, it is envisaged that the defence heights downstream of Sunbeam could not be reasonably extended in the future to take account of climate change due to the likely impact of the significant increase which would be required because of the sensitivity of the downstream culvert system. For this reason, it is considered that the climate change adaptation policy in this reach would be either the introduction of upstream storage or the replacement of the downstream culvert (so that increases in the required wall height would not be required.)

Upstream of Sunbeam, it is considered probable that the longer term strategy for climate change adaptation would be Upstream Storage. Failing that, defence wall heights could feasibly be increased, and therefore, it is recommended that the design of defence walls along this reach, allows for future raising.

If either the storage option and/or the replacement of the culvert downstream of Blackpool Church was to form part of the current scheme, the extent and heights of defences required for the current scheme would reduce. However, in this scenario, we would recommend that the defence walls be designed to allow for extension to the heights required if these measures were not implemented to allow for the reduction of the benefit of these other measures in the climate change scenario.

9 Multi-Criteria Assessment of the Shortlisted Options

9.1 Introduction

The effectiveness of each of the viable options can be measured in terms of how it achieves a set of flood risk management objectives. This section describes the detailed multi-criteria analysis (MCA) of the shortlisted options which was carried out to evaluate the performance of each option in terms of predefined objectives. As part of this process, each objective was given a global and local weighting. Each option was then scored relative to the present day situation (baseline condition), based on how well they met the objectives. The output from this stage was a total weighted score for each option. The option with the highest MCA Benefit/Cost ratio is deemed the most desirable, subject to professional judgement exercised by the project's designers/steering group (as appropriate).

The determination of suitable local weightings and scorings for each of the criteria were determined through a workshop forum held with key representatives of OPW, Cork City Council, Cork County Council, Arup and Ryan Hanley/McCarthy Keville O'Sullivan (environmental consultants for the scheme).

This ensured that the combined expertise and experience of all relevant specialists and disciplines were brought to bear in a transparent fashion in the scoring of each option.

9.2 Flood Risk Management Objectives and Weightings

The flood risk management objectives were categorised as follows:

- Technical
- Economic
- Social
- Environmental

The categories were sub-divided into objectives (see Table 14). Each objective was weighted to reflect its importance and/or sensitivity, and to ensure that the objectives most relevant to the location under consideration were given priority in the decision-making process.

Two types of weighting were used:

- Global weighting (ranging between 5 and 30) which applied a weighting, fixed by the OPW at a national level, to each objective used. The global weightings are shown in **Table 14**.
- Local weighting (ranging between 0 and 5) which was specific to the importance of each objective in the location where the option was being considered. The local weightings are shown in **Table 15.**

Table 14 Flood Risk Management Objectives and Global Weightings

Category	Objective	Global Weighting
Technical	Operationally Robust	20
Technical	Health & Safety Risk	20
Technical	Adaptability	20
Economic	Economic Return	30
Economic	Transport and utility Infrastructure	10
Economic	Agriculture	10
Social	Risk to Human Health	30
Social	Community Risk	10
Social	Risk to Social Amenity	5
Environmental	Water Framework Directive Objectives	15
Environmental	Habitats and Birds Directives Objectives	15
Environmental	Flora and Fauna	5
Environmental	Fisheries	5
Environmental	Landscape Character	10
Environmental	Cultural Heritage	10

Table 15 Local Weightings

Importance	Local Weighting
Major / International importance	5
Significant / National importance	4
Medium / Regional importance	3
Minor / Local importance	2
Negligible importance	1
Not relevant	0

9.3 Scoring

Each option was then scored relative to the present day situation (baseline condition), based on how well they met the objectives. The scores used ranged between -999 and 5 as shown in Table 16.

Table 16 Scoring System

Impact	Score
Achieving aspirational target	5
Partly achieving aspirational target	3
Exceeding minimum target	1
Meeting minimum target	0
Just failing minimum target	-1
Partly failing minimum target	-3

Impact	Score
Fully failing minimum target	-999
Uncertain	N/A

A description of the minimum targets and aspirational targets for each objective are included in Appendix B.

9.4 MCA Assessment

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:

5. WS = Weighted Score
6. GW = Global Weighting
7. LW = Local Weighting
8. S = Score

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

The detailed MCA assessment is included in Appendix B.

9.5 Summary

Table 17 summarises the results of the MCA analysis.

Table 17 MCA Summary Results

	Option 2 Upstream Storage	Option 3 High Walls in Orchard Court	Option 4 Culvert through Orchard Court	Option 5 Culvert Replacement
MCA Benefit Score	1880	2025	2140	2115
Option Selection Benefit Score*	2280	2525	2740	2715
NPV Capital Costs (€m)	10.12	11.51	11.64	13.71
MCA Benefit/Cost Ratio	0.19	0.18	0.19	0.15
NPV Economic Benefit (€m)	10.71	10.71	10.71	10.71
Economic Benefit/Cost Ratio	1.06	0.93	0.92	0.78

Note: The Options Selection Score excludes the score for the Technical Criteria

The analysis suggests that all options are very close in terms of MCA benefit/cost ratios, with option 4 being marginally the most favourable.

Option 4 also scores the highest in terms of both MCA Benefit Score and Option Selection Benefit Score.

Full details of the individual scores for each criteria for each option, together with the rationale for same, is included in Appendix B.

10 Selection of Preferred Option

The extent and severity of the flood risk in the study area was first established through a hydrology study, hydraulic modelling, flow monitoring, etc.

A range of potential flood risk management measures were reviewed as part of an initial screening exercise.

A number of potentially viable flood risk management options were then developed to outline design level, including hydraulic modelling, outline design and costings.

The benefits of defending to the design standard of 1 in 100years was then established to inform a detailed cost benefit analysis.

Significant Public Consultation was carried out throughout the project and is considered to be and have been a vitally important part in the evolution of the proposed scheme and the ultimate decision on a preferred option. This consultation consisted of two public consultation days, one at early Constraints Stage and a second at Emerging Preferred Options Stage, as well as statutory consultation with all relevant stakeholders, extensive face to face landowner consultation and active and regular formal meetings with the Blackpool Flooding Group who have been instrumental in the success of the project to date. The feedback from this consultation process has been carefully considered and taken on board in finalising the scheme, and it is noteworthy that this feedback has resulted in some significant changes from the emerging preferred option initially exhibited in July 2014.

The options were also holistically reviewed by the project team as they were developed, and relevant issues were discussed within the Steering Group.

A final decision on the preferred option was made based on a holistic evaluation of the following key aspects:

- Findings of Cost Benefit Analysis
- Findings of Multi-Criteria Analysis
- Consideration of the key core messages which arose during the stakeholder consultation process
- Consideration of Key Risks
- Consideration of Climate Change Adaptability
- Combined professional judgement of the steering group members

The following sections summarise the critical issues with each potential option, along with reasons for ruling the options out where relevant.

10.1 Option 1 – ‘Do-Minimum’.

This option was ruled out, as the flood risk in the catchment would remain at similar levels to the existing case. This option was primarily used as a baseline to compare with the other options.

10.2 Option 2 – Ballincrokig flood storage, combined with conveyance improvements and direct defences in Common's Road/Blackpool

Based on the assessment carried out, this appeared to be a strong option. It has the strongest cost-benefit ratio, and also gave similar results to the other options in the multi-criteria analysis. However, a number of key issues/concerns resulted in this option being ruled out as an immediate solution:

- Given the absence of a significant existing flood risk in Ballincrokig and its location significantly remote from the at risk area of Blackpool, the appropriateness of the construction of a major flood storage embankment/dam impounding a large volume of flood water and thus creating a new potential hazard (risk of breach or overtopping) upstream of the Ballincrokig community was considered questionable. It was considered that such a solution would understandably meet significant local opposition and would likely result in high risk to the project timescale and budget.
- A passive flow control on the outlet to the storage reservoir was deemed to be desirable in this option. However, it was established that for a passive control system work, a significant area of land in the storage area would be flooded on a much more frequent basis than at present. This would effectively sterilise a large area of productive farmland.
- While the storage area would attenuate flows from a large portion of the catchment, the catchment downstream of the storage area is still a significant area and a significant proportion of the overall catchment to the at risk area in Blackpool. It was established that this unattenuated part of the catchment could in itself potentially generate a flow large enough to pose a flood risk in Blackpool. Sensitivity tests were carried out which verified this risk. It was established that in order to manage the sensitivity to changes in flow, defences would be required downstream similar to the other options. Furthermore, it is considered unlikely that the storage area could continue to be utilised passively in the climate change scenario due to the likely increased flows downstream requiring either active management of the storage area in conjunction with extensive live telemetered gauge data and or downstream defences. In other words, it would have limited adaptability for climate change.
- The Bride/Glenamought catchments were effectively ungauged up to the start of this project, so much of the hydrology is based on ungauged catchment hydrology, calibrated using gauge information from gauges in the Upper Lee. Some information was obtained from the hydrometric gauges installed at the beginning of the project. However, significant uncertainty remains around peak flows, hydrograph shapes and the spatial distribution of rainfall between the Upper Lee and the Bride/Glenamought catchment.
- There are a number of likely geotechnical challenges at the proposed storage location such as a significant risk of seepage requiring the need for significant and deep cut-off, the potential of encountering existing wells and the probable presence of a an area of scree. While none of these issues are insurmountable, they significantly increase the risk to the project.

In conclusion, it was considered more appropriate to review this option as a climate change adaptation strategy rather than undertaking it presently. This

would involve liaising with the planning authority in terms of future planning control to preserve the potential to utilise this area for controlled storage in the future, at which stage a significant record length of gauge data will be available to provide greater confidence in the required design flows, spatial variation of rainfall and actual required storage volumes.

It is therefore considered more appropriate at this stage to develop a solution to manage flows locally through the at risk area using a suitable combination of conveyance improvements where possible and direct defences elsewhere.

10.3 Option 3 – Conveyance improvements and direct defences (with high walls in Orchard Court).

The works on Commons Road in this option consist of a mixture of conveyance improvements and direct defences. No major engineering drawbacks were identified with the solution, and the layout/arrangement of the works was considered optimal. The Commons Road element of these works are consistent across Options 3, 4 and 5.

The proposed solution in Blackpool Village and in particular through Orchard Court were developed taking into account the feedback received from Inland Fisheries Ireland, who expressed a strong desire to maintain the Bride in Orchard Court as an open channel. However, in retaining an open channel, the results of the hydraulic modelling indicated that very high defence walls would be required to contain flood waters. Whilst there were some reservations about the visual and social impacts of such a solution, this option was ultimately exhibited as the emerging preferred option in July 2014. The feedback on this option from the public, demonstrated a consistent and repeated message that this option would be publicly unacceptable and not a solution which the local community could support. A strong preference for the culverted alternative was voiced.

This feedback together with the competing and opposing desire of Inland Fisheries was considered by the Steering Group and was appropriately and transparently scored in the MCA analysis. The MCA analysis indicated that when considering all constraints (including the above) in a holistic way, the culverted option scored marginally more favourably. In addition to the above, there was no viable alternative to the culvert to address the concerns or the local community about the negative impacts of the high walls, whereas it is considered that there are opportunities further upstream in the catchment to compensate or mitigate any local loss of fish habitat in the short length of culverted section through Orchard Court. Such compensatory measures includes the de-culverting of a significant length of culvert through Sunbeam as well as a commitment from OPW to provide appropriate funding to IFI for other mitigation measures in the wider catchment, to be agreed with IFI.

Accordingly, the option incorporating high walls through Orchard Court was discounted.

10.4 Option 4 – Conveyance improvements and direct defences (with culvert through Orchard Court).

This option was developed using Option 3 above as a basis.

The works on Commons Road are essentially identical to what would be required in Options 3 and 5.

In Blackpool Village, in order to alleviate the local concerns, this option replaces the high walls in Orchard Court with a pressurised culvert.

This option was marginally the most favourable in terms of MCA benefit/cost ratios, MCA Benefit Score and Option Selection Benefit Score.

It also had the second strongest cost benefit ratio of the options assessed (after the storage option).

When this option was reviewed holistically in the context of the other options, it was clear that this option had the least amount of drawbacks while still achieving the objectives of the project.

10.5 Option 5 – Conveyance improvements & direct defences (culvert replacement from Orchard Court to Madden's Building).

A number of issues combined to rule this option out:

- An assessment of the available width for a new larger replacement culvert on Watercourse Road was carried out. It was determined that due to the presence of existing services, drainage and sacrificial temporary works undertaken during the previous installation, there would be insufficient width to install a culvert large enough to pass the design flow without surcharging. For this reason, new flood walls would still be required in Orchard Court in this option, which would significantly increase the cost of the works.
- It would be the most disruptive of all options for residents, motorists, and businesses in particular, as Watercourse Road would need to be closed for several months during the works.
- There would be considerable risk of property damage to the existing terraced housing along Watercourse Road.
- It was considered that this option would be the most technically challenging to construct of all options considered.
- It would be the most expensive of all four options with very significant risks of time and cost overruns.
- It was therefore ruled out given the other more favourable alternatives.

10.6 Conclusion

Each of the options were subject to detailed assessment as they were developed.

It was found that the standard decision support tools for options assessment (CBA and MCA) resulted in very small differences between the options and can therefore only be used as indicators on which to inform the use of professional judgement, i.e. it is a decision support tool, not a decision making tool.

Therefore a decision on the preferred option was ultimately made by careful and holistic professional consideration of all of the various issues, resulting in Option 4 being chosen.

11 Refinement of Preferred Option

11.1 Detailed Freeboard Analysis

11.1.1 Introduction

Once the preferred option was chosen, a detailed freeboard analysis was undertaken of the preferred option to establish the sensitivity of the proposed solution to uncertainty in hydrological estimation, hydraulic modelling etc. and to incorporate an appropriate freeboard to ensure that the proposed solution is suitably resilient.

This process is outlined below.

11.1.2 Hydrological Uncertainty

As the Blackpool catchment was ungauged until the start of this study, the hydrological estimation of design flows was largely based on methodologies for ungauged catchments, including the use of FSU methodologies. However, the findings of the detailed analysis carried out on the wider Lower Lee catchment were adopted in determining a Qmed adjustment factor.

Similar work on the Glashaboy Flood Relief Scheme suggests that this adjustment may be conservative as it is significantly influenced by the western headwaters of the Lee which are less representative of the catchment in Blackpool than perhaps the Glashaboy catchment. Nonetheless, the more conservative figure was used.

As part of the sensitivity analysis a POT analysis was carried out on the approx. two years of data received from the recently installed gauges in the Bride catchment. Given the limited data, this exercise was undertaken simply to provide some validation of the current hydrological estimates.

A POT analysis based on two years of data and using the rating curve developed from the model yielded a Qmed of 13.08m^3/s which is equivalent to 1.71 times the ungauged Qmed Estimate from the FSU regression equation. 1.71 is almost the same as the Catchment Qmed Adjustment factor of 1.73 used in the study and leads to higher confidence in our hydrological calculations.

Further research into the development of the sensitivity tables in the CFRAM guidance note was also carried out.

The CFRAM guidance note states:

> *"The uncertainty in QMED can be assessed using the equations for SE and FSE provided in the FSU WP2.2 report. These are provided for estimates derived from catchment descriptors, which will give a scaling factor of 1.37, and can be calculated at gauge sites which have been typically found to be around 1.06."*

Sites with donor adjustments will be in between the above values and so an adjustment factor of circa 1.2 is likely to be valid.

The FSU Work Package WP 2.2 "Frequency Analysis" states the SE of a gauged site is (0.36/√N)*Qmed. Based on a gauge data of 40 years gives an SE of 1.06 and on the Regression equation (N=1) gives a SE of 1.36.

