MOTT MACDONALD

JBA consulting

Peebles Flood Study - Eddleston Water **Appraisal Report**

Final Report

January 2019

Scottish Borders COUNCIL

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Contract

This report describes work commissioned by Duncan Morrison, on behalf of Scottish Borders Council, by a letter dated 16 January 2017. Scottish Borders Council's representative for the contract was Duncan Morrison). Tasmin Fletcher, Barney Bedford, Hannah Otton and Christina Kampanou of JBA Consulting carried out this work.

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Purpose

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JBA Consulting has no liability regarding the use of this report except to Scottish Borders Council.

Our work has followed accepted procedure in providing the services but given the residual risk associated with any prediction and the variability which can be experienced in flood conditions, we can take no liability for the consequences of flooding in relation to items outside our control or agreed scope of service.

Legislative framework

This flood study was commissioned in order to gain a greater understanding of the flood mechanisms in Peebles, improve upon SEPA's Flood Risk Management maps, and provide an appraisal of options which could reduce flood risk. In 2015, as part of the Flood Risk Management (Scotland) Act 2009, the Scottish parts of the Tweed catchment were designated as the Tweed Local Plan District by SEPA. Flood risk must therefore be addressed by SEPA's Flood Risk Management Strategy (FRMS) and the local authorities' Local Flood Risk Management Plan (LFRMP). Of the 13 Potentially Vulnerable Areas (PVA) defined by SEPA within the Tweed

catchment, the Peebles PVA (reference 13/04) includes Peebles and the surrounding communities of Eddleston, Innerleithen, Selkirk, Stow and Galashiels. According to this PVA, Peebles has a lengthy history of flooding and the potential for approximately £1,200,000 Annual Average Damages (AAD). A flood protection study is identified as one of the key actions to be taken as a means to reduce this risk and this report presents the findings of part of the study.

Acknowledgements

We would like to thank Scottish Borders Council, Turner Townsend and Mott MacDonald for the data, supporting information and reviews undertaken throughout the study. We would also like to thank members of SEPA for the review of the hydrological calculations and flood modelling methodologies.

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Eddleston Water FRM Business Case

Context

Peebles in the Scottish Borders has a history of property flooding. JBA was commissioned in 2017 to carry out a review of past flood events, determine the likely risk to different properties and to propose a set of 'options' that may reduce the flood risk to an acceptable level. This report is the culmination of this work and aims to provide a detailed explanation of the various steps carried out in order to identify a preferred set of interventions that offer a sustainable method of flood protection whilst seeking to benefit the environment and the community of Peebles.

This report focusses on the Eddleston Water through Peebles. The Eddleston Water is a tributary of the River Tweed, which runs north to south into the centre of Peebles before it flows into the River Tweed upstream of Tweed Bridge. Properties closely border the watercourse on both banks through Peebles.

A modelling exercise was carried out to estimate river levels on the Eddleston Water from a point upstream of Peebles to its confluence with the River Tweed. A range of possible flood events were modelled from the 2 year flood to a 1000 year flood. Increases due to predicted climate change were included for at the 3.3% AP (30 year) and 0.5% AP (200 year) events.

It was found that 73 properties are at risk of flooding from the 0.5% AP (200 year) event and 120 are at risk for the same event with a climate change allowance. A range of flood protection options were then reviewed and short listed based on their viability.

Risk metrics

The following risk metrics are provided to aid prioritisation by SEPA:

Properties at risk	73 at the 200 year flood (120 with climate change)
Non-residential properties at risk	9 at the 200 year flood (12 with climate change)
Key receptors at risk	Properties along Cuddyside, St Michaels Bank, Biggiesknowe and Greenside.

Note: The properties on Greenside are not included in this assessment but are included instead in the River Tweed appraisal report as the flooding to these properties is dominated by high water levels in the Tweed.

Flood Mitigation Options

A range of flood protection options were then reviewed and short listed based on their viability. Due to the proximity of properties to the constrained watercourse none of the viable options are capable of providing a 200 year standard of protection. Direct defences would be too large within public spaces if designed to protect against such a large magnitude flood. Options designed to varying standards of protection were short-listed and are as follows:

- PLP - provision of property level protection where relevant to give a 5 year standard of protection.
- Option 1 - direct defence option with a 30 year standard of protection.
- Option 2 - direct defence option and removal of the three weirs to give a 30 year standard of protection.
- Option 3 - direct defence option including removal of three weirs and raising of bridges giving a 75 year standard of protection.

Improving public