For the calculation of Qmed catchment adjustment factor we have used 3 gauged sites, with each of the SE shown below and gives an average SE of 0.075 in the calculation of the Qmed adjustment factor.

Site	Length of Record	SE
Healy's Bridge	27	0.069
Kill	19	0.0825
Dripsey	24	0.073
	Average SE	0.075

Incidentally, calculation based on the FSU regression equation using the catchment adjustment factor and 7.5% uncertainty (7.628 ***1.71***1.075= 14.02m^3/s) is approximately equal to applying the 95% to the FSU regression equation. (7.628*1.37*1.37 = 14.31m^3/s)

It is therefore proposed that 7.5% be applied for uncertainty in the Qmed estimate for sensitivity analysis.

In terms of uncertainty in the establishment of an appropriate growth curve, it should be noted that the catchment adjustment factor is not conservative due to its composite nature with the FSR Rainfall Runoff on above N years' record. An average of the Donor catchments single site analysis flood frequency curves only generates a Q100 GF of 2.76, whilst a GF of 2.62 has been found using the composite curves and has been applied in this study.

The FSU report finds a SE of between 4.6 and 10.6% for ungauged stations using pooling analysis and an SE of between 8 and 15% for single site analysis (based on 85 stations with an average record length of 37 years). In this study we have used 4 donor catchments to calculate the catchment growth curve and in total 92 years of record. Therefore, one would expect the SE to lie in between the SE found for single site analysis and that for pooling group analysis. Taking an average of the two SE Bands, an uncertainty of 9.55% is found. This will be applied as the SE in the growth factor.

Combining the 7.5% and 9.55% gives a factor of 1.18 or 118% to be applied for sensitivity flow testing.

11.1.3 Findings of hydraulic modelling of increased flows from sensitivity test.

During the assessment of an appropriate freeboard for the scheme design, the limitations in the previous preferred option became apparent.

The Bride catchment is a heavily constrained catchment, with many culvert crossings. Some are reasonably fixed, such as under the N20 and some could be removed or re-engineered, such as the long culvert at Sunbeam.

Uncertainties considered in the freeboard assessment were:

- Channel roughness is variable throughout the year and depends on the maintenance regime.
- Sediment movement and deposition is event dependant, but there are a number of deposition zones that need to be managed.
- Flow, as this is effectively an ungauged catchment, despite the Lower Lee and Glashaboy hydrological investigations.
- The complex hydraulics at Madden's Buildings bifurcation, the N20 culvert and in the section of culvert in Blackpool village. These are not easily replicated in the ISIS model, and any changes to reflect the works at these locations is only comparative.

Flow is the dominant uncertainty but is the least easily defined, and is a key driver in design of the scheme.

The hydraulic pinch points are:

- Blackpool Church Culvert
- Orchard Court inlet to the culverts in Blackpool village
- Culvert under the northern entrance to Blackpool Shopping Centre (i.e. the short Sunbeam Culvert)
- Fitz's Boreen

As these controls are removed or re-engineered further controls have become notable, particularly when higher bound flows are tested in the hydraulic model.

The increase in water level at key pinch points is significant, and the modelling has shown that these increased levels cannot sensibly be managed by purely increasing the freeboard of the defences.

The additional areas where the hydraulics are particularly sensitive to the uncertainties in flow in the modelling are:

- Madden Buildings bifurcation
- N20 culvert, which has a supercritical flow zone downstream
- Sunbeam culvert

The outcome of this hydraulic sensitivity (that is embedded in a solution based on improving conveyance) is clear and can be summarised as follows:

More pressure is put on culverts at the lower end of the system as flow is conveyed downstream and the limitations of the Blackpool Church culvert are translated upstream.

Accordingly, the new Orchard Court culvert needs to be extended and join the N20 culvert.

The assumed freeboard of 500mm will not provide sufficient resilience in many areas and in particular through Blackpool Shopping Centre and Blackpool Retail Park where the extent and height of defence walls will need to be increased further.

A different approach to uncertainty is needed as a uniform freeboard alone will not be effective in managing the uncertainty. Providing additional defences, increasing the freeboard where appropriate, removing obstructions which are

sensitive to flow, and ensuring a monitoring and maintenance regime which acknowledges the sensitivity of the system will all be required.

11.2 Additional Works required as a result of detailed freeboard analysis

As a result of the freeboard analysis, the final refined scheme layout includes a number of additional measures extra over the outline Option 4 originally assessed.

These can be summarised as follows:

1. Replacement of the long Sunbeam culvert with open channel.
2. Upgrading of the short Sunbeam culvert.
3. Removal of two pedestrian bridges in Blackpool Retail Park.
4. Greater extent and higher defences through Blackpool Retail Park and Shopping Centre.
5. Extending the culverting of the open channel in Orchard Court as far as the existing N20 bridge.
6. Locating the proposed trash screen further upstream than originally planned.
7. Increase the general freeboard from 500mm to 600mm throughout the scheme with a further local increase of up to 1300m locally in the particularly sensitive area upstream of the extended culvert system at Blackpool Retail Park.

Full details of the refined works are summarised in **Figure 44** and **Table 18** below.

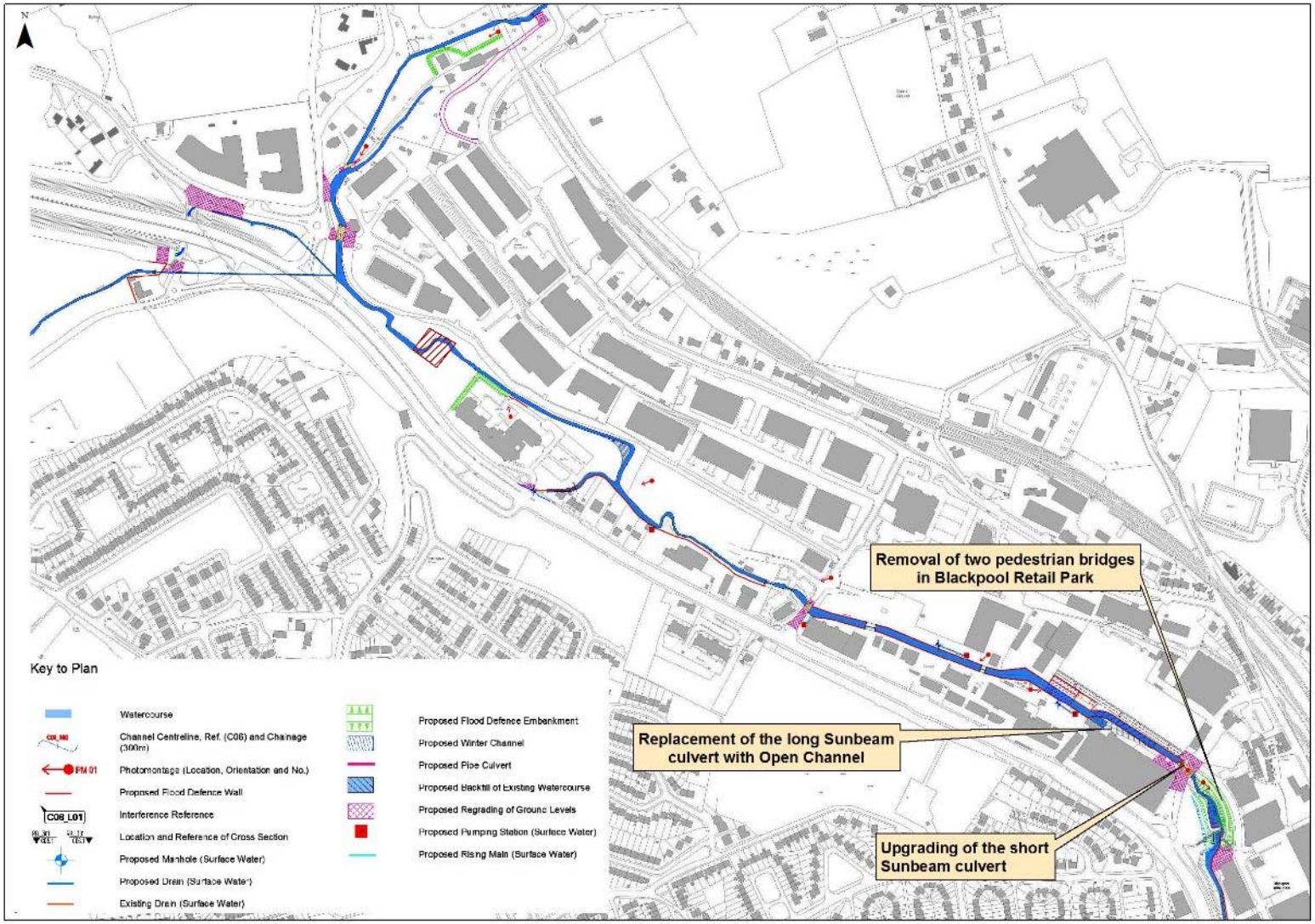


Figure 44 Refined Option 4 highlighting changes from original Option 4

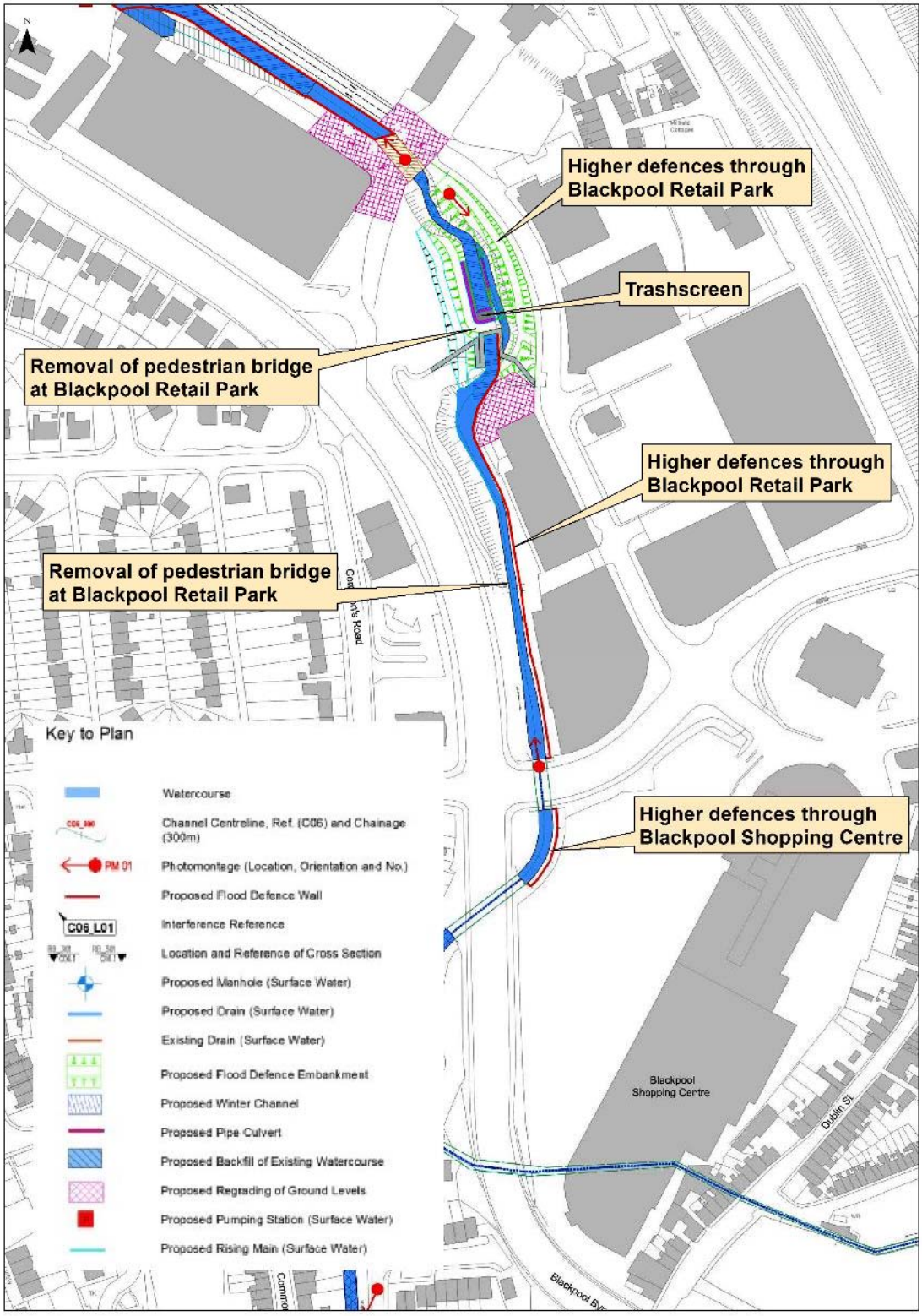


Figure 45 Refined Option 4 highlighting changes from original Option 4

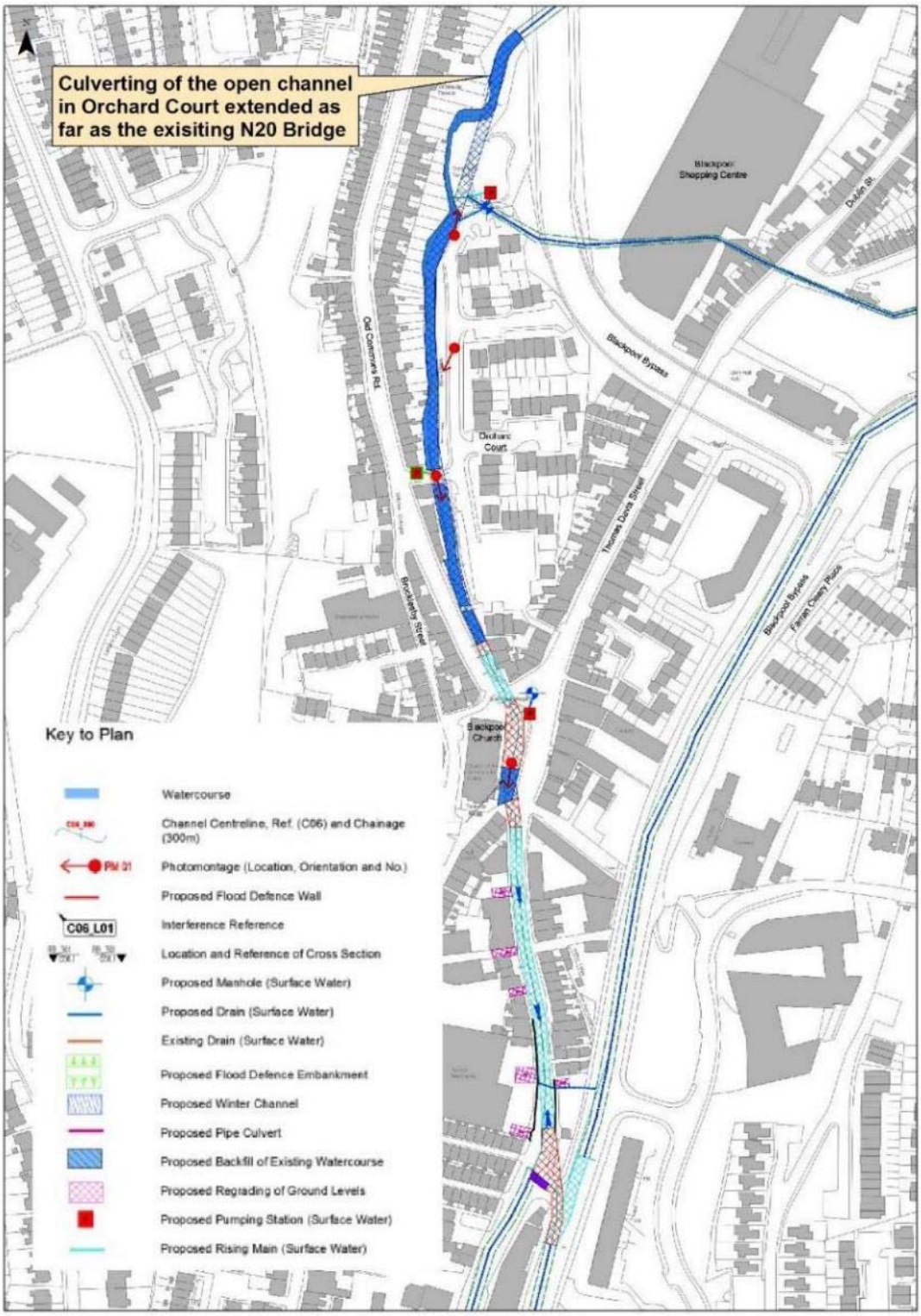


Figure 46 Refined Option 4 highlighting changes from the original option

Table 18 below summarised the proposed measures included in the refined preferred option.

Table 18 Option 4 Conveyance improvements and direct defences (with culvert through Orchard Court) Revised Summary following Freeboard Analysis

Area	Measure category	Chainage	Location (and Total Length of Channel Affected)	Description	Comments
All	Maintenance	C06_2306 to C06_0000, C01_1180 to C01_0000, C02_0824 to C02_0000	The Bride River from its confluence with the Glenamought River, downstream to its outfall to the River Lee (total length approximately 3470m). This measure also includes the Brewery Branch reach of the Kiln River (approximately 825m long)	Implementation of an organised channel maintenance programme throughout the reach with particular attention paid to locations where debris is likely to accumulate, such as at structures, sharp bends, culvert inlets etc. Programme to include checking and cleaning of culverted reaches.	
Commons Road Area	Defence Embankment	C06_2542 to C06_2590	Lower Kileens Road	New flood defence wall, approximately 110m long, average 0.8m high	Wall to tie into high ground at each end
	Conveyance Improvement	C08_0160	Upstream of North Point Business Park (Approximately 7m)	Replace existing masonry bridge with a new RC bridge, 10m wide x 1.5m high	Existing bridge provides access to a residential property. Alternative access to be provided during construction.
	Conveyance Improvement	C08_0000	North Point Business park (Approximately 20m)	Replace existing 3no pipe culverts with a new RC bridge 9m wide by 1.7m high	Existing bridge provides access to the business park. Alternative access to be provided during construction.
	Defence Embankment	C06_2053 to C06_2001	Commons Inn (upstream end of property) (Approximately 52m)	Construction of a new 0.6m high, 85m long flood defence embankment along right bank.	The embankment will be constructed along Commons Inn perimeter, away from any buildings.
	Sediment Management	C06_2150 to C06_2100	North Point Business park (Approximately 50m)	Provisional Natural Sedimentation Area	
	Conveyance Improvement	C06_1845 to C06_1785	Commons Inn (downstream end of property) (approximately 60m)	Creation of a compound "winter channel", facilitating higher flows to remain in bank. Measure involves reducing ground levels on the right bank by approximately 1.5m - 2m over a 60m length to create the enlarged compound channel section.	

Table19 18 (continued) Option 4 Conveyance improvements and direct defences (with culvert through Orchard Court) Revised Summary following Freeboard Analysis

Area	Measure category	Chainage	Location (and Total Length of Channel Affected)	Description	Comments
Commons Road Area	Defence Walls	C06_1855 to C06_1490	Upstream of Fitz's Boreen, to the rear of the properties which face out onto the N20 (approximately 270m on Bride, approximately 85m on side channel)	Construction of a new 1.3m high (maximum height), 355m long, RC defence wall along right bank of the Bride River and a side channel of the Bride.	The wall will be constructed to the rear of the residential & commercial properties. Works will be carried out from the watercourse side.
	Conveyance Improvement	C06_1425 to C06_1420	Fitz's Boreen Arch Bridge.	Replace existing 1m wide by 1.5m high twin masonry arch bridge with new RC rectangular bridge (cross section dimensions approximately 7.4m x 2.4m high)	Existing bridge provides access to the adjacent industrial park. Alternative temporary access route available.
	Defence Walls	C06_1327 to C06_1010	Dulux Paints Factory (Approximately 317m)	Existing channel walls are generally high enough to contain the 1 in 100 year event including 500mm freeboard. Local concrete repairs/joint sealing will be required over the full 317m length of the existing walls on both banks. Local reconstruction of the existing parapet wall may also be required over approximately 20% of the length.	Works will be carried out on an active industrial site.
	Defence Walls	C06_1340 to C06_1327	Dulux Paints Factory upstream bridge	Extend existing RC parapets by approximately 200mm	This measure will ensure that water does not overtop the bridge.
	Defence Walls	C06_1175 to C06_1167	Dulux Paints Factory downstream bridge	Extend existing RC parapets by approximately 300mm	This measure will ensure that water does not overtop the bridge.
	Conveyance Improvement	C06_1072	Sluice structure at Dulux Paints	Permanent removal of steel sluice structure	This measure will reduce blockage risk at this location. Existing structure appears to be abandoned and in disrepair.

Table20 18 (continued) Option 4 Conveyance improvements and direct defences (with culvert through Orchard Court) Revised Summary following Freeboard Analysis

Area	Measure category	Chainage	Location (and Total Length of Channel Affected)	Description	Comments
Commons Road Area	Debris Control	C06_1077 to C06_1015	Dulux Paints Factory (Approximately 62m)	Creation of a sedimentation trap, on the left bank of the Bride River immediately upstream of Sunbeam Industrial Estate	
	Conveyance Improvements	C06_915 to C06_1015	Sunbeam Industrial Estate (approximately 100m)	Removal of the existing Sunbeam culvert and replace with new re-aligned walled open channel 100m long x 8.5m wide	
	Defence Walls	C06_915 to C06_876	Sunbeam Industrial Estate (approximately 39m)	Proposed reinforced concrete flood defence wall to be constructed to a flood defence level of 15.12mOD on both banks. All drainage outfalls to be fitted with non-return valves.	
	Conveyance Improvements	C06_876 to C06_855	Sunbeam Industrial Estate (approximately 21m)	Replace existing concrete bridge with a new reinforced concrete bridge. Bridge to be of 10.50m clear span and 20m wide deck. Soffit level of new bridge to be 14.85mOD.Construct new access ramps to bridge, incorporating new reinforced concrete retaining walls where necessary.	
	Defence Embankment	C06_855 to C06_740	Blackpool Retail Park (approximately 115m)	Proposed flood defence embankment to be constructed typically12m wide and to a height of 1.15m above existing ground levels to flood defence level (14.65mOD). Flood defence embankment to tie into high ground downstream of Sunbeam Industrial Estate bridge and into the proposed flood defence wall at Blackpool Retail Park.	

Table21 18 (continued) Option 4 Conveyance improvements and direct defences (with culvert through Orchard Court) Revised Summary following Freeboard Analysis

Area	Measure category	Chainage	Location (and Total Length of Channel Affected)	Description	Comments
Commons Road Area	Debris Control	C06_810 to C06_770	Blackpool Retail Park (approximately 40m)	Proposed trash screen to be constructed adjacent to Blackpool Retail Park.	
	Defence Walls	C06_756 to C06_546	Blackpool Retail Park (approximately 210m)	Proposed reinforced concrete flood defence wall to be constructed to a height typically 1.2m above existing ground levels to flood defence level (14.65mOD). All drainage outfalls to be fitted with non-return valves.	
	Conveyance Improvements	C06_629	Blackpool Retail Park (approximately 2m)	Existing pedestrian footbridge to be removed.	
	Defence Walls	C06_526 to C06_483	Blackpool Shopping Centre (approximately 47m)	Existing river wall to be raised to a height typically 1.53m above existing ground levels to flood defence level (13.80mOD). The proposal to raise the existing wall is subject to structural assessment. All drainage outfalls to be fitted with non-return valves.	
Blackpool	Conveyance Improvement	C06_0435 to C06_0093	Orchard Court (Approximately 342m)	Installation of a new RC culvert through Orchard Court. Culvert size to be 5.5m x 2.1m	A significant amount of Japanese knotweed is present along the channel in this reach.
	Conveyance Improvement	C06_0190 to C06_0180	Orchard Court (Approximately 10m)	This measure involves the removal of the existing vehicular access bridge to Orchard Court and constructing a new access road over the new culvert.	
	Conveyance Improvement	C06_0115 to C06_0110	Orchard Court (Approximately 5m)	This measure involves the removal of Orchard Court Pedestrian Bridge and reinstating pedestrian access over the new culvert.	

Table22 18 (continued) Option 4 Conveyance improvements and direct defences (with culvert through Orchard Court) Revised Summary following Freeboard Analysis

Area	Measure category	Chainage	Location (and Total Length of Channel Affected)	Description	Comments
Blackpool	Conveyance Improvement	C06_0093 to C06_0084	Orchard Court Culvert inlet (Approximately 9m)	Reconstruction of the existing culvert inlet to remove flow constriction on the Bride. New inlet to be 5.5m x 2.1m.	This measure involves the removal of existing precast cover slab, steel support beams and concrete channel walls to install new culvert inlet. This measure will require works in close proximity to the existing domestic property. Temporary works may be required to secure the property during construction. Access to the residence will be affected during construction.
	Conveyance Improvement	C06_0055 to C06_0000	Blackpool Church (Approximately 55m)	Installation of a new 5.5m x 2.1m RC culvert section to replace existing open channel adjacent to Church.	
	Conveyance Improvement	C01_1171 to C01_1157	Blackpool Church (Approximately 20m)	The existing inlet to the culvert just downstream of the church is to be reconstructed as a 5.5m x 2.1m culvert, tapering to the dimensions of the existing culvert downstream (i.e. 4.8m x 1.6m).	
	Conveyance Improvement	C01_0960 to C01_0900	Madden's Buildings (Approximately 60m)	Reconstruction of the existing culvert junction to minimise head losses for the Bride flow passing through the junction into the Kiln culvert.	Significant traffic disruption during construction. Significant number of services will need to be diverted to facilitate construction.

11.3 Revised Cost Benefit Analysis of Preferred Option

11.3.1 Revised Costs

Table 23 sets out the amended cost estimate for the preferred option following the refinement of the required measures.

Table 23 Cost estimate for refined option 4, including comparison with previous cost estimate

	Option 4 - Culvert in Orchard Court	**Refined Option 4 - Culvert in Orchard Court**
	€	**€**
Construction Cost Estimate of Proposed Measures	€4,694,621	€5,717,000
Prelims 15%	€704,193	€857,550
Risks and Unmeasured Items 20%	€938,924	€1,143,400
Construction Archaeology & Environmental Mitigation 10%	€633,774	€771,795
Subtotal for Construction Cost	**€6,971,512**	**€8,489,745**
Land Acquisition 15%	€1,045,727	€1,273,462
Fees and Supervision 10%	€697,151	€848,975
Art	€38,000	€38,000
Site Investigation & Surveys	€150,000	€150,000
Subtotal	**€8,902,390**	**€10,800,181**
Optimism Bias 20%	€1,780,478	€2,160,036
Capital Cost Total	**€10,682,868**	**€12,960,218**
Maintenance including 20% Optimism Bias (NPV)	€1,361,346	€1,657,816
Project Cost Total	**€12,044,214**	**€14,618,033**

11.3.2 Revised Cost Benefit Analysis

Table 24 below sets out the revised cost benefit analysis for the refined preferred option, including the various sensitivity analysis.

Table 24 Revised Cost Benefit Analysis Summary

	Refined Preferred Option Baseline 4% discount rate)	**Sensitivity Analysis for 5% Reduction in Benefit**	**Sensitivity Analysis for 3% Discount Rate**	**Sensitivity Analysis for 5% Discount Rate**
Present Value Costs (PVc)	€14.12m	€14.12m	€14.24m	€14.01m
Present Value Damage (PVd)	€10.53m	€10.53m	€12.46m	€9.05m
Present Value Benefit (PVb)	€18.65m	€18.65m	€22.07m	€16.03m
Net Present Value (NPV)	€4.52m	€3.59m	€7.82m	€2.02m
Benefit Cost Ratio (BCR)	1.32	1.25	1.55	1.14

It is noted that whilst the Benefit Cost Ratio has reduced, it remains positive in all sensitivity analysis.

11.4 Validity of Options Selection Process post Option Refinement

Given the significant changes that have arisen through the process of refining the preferred option, particularly following the sensitivity/freeboard analysis, it is important to confirm that the Options Selection Process and the choice of preferred option remains valid. This is discussed below by reference to the individual changes numbered 1 to 8 at Section 11.2 above.

11.4.1 Items 1 to 2 Local conveyance improvements from (Sunbeam culverts)

These conveyance improvements are required due to localised pinch points on the system and are sufficiently upstream of the culvert system at or below Orchard Court to be unaffected by the choice of Option below that point. Therefore the same changes would be required regardless of whether Option 3, 4 or 5 was chosen and so do not alter the relative merits of those options. Whilst the same extent of additional work would not likely be required for Option 2, as this was largely discounted on non-cost grounds, the rational appears unaffected by these changes. These changes do not therefore undermine the validity of the option selection process.

11.4.2 Items 3, 4 and 5 (Extended Orchard Court Culvert and Additional defences through Blackpool Shopping Centre and Retail Park)

These changes are required primarily due to the sensitivity of the pressurised culvert system from Blackpool Church to Madden's Buildings. However, the defence heights are also affected by the sensitivity flow exceeding the capacity of the existing N20 road bridge and the shopping centre bridge.

The changes to the defence walls in the retail park would apply equally for Options 3 and Option 4 (and therefore doesn't affect their relative ranking).

The increase in required wall heights in Option 3 would increase further and would outweigh the additional costs of the extended culvert. Option 4 would therefore be more attractive than Option 3.

The impact of the sensitivity flow in Option 5 would still result in an increase in required defence heights versus the original Option 5, albeit to a lesser extent than for Options 3 and 4. This would mean that the cost differential between Option 5 and the preferred option would reduce marginally by an estimated €100k to €300k. However, this would still not change the rankings in terms of Benefit Cost Ratio.

Whilst the same extent of additional work would not likely be required for Option 2, as this was largely discounted on non-cost grounds, the rational appears unaffected by these changes. These changes do not therefore undermine the validity of the option selection process.

11.4.3 Items 6 – Revised Trash Screen Location

Locating the proposed trash screen further upstream than originally planned does not significantly alter the cost or impact of the preferred option.

11.4.4 Items 7 – Increased Scheme Freeboard

The increase in the general freeboard from 500mm to 600mm throughout the scheme would apply equally to all options and therefore does not undermine the validity of the option selection process.

11.5 Climate Change Adaptability of the Preferred Option

All new bridges to be constructed as part of the preferred option will be designed and constructed to take account of climate change such that they will not require future modification.

The climate change adaptability strategy for the scheme along Commons Road as far as and including Dulux is to facilitate two possible future options:

1. Extend existing defence heights to cater for increased flows. The design of the defence walls to be constructed now will allow for the future extension of these walls without the need for full reconstruction, i.e the base and stems of the walls will be designed for the potential of increased defence heights in the future.
2. Upstream Storage on the Glenamought/Bride which would reduce flows such that the proposed defence walls will provide the design standard of protection in the Climate Change Scenario, without further modification.

The climate change adaptability strategy for the scheme between Dulux and Maddens Buildings is to facilitate two possible future options:

1. Replacement of the existing culvert between Blackpool Church and Madden's Buildings with a larger capacity culvert such that the proposed culvert through Orchard Court as far as Blackpool church and the defence walls upstream as far as Dulux, will provide the design standard of protection in the Climate Change Scenario, without further modification.
2. Upstream Storage on the Glenamought/Bride which would reduce flows such that the proposed defence walls and culverts will provide the design standard of protection in the Climate Change Scenario, without further modification.

The future climate change adaptation strategy will require appropriate planning control in the intervening period. Both Cork City Council and Cork County Council are being advised of the key issues through their respective roles on the Steering Group for the Blackpool Flood Relief Scheme.

Through its role as a statutory consultee, OPW will also provide advice to the relevant planning authorities in the preparation of relevant future development plans.

11.6 Conclusion

As set out above, the sensitivity/freeboard analysis undertaken identified that the Blackpool system is particularly sensitive to increases in flow above the design flow at particular pinch points in the system.

This meant that additional conveyance improvements and defence heights higher than the general scheme freeboard were required to ensure the resilience of the preferred option.

These additional measures involved refinement of the preferred option considered at Options Assessment stage and result in increased costs and a reduction in the Benefit Cost Ratio.

Notwithstanding the above, the basis for selection of the preferred option remains valid and the proposed scheme remains cost beneficial in all analysis, including the various sensitivity analysis.

Appendix A

Economic Assessment of Options

A1 Cost Estimates

A1.1 Option 2 - Upstream Storage

Order of Magnitude of Costs			Job No:		230436-00
			Sheet No:		**1**
			Made By:		JF/AL
Project Title	**Blackpool Flood Relief Option**		Date:		**16 November 2015**
Number	Item Description	Unit	Quantity	Rate €	Total €
	Option 2 Upstream Storage				
	Glenamought (Rose Cottage)				
2.1	Ground reprofiling at Rose Cottage entrance	Sum		10,000.00	10,000.00
2.2	1.7m high RC wall stone clad on one side	m	122	1,044.52	127,431.14
2.3	Ground reprofiling and SW measures at Gateway Business Park entrance	Sum		10,000.00	10,000.00
2.4	New roughing screen at Rose Cottage	Sum		30,000.00	30,000.00
	Flood Storage Reservoir (Ballincrokig)				
2.5	New embankment (4m high)	m	182	1,706.00	310,492.00
2.6	Sheet piling (15m long)	m2	2,880	200.00	576,000.00
2.7	Vehicular access road on embankment crest (4m wide)	m2	768	75.00	57,600.00
2.8	New Flow Control Structure	item	1	430,000.00	430,000.00
2.9	Removal of old bridge on Glenville Road	m2	132	100.00	13,200.00
2.10	New culvert (2m x 1.2m)	m	12	1,727.07	20,724.82
2.11	Flood defence Wall stone clad both sides (1.1m)	m	280	1,148.21	321,499.50
2.12	Raised Road	m2	1,350	130.00	175,500.00
	Contd.				

Order of Magnitude of Costs			Job No:		230436-00
			Sheet No:		**1**
			Made By:		JF/AL
Project Title	**Blackpool Flood Relief Option**		Date:		**16 November 2015**
Number	Item Description	Unit	Quantity	Rate €	Total €
	Commons Road				
2.13	New roughing screen at Woodview incl improvements to access track	Item		50,000.00	50,000.00
2.14	Removal of existing culvert at entrance to North Point Business park	m2	288	50.00	14,400.00
2.15	New culvert at entrance to North Point Business park (7m x 1.5m)	m	24	6,407.25	153,774.00
2.16	Removal of 1m x 1.5m high twin arch masonry bridge at Fitz's Boreen	m2	140	100.00	14,000.00
2.17	Replacement of existing Fitz's Boreen bridge with new RC rectangular bridge (7.4m x 1.8m)	m	24	8,115.85	194,780.40
2.18	Natural Sediment Area at Northpoint Business Park and Sediment Trap at Sunbeam site	Item	1	125,000.00	125,000.00
2.19	New 0.8m high flood defence wall at rear of properties on Commons Road	m	65	905.84	58,879.44
	Option 2 Upstream Storage				
	Blackpool				
2.20	New trashscreen structure in Blackpool	item	1	200,000.00	200,000.00
2.21	New 0.8m high embankment adjacent to trash screen	m	45	178.80	8,046.00
2.22	New 0.5m high wall along left bank of Orchard Court	m	94	810.54	76,190.53
2.23	Removal of Orchard Court pedestrian bridge	m2	64	100.00	6,400.00
2.24	Exisiting Inlet to Orchard Court culvert to be reconstructed (5.5m x 2.1m)	m	12	5,495.02	65,940.22
2.25	New culvert at Blackpool church (5.5m x 2.1m)	m	60	5,495.02	329,701.10
2.26	Allowance for SW collector drain and pumping stations	Item	1	200,000.00	200,000.00
2.27	Works at Spring Lane	item	1	50,000.00	50,000.00
2.28	Repairs to Brewery Branch	Item	1	30,000.00	30,000.00
	Total				
	Total				**3,659,559.14**

A1.2 Option 3 – Direct Defences

Order of Magnitude of Costs			Job No:		230436-00
			Sheet No:		**1**
			Made By:		JF/AL
Project Title	**Blackpool Flood Relief Option**		Date:		**16 November 2015**
Number	Item Description	Unit	Quantity	Rate €	Total €
	Option 3 High Walls in Orchard Court				
	Glenamought (Rose Cottage)				
3.1	Ground reprofiling at Rose Cottage entrance	Sum		10,000.00	10,000.00
3.2	1.7m high RC wall stone clad on one side	m	122	1,044.52	127,431.14
3.3	Ground reprofiling and SW measures at Gateway Business Park entrance	Sum			10,000.00
3.4	New roughing screen at Rose Cottage	Sum		30,000.00	30,000.00
	Common's Road (including Kilnap Viaduct)				
3.5	New roughing screen at Woodview incl improvements to access track				50,000.00
3.6	Ground reprofiling and SW measures at Woodview entrance	Sum			7,000.00
3.7	New embankment at Woodview (1.1m high)	m	133	253.15	33,668.95
3.8	Removal of existing masonry bridge at Woodview	m2	120	100.00	12,000.00
3.9	Replace existing masonry bridge at Woodview with new RC bridge (10m x 1.5m)	m	6	9,153.21	54,919.29
3.10	Removal of existing culvert at entrance to North Point Business park	m2	288	50.00	14,400.00
3.11	New culvert at entrance to North Point Business park (9m x 1.7m)	m	24	9,153.21	219,677.14
3.12	New embankment at rear of Commons Inn (0.6m high)	m	110	163.10	17,941.00
3.13	New wall at rear of Commons Inn (0.6m high)	m	34	945.05	32,131.70
3.14	Winter channel at Commons Inn	item	1	10,000.00	10,000.00
3.15	Flood defence Wall (1.3m high) along rear of Commons Road domestic properties	m	330	1,318.64	435,152.03
	Contd.				

Order of Magnitude of Costs			Job No:		230436-00
			Sheet No:		**1**
			Made By:		JF/AL
Project Title	**Blackpool Flood Relief Option**		Date:		**16 November 2015**
Number	Item Description	Unit	Quantity	Rate €	Total €
3.16	Removal of 1m x 1.5m high twin arch masonry bridge at Fitz's Boreen	m2	140	100.00	14,000.00
3.17	Replacement of existing Fitz's Boreen bridge with new RC rectangular bridge (7.4m x 2.4m)	m	24	10,837.41	260,097.74
3.18	Dulux existing channel walls repairs/joint sealing	m	317	100.00	31,700.00
3.19	Dulux parapet walls local reconstruction 100% of the length	m	317	200.00	63,400.00
3.20	Dulux upstream bridge RC parapets extension by 200mm	item	1	10,000.00	10,000.00
3.21	Dulux downstream bridge RC parapets extension by 300mm	item	1	10,000.00	10,000.00
3.22	New 0.6 m high wall at DS end of Dulux (LB)	m	116	750.00	87,000.00
3.23	Dulux permanent removal of steel sluice structure and weir	m2	98	50.00	4,875.00
3.24	Natural Sediment Area at Northpoint Business Park and Sediment Trap at Sunbeam site	Item	1	125,000.00	125,000.00
	Contd.				

Order of Magnitude of Costs			Job No:		230436-00
			Sheet No:		**1**
			Made By:		JF/AL
Project Title	**Blackpool Flood Relief Option**		Date:		**16 November 2015**
Number	Item Description	Unit	Quantity	Rate €	Total €
	Option 3 High Walls in Orchard Court				
	Blackpool				
3.25	New trashscreen structure at Retail Park	item	1	200,000.00	200,000.00
3.26	Flood defence Wall (1m) adjacent to trash screen	m	39	1,045.05	40,756.95
3.27	New 1m high embankment adjacent to trash screen	m	52	253.15	13,163.80
3.28	Flood defence Wall (average 1.8m high along both banks in Orchard Court)	m	500	1,920.86	960,431.25
3.29	Removal of old Orchard Court road bridge	m2	136	100.00	13,600.00
3.30	Replace Orchard Court Bridge with new elevated road bridge	m2	80	1,650.00	132,000.00
3.31	Removal of Orchard Court footbridge	m2	64	100.00	6,400.00
3.32	Existing Inlet to Orchard Court culvert to be reconstructed (5.5m x 2.1m)	m	12	5,495.02	65,940.22
3.33	New culvert at Blackpool church (5.5m x 2.1m)	m	60	5,495.02	329,701.10
3.34	Existing inlet to Blackpool Church culvert to be reconstructed (5.5m x 2.1m)	m	10	5,495.02	54,950.18
3.35	Exisiting culvert junction at Maddens to be reconstructed	Item	1	400,000.00	400,000.00
3.36	Allowance for SW collector drain and pumping stations	Item	1	500,000.00	500,000.00
3.37	Upholding main drainage pipe in Orchard Court (750mm diameter). Allow for temporary sheet piling, 5m long	m2	1,250	75.00	93,750.00
3.38	Existing culvert to be pressurised - resealing internal joints	Sum			20,000.00
3.39	Works to channel bed, armouringm, river gravels, etc.	m	300	200.00	60,000.00
					0.00
3.40	Works at Spring Lane	item	1	50,000.00	50,000.00
3.41	Repairs to Brewery Branch	Item	1	30,000.00	30,000.00
	Total				**4,641,087.48**

A1.3 Option 4 – Culverting at Orchard Court

Order of Magnitude of Costs			Job No:		230436-00
			Sheet No:		**1**
			Made By:		JF/AL
Project Title	**Blackpool Flood Relief Option**		Date:		**16 November 2015**
Number	Item Description	Unit	Quantity	Rate €	Total €
	Option 4 Culvert through Orchard Court				
	Glenamought (Rose Cottage)				
4.1	Ground reprofiling at Rose Cottage entrance	Sum		10,000.00	10,000.00
4.2	1.7m high RC wall stone clad on one side	m	122	1,044.52	127,431.14
4.3	Ground reprofiling and SW measures at Gateway Business Park entrance	Sum		10,000.00	10,000.00
4.4	New roughing screen at Rose Cottage	Sum		30,000.00	30,000.00
	Common's Road				
4.5	New roughing screen at Woodview incl improvements to access track				50,000.00
4.6	Ground reprofiling and SW measures at Woodview entrance	Sum			7,000.00
4.7	New embankment at Woodview (1.1m high)	m	133	253.15	33,668.95
4.8	Removal of existing masonry bridge at Woodview	m2	120	100.00	12,000.00
4.9	Replace existing masonry bridge at Woodview with new RC bridge (10m x 1.5m)	m	6	9,153.21	54,919.29
4.10	Removal of existing culvert at entrance to North Point Business park	m2	288	50.00	14,400.00
4.11	New culvert at entrance to North Point Business park (9m x 1.7m)	m	24	9,153.21	219,677.14
4.12	New embankment at rear of Commons Inn (0.6m high)	m	110	163.10	17,941.00
4.13	New wall at rear of Commons Inn (0.6m high)	m	34	945.05	32,131.70
4.14	Winter channel at Commons Inn	item	1	10,000.00	10,000.00
	Contd.				

Order of Magnitude of Costs			Job No:		230436-00
			Sheet No:		**1**
			Made By:		JF/AL
Project Title	**Blackpool Flood Relief Option**		Date:		**16 November 2015**
Number	Item Description	Unit	Quantity	Rate €	Total €
4.15	Flood defence Wall (1.3m high) along rear of Commons Road domestic properties	m	330	1,318.64	435,152.03
4.16	Removal of 1m x 1.5m high twin arch masonry bridge at Fitz's Boreen	m2	140	100.00	14,000.00
4.17	Replacement of existing Fitz's Boreen bridge with new RC rectangular bridge (7.4m x 2.4m)	m	24	10,837.41	260,097.74
4.18	Dulux existing channel walls repairs/joint sealing	m	317	100.00	31,700.00
4.19	Dulux parapet walls local reconstruction 100% of the length	m	317	200.00	63,400.00
4.20	Dulux upstream bridge RC parapets extension by 200mm	item	1	10,000.00	10,000.00
4.21	Dulux downstream bridge RC parapets extension by 300mm	item	1	10,000.00	10,000.00
4.22	New 0.6 m high wall at DS end of Dulux (LB)	m	116	750.00	87,000.00
4.23	Dulux permanent removal of steel sluice structure and weir	m2	98	50.00	4,875.00
4.24	Natural Sediment Area at Northpoint Business Park and Sediment Trap at Sunbeam site	Item	1	125,000.00	125,000.00
	Contd.				

Order of Magnitude of Costs			Job No:		230436-00
			Sheet No:		**1**
			Made By:		JF/AL
Project Title	**Blackpool Flood Relief Option**		Date:		**16 November 2015**
Number	Item Description	Unit	Quantity	Rate €	Total €
	Option 4 Culvert through Orchard Court Blackpool				
4.25	New trashscreen structure at Blackpool Retail Park	item	Sum		200,000.00
4.26	Flood defence Wall (1m) adjacent to trash screen	m	39	1,045.05	40,756.95
4.27	New 1m high embankment adjacent to trash screen	m	52	253.15	13,163.80
4.28	Orchard court new culvert (5.5m x 2.1m)	m	248	4,495.02	1,114,764.54
4.29	Removal of old Orchard Court road bridge	m2	136	100.00	13,600.00
4.30	Replace vehicular access road over new culvert in Orchard Court	m2	135	120.00	16,200.00
4.31	Removal of Orchard Court footbridge	m2	64	100.00	6,400.00
4.32	Existing Inlet to Orchard Court culvert to be reconstructed (5.5m x 2.1m)	m	12	5,495.02	65,940.22
4.33	New culvert at Blackpool church (5.5m x 2.1m)	m	60	5,495.02	329,701.10
4.34	Existing inlet to Blackpool Church culvert to be reconstructed (5.5m x 2.1m)	m	10	5,495.02	54,950.18
4.35	Existing culvert junction at Maddens to be reconstructed	Item	1	400,000.00	400,000.00
4.36	Allowance for SW collector drain and pumping stations	Item	1	500,000.00	500,000.00
4.37	Upholding main drainage pipe in Orchard Court (750mm diameter). Allow for temporary sheet piling, 5m long	m2	1,250	75.00	93,750.00
4.38	Existing culvert to be pressurised - resealing internal joints	Sum			20,000.00
4.39	Blockwork Boundary Wall in Orchard Court	m	300	250.00	75,000.00
4.40	Works at Spring Lane	item	1	50,000.00	50,000.00
4.41	Repairs to Brewery Branch	Item	1	30,000.00	30,000.00
	Total				**4,694,620.77**

A1.4 Option 5 – Culvert Replacement (Orchard Court – Madden's Buildings)

Order of Magnitude of Costs			Job No:		230436-00
			Sheet No:		**1**
			Made By:		JF/AL
Project Title	**Blackpool Flood Relief Option**		Date:		**16 November 2015**
Number	Item Description	Unit	Quantity	Rate €	Total €
	Option 5 Culvert Replacement from Orchard Court to Maddens Buildings				
	Glenamought (Rose Cottage)				
5.1	Ground reprofiling at Rose Cottage entrance	Sum		10,000.00	10,000.00
5.2	1.7m high RC wall stone clad on one side	m	122	1,044.52	127,431.14
5.3	Ground reprofiling and SW measures at Gateway Business Park entrance	Sum		10,000.00	10,000.00
5.4	New roughing screen at Rose Cottage	Sum		30,000.00	30,000.00
	Common's Road				
5.5	New roughing screen at Woodview incl improvements to access track				50,000.00
5.6	Ground reprofiling and SW measures at Woodview entrance	Sum			7,000.00
5.7	New embankment at Woodview (1.1m high)	m	133	253.15	33,668.95
5.8	Removal of existing masonry bridge at Woodview	m2	120	100.00	12,000.00
5.9	Replace existing masonry bridge at Woodview with new RC bridge (10m x 1.5m)	m	6	9,153.21	54,919.29
5.10	Removal of existing culvert at entrance to North Point Business park	m2	288	50.00	14,400.00
5.11	New culvert at entrance to North Point Business park (9m x 1.7m)	m	24	9,153.21	219,677.14
5.12	New embankment at rear of Commons Inn (0.6m high)	m	110	163.10	17,941.00
5.13	New wall at rear of Commons Inn (0.6m high)	m	34	945.05	32,131.70
5.14	Winter channel at Commons Inn	item	1	10,000.00	10,000.00
	Contd.				

Order of Magnitude of Costs			Job No:		230436-00
			Sheet No:		**1**
			Made By:		JF/AL
Project Title	**Blackpool Flood Relief Option**		Date:		**16 November 2015**
Number	Item Description	Unit	Quantity	Rate €	Total €
5.15	Flood defence Wall (1.3m high) along rear of Commons Road domestic properties	m	330	1,318.64	435,152.03
5.16	Removal of 1m x 1.5m high twin arch masonry bridge at Fitz's Boreen	m2	140	100.00	14,000.00
5.17	Replacement of existing Fitz's Boreen bridge with new RC rectangular bridge (6.0m x 1.8m)	m	24	10,837.41	260,097.74
5.18	Dulux existing channel walls repairs/joint sealing	m	317	100.00	31,700.00
5.19	Dulux parapet walls local reconstruction 100% of the length	m	317	200.00	63,400.00
5.20	Dulux upstream bridge RC parapets extension by 200mm	item	1	10,000.00	10,000.00
5.21	Dulux downstream bridge RC parapets extension by 300mm	item	1	10,000.00	10,000.00
5.22	New 0.6 m high wall at DS end of Dulux (LB)	m	116	750.00	87,000.00
5.23	Dulux permanent removal of steel sluice structure and weir	m2	98	100.00	9,750.00
5.24	Natural Sediment Area at Northpoint Business Park and Sediment Trap at Sunbeam site	Item	1	125,000.00	125,000.00
	Contd.				

Order of Magnitude of Costs			Job No:		230436-00
			Sheet No:		**1**
			Made By:		JF/AL
Project Title	**Blackpool Flood Relief Option**		Date:		**16 November 2015**
Number	Item Description	Unit	Quantity	Rate €	Total €
	Option 5 Culvert Replacement from Orchard Court to Maddens Buildings **Blackpool**				
5.25	New trashscreen structure at Retail park	item	1	200,000.00	200,000.00
5.26	Flood defence Wall (average 1.0m high along both banks in Orchard Court)	m	500	1,045.05	522,525.00
5.27	Removal of old Orchard Court road bridge	m2	136	100.00	13,600.00
5.28	Replace Orchard Court Bridge with new elevated road bridge	m2	80	1,650.00	132,000.00
5.29	Removal of Orchard Court footbridge	m2	64	100.00	6,400.00
5.30	Exisiting Inlet to Orchard Court culvert to be reconstructed (5.5m x 2.1m)	m	12	5,495.02	65,940.22
5.31	New culvert at Blackpool church (5.5m x 2.1m)	m	60	5,495.02	329,701.10
5.32	Removal of old culvert between Blackpool Church and Maddens Buildings and replaced with new culvert (5.5m x 2.1m)	m	211	7,143.52	1,507,283.52
5.33	Exisiting culvert junction at Maddens to be reconstructed	Item	1	400,000.00	400,000.00
5.34	Allowance for SW collector drain and pumping stations	Item	1	500,000.00	500,000.00
5.35	Upholding main drainage pipe in Orchard Court (750mm diameter). Allow for temporary sheet piling, 5m long	m2	1,250	75.00	93,750.00
5.36	Existing culvert to be pressurised - resealing internal joints	Sum			20,000.00
5.37	Works at Spring Lane	item	1	50,000.00	50,000.00
5.38	Repairs to Brewery Branch	Item	1	30,000.00	30,000.00
	Total				
	Total				**5,546,468.82**

A1.5 Option 4 – Refined Preferred Option

Order of Magnitude of Costs			Job No:		230436-00
			Sheet No:		**1**
			Made By:		JF/AL
Project Title	**Blackpool Flood Relief Option**		Date:		**16 November 2015**
Number	Item Description	Unit	Quantity	Rate €	Total €
	Option 4 Culvert through Orchard Court				
	Glenamought (Rose Cottage)				
4.1	Ground reprofiling at Rose Cottage entrance	Sum		10,000.00	10,000.00
4.2	1.7m high RC wall stone clad on one side	m	122	1,044.52	127,431.14
4.3	Ground reprofiling and SW measures at Gateway Business Park entrance	Sum		10,000.00	10,000.00
4.4	New roughing screen at Rose Cottage	Sum		30,000.00	30,000.00
	Common's Road				
4.5	New roughing screen at Woodview incl improvements to access track				50,000.00
4.6	Ground reprofiling and SW measures at Woodview entrance	Sum			7,000.00
4.7	New embankment at Woodview (1.1m high)	m	133	253.15	33,668.95
4.8	Removal of existing masonry bridge at Woodview	m2	120	100.00	12,000.00
4.9	Replace existing masonry bridge at Woodview with new RC bridge (10m x 1.5m)	m	6	9,153.21	54,919.29
4.10	Removal of existing culvert at entrance to North Point Business park	m2	288	50.00	14,400.00
4.11	New culvert at entrance to North Point Business park (9m x 1.7m)	m	24	9,153.21	219,677.14
4.12	New embankment at rear of Commons Inn (0.6m high)	m	110	163.10	17,941.00
4.13	New wall at rear of Commons Inn (0.6m high)	m	34	945.05	32,131.70
4.14	Winter channel at Commons Inn	item	1	10,000.00	10,000.00
4.15	Flood defence Wall (1.3m high) along rear of Commons Road domestic properties	m	320	1,318.64	421,965.60
4.16	Removal of 1m x 1.5m high twin arch masonry bridge at Fitz's Boreen	m2	140	100.00	14,000.00
	Contd.				

Order of Magnitude of Costs			Job No:		230436-00
			Sheet No:		**1**
			Made By:		JF/AL
Project Title	**Blackpool Flood Relief Option**		Date:		**16 November 2015**
Number	Item Description	Unit	Quantity	Rate €	Total €
4.17	Replacement of existing Fitz's Boreen bridge with new RC rectangular bridge (7.4m x 2.4m)	m	24	10,837.41	260,097.74
4.18	Dulux existing channel walls repairs/joint sealing	m	317	100.00	31,700.00
4.19	Dulux parapet walls local reconstruction 100% of the length	m	317	200.00	63,400.00
4.20	Dulux upstream bridge RC parapets extension by 200mm	item	1	10,000.00	10,000.00
4.21	Dulux downstream bridge RC parapets extension by 300mm	item	1	10,000.00	10,000.00
4.22	New 0.6 m high wall at DS end of Dulux (LB)	m	116	750.00	87,000.00
4.23	Dulux permanent removal of steel sluice structure and weir	m2	98	50.00	4,875.00
4.24	Natural Sediment Area at Northpoint Business Park and Sediment Trap at Sunbeam site	Item	1	125,000.00	125,000.00
	Contd.				

Order of Magnitude of Costs			Job No:		230436-00
			Sheet No:		**1**
			Made By:		JF/AL
Project Title	**Blackpool Flood Relief Option**		Date:		**16 November 2015**
Number	Item Description	Unit	Quantity	Rate €	Total €
	Option 4 Culvert through Orchard Court				
	Blackpool				
4.25	New trashscreen structure at Blackpool Retail Park	item	Sum		200,000.00
4.26	Flood defence Wall (1m) adjacent to trash screen	m	0	1,045.05	0.00
4.27	New 1m high embankment adjacent to trash screen	m	0	253.15	0.00
4.28	Orchard court new culvert (5.5m x 2.1m)	m	248	4,495.02	1,114,764.54
4.29	Removal of old Orchard Court road bridge	m2	136	100.00	13,600.00
4.30	Replace vehicular access road over new culvert in Orchard Court	m2	135	120.00	16,200.00
4.31	Removal of Orchard Court footbridge	m2	64	100.00	6,400.00
4.32	Exisiting Inlet to Orchard Court culvert to be reconstructed (5.5m x 2.1m)	m	12	5,495.02	65,940.22
4.33	New culvert at Blackpool church (5.5m x 2.1m)	m	60	5,495.02	329,701.10
4.34	Existing inlet to Blackpool Church culvert to be reconstructed (5.5m x 2.1m)	m	10	5,495.02	54,950.18
4.35	Exisiting culvert junction at Maddens to be reconstructed	Item	1	400,000.00	400,000.00
4.36	Allowance for SW collector drain and pumping stations	Item	1	500,000.00	500,000.00
4.37	Upholding main drainage pipe in Orchard Court (750mm diameter). Allow for temporary sheet piling, 5m long	m2	1,250	75.00	93,750.00
4.38	Existing culvert to be pressurised - resealing internal joints	Sum			20,000.00
4.39	Blockwork Boundary Wall in Orchard Court	m	300	250.00	75,000.00
4.40	Works at Spring Lane	item	1	50,000.00	50,000.00
4.41	Repairs to Brewery Branch	Item	1	30,000.00	30,000.00
	Contd.				

Order of Magnitude of Costs			Job No:		230436-00
			Sheet No:		**1**
			Made By:		JF/AL
Project Title	**Blackpool Flood Relief Option**		Date:		**16 November 2015**
Number	Item Description	Unit	Quantity	Rate €	Total €
	Option 4 Culvert through Orchard Court				
	Additions following Freeboard Analysis and Sensitivity testing - Commons Road and Blackpool				
4.42	Removal of existing culvert & creation of open channel at Sunbeam Industrial Estate (incl retaining walls both sides)	m	70	3,842.35	268,964.15
4.43	Existing bridge at entrance to Sunbeam/Blackpool SC to be upgraded	m	23	8,349.80	192,045.40
4.44	New Embankment 0.9m high to the west of Blackpool retail park	m	150	253.15	37,972.50
4.45	New 0.6m high wall to the west of Blackpool shopping centre	m	176	1,070.61	188,427.80
4.46	New Culvert through Orchard court - extra over length	m	85	4,495.02	382,076.56
4.47	Removal of existing footbridges in Blackpool Retail Park and construction of alternative walkways	no	2	10,000.00	20,000.00
	Total				**5,717,000.00**

A2 Cost-Benefit Analysis

Project Summary Sheet
4% Discount Rate

Client/Authority		Prepared (date)	16/11/2015
Office of Public Works		Printed	
Project name		Prepared by	KB/AL
Blackpool Flood Relief Scheme		Checked by	KL
Project reference		Checked date	
Base date for estimates (year 0)	Jan-2016		
Scaling factor (e.g. £m, £k, £)	Euro, m	(used for all costs, losses and benefits)	
Discount rate	4.0%		

Costs and benefits of options

	Costs and benefits Euro, m				
	Do Minimum	Option 2 Upstream Storage	Option 3 High Walls	Option 4 Orchard Court Culvert	Option 5 Replace Existing Culvert
PV costs PVc	0.503	10.120	11.507	11.637	13.712
PV damage PVd	29.174	10.526	10.526	10.526	10.526
PV damage avoided		18.65	18.65	18.65	18.65
PV assets Pva	-	-	-	-	-
PV asset protection benefits		-	-	-	-
Total PV benefits PVb		18.65	18.65	18.65	18.65
Net Present Value NPV		8.53	7.14	7.01	4.93
Average benefit/cost ratio		1.84	1.62	1.60	1.36

Brief description of options:

Do Minimum	Maintenance of Existing Defences
Flood Defence Options 2 to 5	Standard of Protection 1 in 100 year fluvial

Notes:

1) Benefits will normally be expressed either in terms of damage avoided or asset values protected. Care is needed to avoid double counting

2) PV damage avoided is calculated as PV damage (No Project) - PV damage (Option)
   PV asset protection benefits are calculated as PVa (Option) - PVa (No Project)
   PV benefits calculated as PV damage avoided + PV asset protection benefits

3) Incremental benefit/cost ratio is calculated as:
   (PVb(current option) - PVb(previous option))/(PVc(current option) - PVc(previous option))

Project Summary Sheet
3% Discount Rate

Client/Authority		Prepared (date)	16/11/2015
Office of Public Works		Printed	
Project name		Prepared by	KB/AL
Blackpool Flood Relief Scheme		Checked by	KL
Project reference		Checked date	
Base date for estimates (year 0)	Jan-2016		
Scaling factor (e.g. £m, £k, £)	Euro, m	(used for all costs, losses and benefits)	
Discount rate	3.0%		

Costs and benefits of options

	Costs and benefits Euro, m				
	Do Minimum	Option 2 Upstream Storage	Option 3 High Walls	Option 4 Orchard Court Culvert	Option 5 Replace Existing Culvert
PV costs PVc	0.596	10.202	11.604	11.735	13.828
PV damage PVd	34.525	12.457	12.457	12.457	12.457
PV damage avoided		22.07	22.07	22.07	22.07
PV assets Pva	-	-	-	-	-
PV asset protection benefits		-	-	-	-
Total PV benefits PVb		22.07	22.07	22.07	22.07
Net Present Value NPV		11.87	10.46	10.33	8.24
Average benefit/cost ratio		2.16	1.90	1.88	1.60

Brief description of options:

Do Minimum	Maintenance of Existing Defences
Flood Defence Options 2 to 5	Standard of Protection 1 in 100 year fluvial

Notes:

1) Benefits will normally be expressed either in terms of damage avoided or asset values protected. Care is needed to avoid double counting

2) PV damage avoided is calculated as PV damage (No Project) - PV damage (Option)
   PV asset protection benefits are calculated as PVa (Option) - PVa (No Project)
   PV benefits calculated as PV damage avoided + PV asset protection benefits

3) Incremental benefit/cost ratio is calculated as:
   (PVb(current option) - PVb(previous option))/(PVc(current option) - PVc(previous option))

Project Summary Sheet
5% Discount Rate

Client/Authority		Prepared (date)	16/11/2015
Office of Public Works		Printed	
Project name		Prepared by	KB/AL
Blackpool Flood Relief Scheme		Checked by	KL
Project reference		Checked date	
Base date for estimates (year 0)	Jan-2016		
Scaling factor (e.g. £m, £k, £)	Euro, m	(used for all costs, losses and benefits)	
Discount rate	5.0%		

Costs and benefits of options

	Costs and benefits Euro, m				
	Do Minimum	Option 2 Upstream Storage	Option 3 High Walls	Option 4 Orchard Court Culvert	Option 5 Replace Existing Culvert
PV costs PVc	0.431	10.041	11.412	11.541	13.600
PV damage PVd	25.075	9.048	9.048	9.048	9.048
PV damage avoided		16.03	16.03	16.03	16.03
PV assets Pva	-	-	-	-	-
PV asset protection benefits		-	-	-	-
Total PV benefits PVb		16.03	16.03	16.03	16.03
Net Present Value NPV		5.99	4.62	4.49	2.43
Average benefit/cost ratio		1.60	1.40	1.39	1.18

Brief description of options:

Do Minimum	Maintenance of Existing Defences
Flood Defence Options 2 to 5	Standard of Protection 1 in 100 year fluvial

Notes:

1) Benefits will normally be expressed either in terms of damage avoided or asset values protected. Care is needed to avoid double counting

2) PV damage avoided is calculated as PV damage (No Project) - PV damage (Option)
   PV asset protection benefits are calculated as PVa (Option) - PVa (No Project)
   PV benefits calculated as PV damage avoided + PV asset protection benefits

3) Incremental benefit/cost ratio is calculated as:
   (PVb(current option) - PVb(previous option))/(PVc(current option) - PVc(previous option))

Project Summary Sheet
4% Discount Rate, 5% Benefit Reduction

Client/Authority		Prepared (date)	16/11/2015
Office of Public Works		Printed	
Project name		Prepared by	KB/AL
Blackpool Flood Relief Scheme		Checked by	KL
Project reference		Checked date	
Base date for estimates (year 0)	Jan-2016		
Scaling factor (e.g. £m, £k, £)	Euro, m	(used for all costs, losses and benefits)	
Discount rate	4.0%		

Costs and benefits of options

	Costs and benefits Euro, m				
	Do Minimum	Option 2 Upstream Storage	Option 3 High Walls	Option 4 Orchard Court Culvert	Option 5 Replace Existing Culvert
PV costs PVc	0.503	10.120	11.507	11.637	13.712
PV damage PVd	29.174	10.526	10.526	10.526	10.526
PV damage avoided		18.65	18.65	18.65	18.65
PV assets Pva	-	-	-	-	-
PV asset protection benefits		-	-	-	-
Total PV benefits PVb		17.71	17.71	17.71	17.71
Net Present Value NPV		7.59	6.21	6.08	4.00
Average benefit/cost ratio		1.75	1.54	1.52	1.29

Brief description of options:

Do Minimum	Maintenance of Existing Defences
Flood Defence Options 2 to 5	Standard of Protection 1 in 100 year fluvial

Notes:

1) Benefits will normally be expressed either in terms of damage avoided or asset values protected. Care is needed to avoid double counting

2) PV damage avoided is calculated as PV damage (No Project) - PV damage (Option)
   PV asset protection benefits are calculated as PVa (Option) - PVa (No Project)
   PV benefits calculated as PV damage avoided + PV asset protection benefits

3) Incremental benefit/cost ratio is calculated as:
   (PVb(current option) - PVb(previous option))/(PVc(current option) - PVc(previous option))

Project Summary Sheet
4% Discount Rate, Refined Option 4

Client/Authority		Prepared (date)	16/11/2015
Office of Public Works		Printed	
Project name		Prepared by	KB/AL
Blackpool Flood Relief Scheme		Checked by	KL
Project reference		Checked date	
Base date for estimates (year 0)	Jan-2016		
Scaling factor (e.g. £m, £k, £)	Euro, m	(used for all costs, losses and benefits)	
Discount rate	4.0%		

Costs and benefits of options

	Costs and benefits Euro, m				
	Do Minimum			Option 4 Orchard Court Culvert - Refined	
PV costs PVc	0.503			14.124	
PV damage PVd	29.174			10.526	
PV damage avoided				18.65	
PV assets Pva	-			-	
PV asset protection benefits				-	
Total PV benefits PVb				18.65	
Net Present Value NPV				4.52	
Average benefit/cost ratio				1.32	

Brief description of options:

Do Minimum	Maintenance of Existing Defences
Flood Defence Options 2 to 5	Standard of Protection 1 in 100 year fluvial

Notes:

1) Benefits will normally be expressed either in terms of damage avoided or asset values protected. Care is needed to avoid double counting

2) PV damage avoided is calculated as PV damage (No Project) - PV damage (Option)
   PV asset protection benefits are calculated as PVa (Option) - PVa (No Project)
   PV benefits calculated as PV damage avoided + PV asset protection benefits

3) Incremental benefit/cost ratio is calculated as:
   (PVb(current option) - PVb(previous option))/(PVc(current option) - PVc(previous option))

Project Summary Sheet
3% Discount Rate, Refined Option 4

Client/Authority		Prepared (date)	16/11/2015
Office of Public Works		Printed	
Project name		Prepared by	KB/AL
Blackpool Flood Relief Scheme		Checked by	KL
Project reference		Checked date	
Base date for estimates (year 0)	Jan-2016		
Scaling factor (e.g. £m, £k, £)	Euro, m	(used for all costs, losses and benefits)	
Discount rate	3.0%		

Costs and benefits of options

	Costs and benefits Euro, m				
	Do Minimum			Option 4 Orchard Court Culvert	
PV costs PVc	0.596			14.243	
PV damage PVd	34.525			12.457	
PV damage avoided				22.07	
PV assets Pva	-	-	-	-	-
PV asset protection benefits				-	
Total PV benefits PVb				22.07	
Net Present Value NPV				7.82	
Average benefit/cost ratio				1.55	

Brief description of options:

Do Minimum	Maintenance of Existing Defences
Flood Defence Options 2 to 5	Standard of Protection 1 in 100 year fluvial

Notes:

1) Benefits will normally be expressed either in terms of damage avoided or asset values protected. Care is needed to avoid double counting

2) PV damage avoided is calculated as PV damage (No Project) - PV damage (Option)
PV asset protection benefits are calculated as PVa (Option) - PVa (No Project)
PV benefits calculated as PV damage avoided + PV asset protection benefits

3) Incremental benefit/cost ratio is calculated as:
(PVb(current option) - PVb(previous option))/(PVc(current option) - PVc(previous option))

Project Summary Sheet
5% Discount Rate, Refined Option 4

Client/Authority		Prepared (date)	16/11/2015
Office of Public Works		Printed	
Project name		Prepared by	KB/AL
Blackpool Flood Relief Scheme		Checked by	KL
Project reference		Checked date	
Base date for estimates (year 0)	Jan-2016		
Scaling factor (e.g. £m, £k, £)	Euro, m	(used for all costs, losses and benefits)	
Discount rate	5.0%		

Costs and benefits of options

	Costs and benefits Euro, m				
	Do Minimum			Option 4 Orchard Court Culvert	
PV costs PVc	0.431			14.008	
PV damage PVd	25.075			9.048	
PV damage avoided				16.03	
PV assets Pva	-	-	-	-	-
PV asset protection benefits				-	
Total PV benefits PVb				16.03	
Net Present Value NPV				2.02	
Average benefit/cost ratio				1.14	

Brief description of options:

Do Minimum	Maintenance of Existing Defences
Flood Defence Options 2 to 5	Standard of Protection 1 in 100 year fluvial

Notes:

1) Benefits will normally be expressed either in terms of damage avoided or asset values protected. Care is needed to avoid double counting

2) PV damage avoided is calculated as PV damage (No Project) - PV damage (Option)
PV asset protection benefits are calculated as PVa (Option) - PVa (No Project)
PV benefits calculated as PV damage avoided + PV asset protection benefits

3) Incremental benefit/cost ratio is calculated as:
(PVb(current option) - PVb(previous option))/(PVc(current option) - PVc(previous option))

Project Summary Sheet

4% Discount Rate, 5% Benefit Reduction, Refined Option 4

Client/Authority		Prepared (date)	16/11/2015
Office of Public Works		Printed	
Project name		Prepared by	KB/AL
Blackpool Flood Relief Scheme		Checked by	KL
Project reference		Checked date	
Base date for estimates (year 0)	Jan-2016		
Scaling factor (e.g. £m, £k, £)	Euro, m	(used for all costs, losses and benefits)	
Discount rate	4.0%		

Costs and benefits of options

	Costs and benefits Euro, m				
	Do Minimum			Option 4 Orchard Court Culvert	
PV costs PVc	0.503			14.124	
PV damage PVd	29.174			10.526	
PV damage avoided				18.65	
PV assets Pva	-	-	-	-	-
PV asset protection benefits				-	
Total PV benefits PVb				17.71	
Net Present Value NPV				3.59	
Average benefit/cost ratio				1.25	

Brief description of options:

Do Minimum	Maintenance of Existing Defences
Flood Defence Options 2 to 5	Standard of Protection 1 in 100 year fluvial

Notes:

1) Benefits will normally be expressed either in terms of damage avoided or asset values protected. Care is needed to avoid double counting

2) PV damage avoided is calculated as PV damage (No Project) - PV damage (Option)
   PV asset protection benefits are calculated as PVa (Option) - PVa (No Project)
   PV benefits calculated as PV damage avoided + PV asset protection benefits

3) Incremental benefit/cost ratio is calculated as:
   (PVb(current option) - PVb(previous option))/(PVc(current option) - PVc(previous option))

Appendix B

Multi-criteria Assessment of Options

B1 MCA Objectives and Targets

Core Criteria	Objective	Sub objective	Code	Indicator	Basic Requirement	Aspirational Target
Technical	Ensure flood risk management options are operationally robust	"	1.A.	Level of operational risk of option - Degree of reliance on mechanical, electrical or electronic systems, or on human intervention, action or decision, for the option to operate or perform successfully	Moderate to high, but manageable, degree of operational risk, i.e., an option with a high degree of reliance on mechanical, electrical or electronic systems, or on human intervention, action or decision, but which, with the allocation of adequate resources, could be operated with an acceptable degree of risk of failure	No operational risk, i.e., no reliance on mechanical, electrical or electronic systems, or on human intervention, action or decision for the option to operate or perform successfully
	Minimise health and safety risk in construction and operation of the flood risk management option	"	1.B	Degree of health and safety risk during construction and operation	Moderate to high, but acceptable and manageable, level of health and safety risk during either construction or operation	Negligible risk to health and safety during either construction or operation
	Ensure flood risk can be managed effectively and sustainably into the future	"	1.C	Sustainability and adaptability of the flood risk management measure in the face of potential future changes, including the potential impacts of climate change	Option to provide for, or be adaptable to, the MRFS in terms of maintaining the standard of protection at acceptable cost	Option to provide for, or be adaptable to, the HEFS in terms of maintaining the standard of protection at negligible cost
Economic	Reduce economic damage	"	2.A	Annual Average Damage (AAD) expressed in Euro / year, calculated in accordance with the economic risk assessment methods, but with no allowance for social / intangible benefits	AAD is not increased	100% reduction in AAD
	Minimise risk to transport infrastructure	"	2.B	Number and type of transport routes at risk from flooding	No increase in risk to transport infrastructure	Reduce risk to transport infrastructure to zero
	Minimise risk to utilities infrastructure	"	2.C	Number and type of infrastructure assets at risk from flooding	No increase in risk to utility infrastructure	Reduce risk to utility infrastructure to zero
	Minimise risk to agriculture	"	2.D	Agricultural production	No increase in the negative impact of flooding on agricultural production	Provide the potential for enhanced agricultural production
Social	Minimise risk to human health and life	(i) residents	3.A.(i)	Annual Average Number of residential properties at risk from flooding	Number of properties at risk is not increased	100% reduction in number of residential properties at risk
		(ii) high vulnerability properties	3.A.(ii)	Number and type of high vulnerability properties at risk from flooding	Number of high vulnerability properties at risk not increased	100% reduction in number of high vulnerability properties at risk
	Minimise risk to community	(i) social infrastructure	3.B.(i)	Number of social infrastructure assets at risk from flooding in a 0.1% AEP Event	Number of social infrastructure assets at risk not increased	100% reduction in number of social infrastructure assets at risk
	"	(ii) local employment	3.B.(ii)	Number of non-residential (i.e., commercial) properties at risk not increased.	Number of non-residential properties at risk not increased	100% reduction in number of non-residential properties at risk
	Minimise risk to, and where possible enhance, social amenity sites	"	3.C	Number of social amenity sites at risk from flooding in a 1% AEP Event	Number of social amenity sites at risk not increased	100% reduction in number of flood-sensitive social amenity sites at risk. Enhancement or creation of social amenity sites
Environmental	Support the objectives of the WFD	Provide no impediment to the achievement of water body objectives and, if possible, contribute to the achievement of water body objectives	4.A	-	Provide no constraint to the achievement of water body objectives.	Contribute to the achievement of water body objectives
	Support the objectives of the Habitats and Birds Directives	Avoid detrimental effects to, and where possible enhance, Natura 200 network, protected species and their key habitats, recognising relevant landscape features and stepping stones.	4.B	-	No deterioration in the conservation status of designated sites as a result of flood risk management measures.	Improvement in the conservation status of designated sites as a result of flood risk management sites.
	Avoid damages to, and where possible enhance, the flora and fauna of the catchment	Avoid damage to, and where possible enhance, legally protected sites / habitats and other sites / habitats of national, regional and local nature conservation importance	4.C	-	No deterioration in the condition of existing sites due to the implementation of flood risk management option	Creation of new or improvement in condition of existing sites due to the implementation of flood risk management option
	Protect and where possible enhance fisheries resource within the catchment	Maintain existing and where possible create new fisheries habitat including the maintenance or improvement of conditions that allow upstream migration for fish species	4.D	-	No loss of integrity of fisheries habitat. Maintenance of upstream accessibility	No loss of fisheries habitat. Improvement in habitat quality/quantity. Enhanced upstream accessibility
	Protect and where possible enhance, landscape character and visual amenity within the zone of influence.	Protect, and where possible enhance, visual amenity, landscape protection zones and views into/from designated scenic areas within the zone of influence	4.E	-	No significant impact on landscape designation (protected site, scenic route/amenity, natural landscape form) within zone of visibility of measures. No significant change in the quality of existing landscape characteristics of the receiving environment	No change to the existing landscape form. Enhancement of existing landscape or landscape feature
	Avoid damage to or loss of features of cultural heritage importance and their setting, and improve their protection from extreme floods.	(i) Avoid damage to or loss of features of architectural value and their setting, and improve their protection from extreme floods where this is beneficial	4.F.(i)	-	No increase in the risk to architectural features at risk from flooding. No detrimental impacts from flood risk management measures on architectural features.	Complete removal of all relevant architectural features from the risk of harm by extreme floods. Enhanced protection and value of architectural features importance arising from the implementation of the selected measures.
	"	(ii) Avoid damage to or loss of features of archaeological value and their setting, and improve their protection from extreme floods where this is beneficial	4.F.(ii)	-	No increase in the risk to archaeological features at risk from flooding. No detrimental impacts from flood risk management measures on archaeological features.	Complete removal of all relevant archaeological features from the risk of harm by extreme floods. Enhanced protection and value of archaeological features importance arising from the implementation of the selected measures.

B2 MCA Scoring Sheets

Multicriteria Analysis - Flood Risk Management OPTION 2 - Ballincrokig flood storage, combined with conveyance improvements and direct defences in Common's Road/Blackpool

Core Criteria	Objective	Global Weighting	Local Weighting	Local Weighting Rationale	FRS OPTION 2 - Ballincrokig flood storage, combined with conveyance improvements and direct defences in Common's Road/Blackpool		
					SCORING	Rationale	MCA SCORE
Technical	Ensure flood risk management options are operationally robust	20	5	As per GN28 guidance	3	Very low operational risk assuming the storage control would be largely passive. Reduced flwo would reduce the extent of defences required and would mean that the culvert systems would be less susceptible to sediment builup and debris, thus reducing criticality of maintenance.	300
	Minimise health and safety risk in construction and operation of the flood risk management option	20	5	As per GN28 guidance	0	Considered to have marginally higher risk than Options 3 and 4 due to deep water within storage area and new low residual risk of dam breach.	0
	Ensure flood risk can be managed effectively and sustainably into the future	20	5	As per GN28 guidance	1	All proposed options will require the incorporation of other options to adapt for climate change. The storage area was considered least adaptable as there is a finite storage volume and because of the proportion of the catchment downstream and lack of information on spatial distribution of rainfall, significant further work would be required to establish with confidence that this option could cater for the climate change scenario in conjunction with reasonable measures within the at risk area.	100
		60				**Technical Score**	**400**
Economic	Reduce economic damage	30	5	As per GN28 guidance	5	All options scored similar at close to top scores as each option provides protection to the same 1 in 100 year standard, with no significant difference in risidual risk to the economy, transport or utility infrastructure	750
	Minimise risk to transport infrastructure	10	3	Changed from 5 due to absense of major infrastructure routes within the at risk area.	5		150
	Minimise risk to utilities infrastructure	10	2	Changed from 5 due to absense of major utility routes within the at risk area.	4		80
	Minimise risk to agriculture	10	5	Set at 5 due to significance of potential agricultural loss upstream in catchment.	-5	Effective sterilisation of a large area of agricultural land in Ballincrokig is considered to be a very significant impact in terms of agriculture.	-250
		60				**Economic Score**	**730**
Social	Minimise risk to human health and life	30	5	All set at maximum local weighting due to significant existing risk, regular flood history and locla feedback of both personaland business impacts of past flooding	5	All options provide protection to the 1% AEP standard	750
		10	5		5		250
	Minimise risk to community	5	5		5		125
	"	10	5		4	All options provide protection to the 1% AEP standard. 1 mark deducted for resildual risk which is considered similar in all options	200
	Minimise risk to, and where possible enhance, social amenity sites	5	2	Local weighting reduced to reflect the status of social amenity sites considered. (limited high values areas)	0	No change from status quo	0
		60				**Social Score**	**1325**
Environmental	Support the objectives of the WFD	15	5	As per GN28 guidance	1	Possible improvement in water quality and the main objectives of the Water Framework Directive River Basin District Management Plan (RBDMP). No significant impact of permanent works during operation, however there is potential for temporary impact during construction stage.	75
	Support the objectives of the Habitats and Birds Directives	15	3	Local weighting reflects absense of SACs and SPAs in close proximity to works area.	-1	Potential for construction related water-quality impacts on water dependent Annex I habitats and Annex II species as a result of instream works. Potential for disturbance/loss of Kingfisher nest sites (low potential). Potential for change in water levels on the Glenamought River during the operational stage which may impact on Annex II water dependent species. Potential for loss of bat (Annex IV species) roosting sites. Potential for habitat loss for Annex II water dependant species e.g. Lamprey. This score was selected on the basis that very little work would be required downstream of the storage area.	-45
	Avoid damages to, and where possible enhance, the flora and fauna of the catchment	5	2	Local weighting reflects absense of sensitive areas such as NHAs, national parks etc. in close proximity to works area.	-1	Potential for loss of hedgerow/woody vegetation during construction works with impacts on native bird species. Potential for disturbance and spread of invasive Japanese Knotweed and other non-native/invasive species during bankside construction works.	-10
	Protect and where possible enhance fisheries resource within the catchment	5	5	As per GN28 guidance	-3	Potential for construction related water-quality impacts on fish species as a result of instream and bankside works. Potential for change in water levels on the Glenamought River during the operational stage which may impact on fish species. One of the biggest issues will be potential siltation during construction. There will need to be very stringent mitigation measures in place and an ecologist on site to supervise. Swim speeds of fish and hydrobreak operation will determine resistance to entrainment. The inclusion of a hydrobreak has teh potential to significantly impact on fishpass from upstream to downstream of the storage area.	-75
	Protect and where possible enhance, landscape character and visual amenity within the zone of influence.	10	4	Considered in the context of the landscape cahracter of the area and the site's location within a Architectural Conservation Area	-2	Potential for construction related and operation visual impacts on completion, based on introduction of new man-made structure in existing agricultural setting. Reduction in any visual impact likely possible through landscaping and screening. Elsewhere, potential for some local but no significant visual impacts, based on limited views from public spaces and location within largely urban and industrial area.	-80
	Avoid damage to or loss of features of cultural heritage importance and their setting, and improve their protection from extreme floods.	5	2	Local weighting reflects absense of any national monuments and very limited number of features of archaeological interest..	-2	The Church of the Annunciation (Blackpool Church) to south is listed in NIAH and no significant impacts are foreseen. Area to be impacted construction works is within the site of a former flax mill listed in RMP (CO074-115). While this site appears to have been demolished, it is recommended that consultation be undertaken with NMS and City Council heritage staff to determine appropriate assessment and mitigation. Any in-channel works may impact on unrecorded riverine archaeological features. Underwater Archaeological Unit should be consulted in relation to appropriate assessment and mitigation.	-20
	"	5	2		-2		-20
		60				**Environmental Score**	**-175**

MCA Benefit Score	**1880**
Option Selection Benefit Score	**2280**
Total Capital Costs (M€)	**10.12**
MCA Benefit/Cost Ratio	**0.19**
Economic Benefit (M€)	**10.71**
Economic Benefit/Cost Ratio	**1.06**

Multicriteria Analysis - Flood Risk Management OPTION 3 - Conveyance improvements and direct defences (with high walls in Orchard Court)

Core Criteria	Objective	Global Weighting	Local Weighting	Local Weighting Rationale	FRS OPTION 3 - Conveyance improvements and direct defences (with high walls in Orchard Court)		
					SCORING	Rationale	MCA SCORE
Technical	Ensure flood risk management options are operationally robust	20	5	As per GN28 guidance	2	Low operational risk. Score reduced from very low to low because of concerns over the requirement for very active management of debris control, with concerns over risks of blockage from fly tipping etc.	200
	Minimise health and safety risk in construction and operation of the flood risk management option	20	5	As per GN28 guidance	1	Standard construction in low risk areas. Standard maintenance. Considered to be similar to Option 4 in terms of H&S	100
	Ensure flood risk can be managed effectively and sustainably into the future	20	5	As per GN28 guidance	2	All proposed options will require the incorporation of other options to adapt for climate change.	200
		60				**Technical Score**	**500**
Economic	Reduce economic damage	30	5	As per GN28 guidance	5	All options scored similar at close to top scores as each option provides protection to the same 1 in 100 year standard, with no significant difference in risidual risk to the economy, transport or utility infrastructure	750
	Minimise risk to transport infrastructure	10	3	Changed from 5 due to absense of major infrastructure routes within the at risk area.	5		150
	Minimise risk to utilities infrastructure	10	2	Changed from 5 due to absense of major utility routes within the at risk area.	4		80
	Minimise risk to agriculture	10	5	Set at 5 due to significance of potential agricultural loss upstream in catchment.	0	No significant change to the Status Quo	0
		60				**Economic Score**	**980**
Social	Minimise risk to human health and life	30	5	All set at maximum local weighting due to significant existing risk, regular flood history and locla feedback of both personaland business impacts of past flooding	5	All options provide protection to the 1% AEP standard	750
		10	5		5		250
	Minimise risk to community	5	5		5		125
	"	10	5		4	All options provide protection to the 1% AEP standard. 1 mark deducted for resildual risk which is considered similar in all options	200
	Minimise risk to, and where possible enhance, social amenity sites	5	2	Local weighting reduced to reflect the status of social amenity sites considered. (limited high values areas)	-3	Whilst this indicator was intended to refer to residual risk of flooding, in light of the significnat public feedback, it was considered appropriate to also consider here the overlal impact of the proposed scheme on the social fabric of the area. In this regard, the high walls in Orchard Court were considered to be likely to have a very significant negative social impact in the Orchard Court area.	-30
		60				**Social Score**	**1295**
Environmental	Support the objectives of the WFD	15	5	As per GN28 guidance	1	Possible improvement in water quality and the main objectives of the Water Framework Directive River Basin District Management Plan (RBDMP). No significant impact of permanent works during operation, however there is potential for temporary impact during construction stage.	75
	Support the objectives of the Habitats and Birds Directives	15	3	Local weighting reflects absense of SACs and SPAs in close proximity to works area.	-2	Potential for construction related water-quality impacts on water dependent Annex I habitats and Annex II species as a result of instream works. Potential for disturbance/loss of Kingfisher nest sites (low potential). Potential for loss of bat (Annex IV species) roosting sites. Potential for habitat loss for Annex II water dependant species e.g. Lamprey.	-90
	Avoid damages to, and where possible enhance, the flora and fauna of the catchment	5	2	Local weighting reflects absense of sensitive areas such as NHAs, national parks etc. in close proximity to works area.	-1	Potential for loss of hedgerow/woody vegetation during construction works with impacts on native bird species. Potential for disturbance and spread of invasive Japanese Knotweed and other non-native/invasive species during bankside construction works.	-10
	Protect and where possible enhance fisheries resource within the catchment	5	5	As per GN28 guidance	-1	Potential for construction related water-quality impacts on fish species as a result of instream and bankside works. Potential for habitat loss for fish species. Potential for obstruction to migration of fish species.	-25
	Protect and where possible enhance, landscape character and visual amenity within the zone of influence.	10	4	Considered in the context of the landscape cahracter of the area and the site's location within a Architectural Conservation Area	-4	Proposed Option C wall height of 2.1m would represent significant visual intrusion in the residential area of Orchard Court. Visual impact likely to be significant. Elsewhere, potential for some local but no significant visual impacts, based on limited views from public spaces and location within largely urban and industrial area.	-160
	"	5	2		-2		-20
		55				**Environmental Score**	**-230**

MCA Benefit Score	**2045**
Option Selection Benefit Score	**2545**
Total Capital Costs (M€)	**11.51**
MCA Benefit/Cost Ratio	**0.18**
Economic Benefit (M€)	**10.71**
Economic Benefit/Cost Ratio	**0.93**

Multicriteria Analysis - Flood Risk Management OPTION 4 - Conveyance improvements and direct defences (with culvert through Orchard Court)

Core Criteria	Objective	Global Weighting	Local Weighting	Local Weighting Rationale	FRS OPTION 4 - Conveyance improvements and direct defences (with culvert through Orchard Court)		
					SCORING	Rationale	MCA SCORE
Technical	Ensure flood risk management options are operationally robust	20	5	As per GN28 guidance	3	Very low risk. Generally passive controls with little intervention during a flood event. Lower risk of blckage than option 3 due to culverting through Orchard Court.	300
	Minimise health and safety risk in construction and operation of the flood risk management option	20	5	As per GN28 guidance	1	Standard construction in low risk areas. Standard maintenance. Considered to be similar to Option 4 in terms of H&S	100
	Ensure flood risk can be managed effectively and sustainably into the future	20	5	As per GN28 guidance	2	All proposed options will require the incorporation of other options to adapt for climate change.	200
		60				**Technical Score**	**600**
Economic	Reduce economic damage	30	5	As per GN28 guidance	5	All options scored similar at close to top scores as each option provides protection to the same 1 in 100 year standard, with no significant difference in risidual risk to the economy, transport or utility infrastructure	750
	Minimise risk to transport infrastructure	10	3	Changed from 5 due to absense of major infrastructure routes within the at risk area.	5		150
	Minimise risk to utilities infrastructure	10	2	Changed from 5 due to absense of major utility routes within the at risk area.	4		80
	Minimise risk to agriculture	10	5	Set at 5 due to significance of potential agricultural loss upstream in catchment.	0	No significant change to the Status Quo	0
		60				**Economic Score**	**980**
Social	Minimise risk to human health and life	30	5	All set at maximum local weighting due to significant existing risk, regular flood history and locla feedback of both personaland business impacts of past flooding	5	All options provide protection to the 1% AEP standard	750
		10	5		5		250
	Minimise risk to community	5	5		5		125
	"	10	5		4	All options provide protection to the 1% AEP standard. 1 mark deducted for resildual risk which is considered similar in all options	200
	Minimise risk to, and where possible enhance, social amenity sites	5	2	Local weighting reduced to reflect the status of social amenity sites considered. (limited high values areas)	1	Whilst this indicator was intended to refer to residual risk of flooding, in light of the significnat public feedback, it was considered appropriate to also consider here the overlal impact of the proposed scheme on the social fabric of the area. In this regard, the culverting of Orchard Court and the creation of a linear maintainable amenity area was considered a marginal improvement.	10
		60				**Social Score**	**1335**
Environmental	Support the objectives of the WFD	15	5	As per GN28 guidance	2	Possible improvement in water quality and the main objectives of the Water Framework Directive River Basin District Management Plan (RBDMP) will be enhanced by limiting potential for dumping in river. No significant impact of permanent works during operation, however there is potential for temporary impact during construction stage.	150
	Support the objectives of the Habitats and Birds Directives	15	3	Local weighting reflects absense of SACs and SPAs in close proximity to works area.	-3	Potential for construction related water-quality impacts on water dependent Annex I habitats and Annex II species as a result of instream works. Potential for permanent loss of habitat for Annex II water dependent species as a result of river bed excavation. Potential for habitat loss for Annex II water dependant species e.g. Lamprey. Potential for obstruction to migration of Annex II species.	-135
	Avoid damages to, and where possible enhance, the flora and fauna of the catchment	5	2	Local weighting reflects absense of sensitive areas such as NHAs, national parks etc. in close proximity to works area.	-1	Potential for loss of hedgerow/woody vegetation during construction works with impacts on native bird species. Potential for disturbance and spread of invasive Japanese Knotweed and other non-native/invasive species during bankside construction works.	-10
	Protect and where possible enhance fisheries resource within the catchment	5	5	As per GN28 guidance	-4	Potential for construction related water-quality impacts on fish species as a result of instream and bankside works. probability of permanent habitat loss for fish species along route of proposed culvert. Potential for obstruction to migration of fish species. Score reflects concerns raised by IFI.	-100
	Protect and where possible enhance, landscape character and visual amenity within the zone of influence.	10	4	Considered in the context of the landscape cahracter of the area and the site's location within a Architectural Conservation Area	-1	Potential for positive visual impact in Orchard Court by creation of a maintainable landscaped area. Elsewhere, potential for some local but no significant visual impacts, based on limited views from public spaces and location within largely urban and industrial area.	-40
	Avoid damage to or loss of features of cultural heritage importance and their setting, and improve their protection from extreme floods.	5	2	Local weighting reflects absense of any national monuments and very limited number of features of archaeological interest..	-2	The Church of the Annunciation (Blackpool Church) to south is listed in NIAH and no significant impacts are foreseen. Area to be impacted construction works is within the site of a former flax mill listed in RMP (CO074-115). While this site appears to have been demolished, it is recommended that consultation be undertaken with NMS and City Council heritage staff to determine appropriate assessment and mitigation. Any in-channel works may impact on unrecorded riverine archaeological features. Underwater Archaeological Unit should be consulted in relation to appropriate assessment and mitigation.	-20
		55				**Environmental Score**	**-155**

MCA Benefit Score	**2160**
Option Selection Benefit Score	**2760**
Total Capital Costs (M€)	**11.64**
MCA Benefit/Cost Ratio	**0.19**
Economic Benefit (M€)	**10.71**
Economic Benefit/Cost Ratio	**0.92**

Multicriteria Analysis - Flood Risk Management OPTION 5 - Conveyance improvements & direct defences (culvert replacement from Orchard Court to Madden's Building)

Core Criteria	Objective	Global Weighting	Local Weighting	Local Weighting Rationale	FRS OPTION 5 - Conveyance improvements & direct defences (culvert replacement from Orchard Court to Madden's Building)		
					SCORING	Rationale	MCA SCORE
Technical	Ensure flood risk management options are operationally robust	20	5	As per GN28 guidance	4	Negligible operational risk. This scored better than options 3 and 4 as the existing throttle between Madden's Buildings and Blackpool Church would be upsized, thus meaning that the culvert systems would be less susceptible to sediment builup and debris, thus reducing criticality of maintenance. Scored better than Option 1 because operational risk of storage reservoir not included.	400
	Minimise health and safety risk in construction and operation of the flood risk management option	20	5	As per GN28 guidance	0	Considered to have marginally higher risk than Options 3 and 4 primarilly due to high risk during construction along waterocurse road in close proximity to old houses, breaking out large volumens of concrete, and congestion of major services.	0
	Ensure flood risk can be managed effectively and sustainably into the future	20	5	As per GN28 guidance	2	All proposed options will require the incorporation of other options to adapt for climate change.	200
		60				**Technical Score**	**600**
Economic	Reduce economic damage	30	5	As per GN28 guidance	5	All options scored similar at close to top scores as each option provides protection to the same 1 in 100 year standard, with no significant difference in risidual risk to the economy, transport or utility infrastructure	750
	Minimise risk to transport infrastructure	10	3	Changed from 5 due to absense of major infrastructure routes within the at risk area.	5		150
	Minimise risk to utilities infrastructure	10	2	Changed from 5 due to absense of major utility routes within the at risk area.	4		80
	Minimise risk to agriculture	10	5	Set at 5 due to significance of potential agricultural loss upstream in catchment.	0	No significant change to the Status Quo	0
		60				**Economic Score**	**980**
Social	Minimise risk to human health and life	30	5	All set at maximum local weighting due to significant existing risk, regular flood history and locla feedback of both personaland business impacts of past flooding	5	All options provide protection to the 1% AEP standard	750
		10	5		5		250
	Minimise risk to community	5	5		5		125
	"	10	5		4	All options provide protection to the 1% AEP standard. 1 mark deducted for resildual risk which is considered similar in all options	200
	Minimise risk to, and where possible enhance, social amenity sites	5	2	Local weighting reduced to reflect the status of social amenity sites considered. (limited high values areas)	0	No change from status quo	0
		60				**Social Score**	**1325**
Environmental	Support the objectives of the WFD	15	5	As per GN28 guidance	1	Possible improvement in water quality and the main objectives of the Water Framework Directive River Basin District Management Plan (RBDMP). No significant impact of permanent works during operation, however there is potential for temporary impact during construction stage.	75
	Support the objectives of the Habitats and Birds Directives	15	3	Local weighting reflects absense of SACs and SPAs in close proximity to works area.	-2	Potential for construction related water-quality impacts on water dependent Annex I habitats and Annex II species as a result of instream works. Potential for disturbance/loss of Kingfisher nest sites (low potential). Potential for loss of bat (Annex IV species) roosting sites. Potential for habitat loss for Annex II water dependant species e.g. Lamprey.	-90
	Avoid damages to, and where possible enhance, the flora and fauna of the catchment	5	2	Local weighting reflects absense of sensitive areas such as NHAs, national parks etc. in close proximity to works area.	-1	Potential for loss of hedgerow/woody vegetation during construction works with impacts on native bird species. Potential for disturbance and spread of invasive Japanese Knotweed and other non-native/invasive species during bankside construction works.	-10
	Protect and where possible enhance fisheries resource within the catchment	5	5	As per GN28 guidance	-1	Potential for construction related water-quality impacts on fish species as a result of instream and bankside works. Potential for habitat loss for fish species . Potential for obstruction to migration of fish species.	-25
	Protect and where possible enhance, landscape character and visual amenity within the zone of influence.	10	4	Considered in the context of the landscape cahracter of the area and the site's location within a Architectural Conservation Area	-2	Potential for some local but no significant visual impacts, based on limited views from public spaces and location within largely urban and industrial area.	-80
	Avoid damage to or loss of features of cultural heritage importance and their setting, and improve their protection from extreme floods.	5	2	Local weighting reflects absense of any national monuments and very limited number of features of archaeological interest..	-3	It is noted that works are in vicinity of 19 Watercourse Rd (listed in NIAH) and Madden's Buildings (RPS 491). No significant impacts are foreseen. The Church of the Annunciation (Blackpool Church) to south is listed in NIAH and no significant impacts are foreseen. Area to be impacted construction works is within the site of a former flax mill listed in RMP (CO074-115). While this site appears to have been demolished, it is recommended that consultation be undertaken with NMS and City Council heritage staff to determine appropriate assessment and mitigation. Any in-channel works may impact on unrecorded riverine archaeological features. Underwater Archaeological Unit should be consulted in relation to appropriate assessment and mitigation.	-30
		55				**Environmental Score**	**-160**

MCA Benefit Score	**2145**
Option Selection Benefit Score	**2745**
Total Capital Costs (M€)	**13.71**
MCA Benefit/Cost Ratio	**0.16**
Economic Benefit (M€)	**10.71**
Economic Benefit/Cost Ratio	**0.78**

B3 MCA Scoring Summary

Prepared by: DR
Checked by: KL
Issued: November 2015

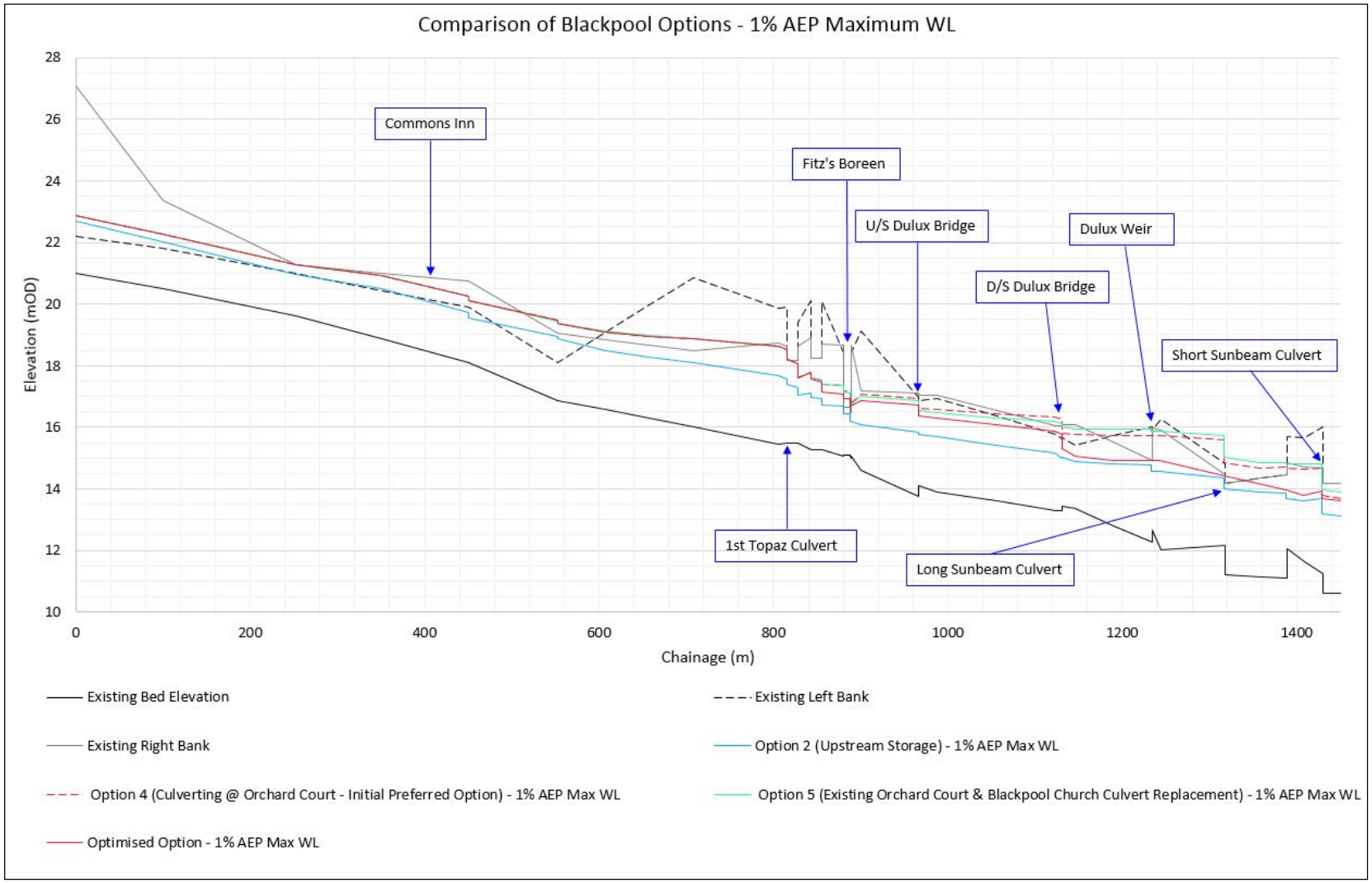
Multicriteria Analysis Summary Sheet					
River Bride (Blackpool) Certified Drainage Scheme	**FRS OPTION 1 - 'Do Minimum'**	**FRS OPTION 2 - Ballincrokig flood storage, combined with conveyance improvements and direct defences in Common's**	**FRS OPTION 3 - Conveyance improvements and direct defences (with high walls in Orchard Court)**	**FRS OPTION 4 - Conveyance improvements and direct defences (with culvert through Orchard Court)**	**FRS OPTION 5 - Conveyance improvements & direct defences (culvert replacement from Orchard Court to Madden's Building)**
Technical Score	-200100	400	500	600	600
Economic Score	-199850	730	980	980	980
Social Score	-284715	1325	1295	1335	1325
Environmental Score	140	-175	-250	-175	-190
MCA Benefit Score	-484425	1880	2025	2140	2115
Option Selection Benefit Score	-684525	2280	2525	2740	2715
Total Capital Costs (M€)	0.5	10.12	11.51	11.64	13.71
MCA Benefit/Cost Ratio	N/A	0.186	0.176	0.184	0.154
Economic Benefit (M€)	N/A	10.71	10.71	10.71	10.71
Economic Benefit/Cost Ratio	N/A	1.058	0.930	0.920	0.781

Appendix C

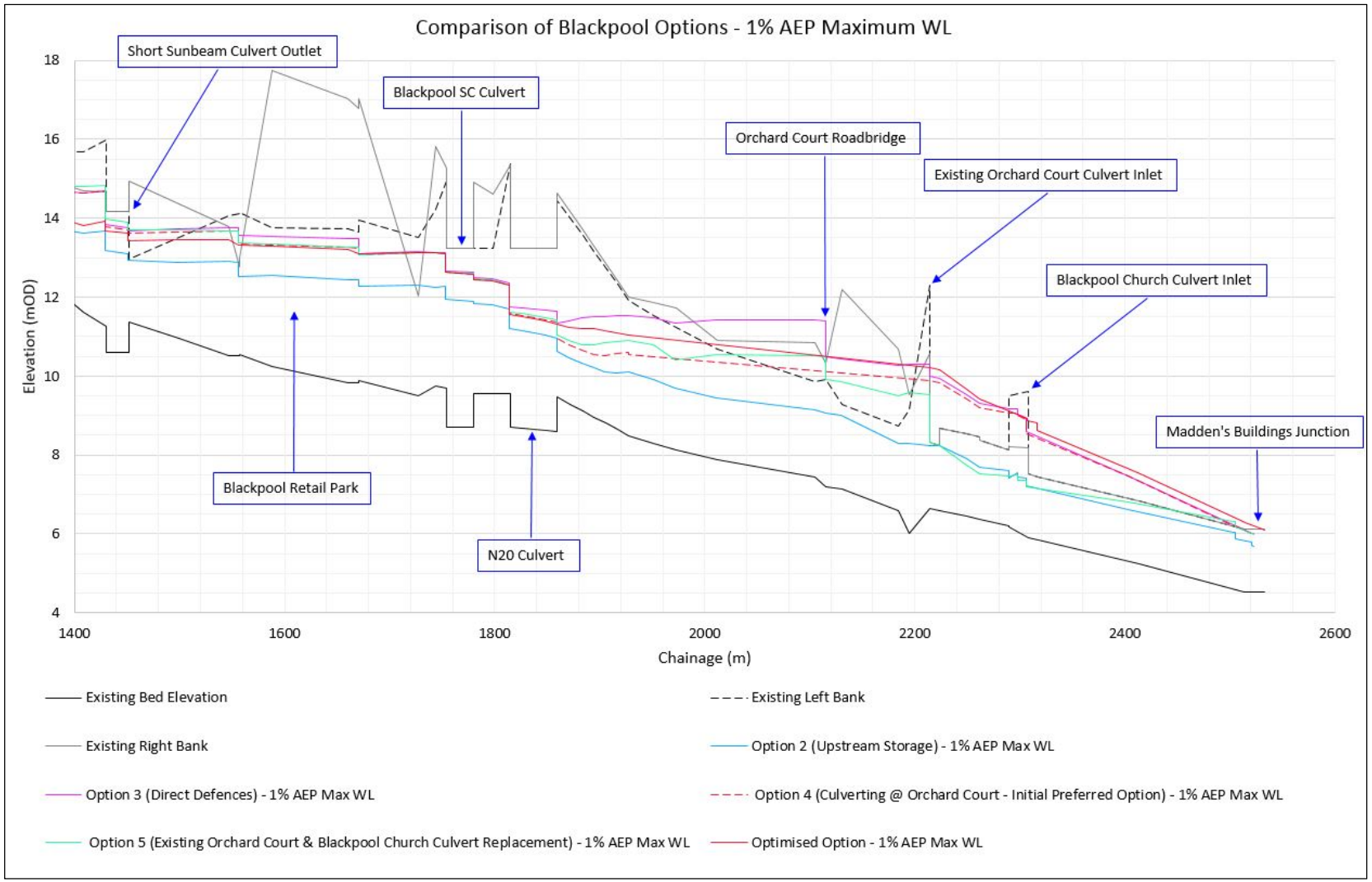
Hydraulic Modelling Outputs for Potential Options

C1 Long Sections for Proposed Options

C1.1.1 Commons Road – Blackpool Retail Park


Comparison of Blackpool Options - 1% AEP Maximum WL
Elevation (mOD)
28
26
24
22
20
18
16
14
12
10
0
200
400
600
800
1000
1200
1400
Chainage (m)
Commons Inn
Fitz's Boreen
U/S Dulux Bridge
Dulux Weir
D/S Dulux Bridge
Short Sunbeam Culvert
1st Topaz Culvert
Long Sunbeam Culvert
Existing Bed Elevation
Existing Left Bank
Existing Right Bank
Option 2 (Upstream Storage) - 1% AEP Max WL
Option 4 (Culverting @ Orchard Court - Initial Preferred Option) - 1% AEP Max WL
Option 5 (Existing Orchard Court & Blackpool Church Culvert Replacement) - 1% AEP Max WL
Optimised Option - 1% AEP Max WL

C1.1.2 Blackpool Retail Park – Madden's Buildings Junction


Comparison of Blackpool Options - 1% AEP Maximum WL
Short Sunbeam Culvert Outlet
Blackpool SC Culvert
Orchard Court Roadbridge
Existing Orchard Court Culvert Inlet
Blackpool Church Culvert Inlet
Madden's Buildings Junction
Blackpool Retail Park
N20 Culvert
Elevation (mOD)
Chainage (m)
Existing Bed Elevation
Existing Left Bank
Existing Right Bank
Option 2 (Upstream Storage) - 1% AEP Max WL
Option 3 (Direct Defences) - 1% AEP Max WL
Option 4 (Culverting @ Orchard Court - Initial Preferred Option) - 1% AEP Max WL
Option 5 (Existing Orchard Court & Blackpool Church Culvert Replacement) - 1% AEP Max WL
Optimised Option - 1% AEP Max WL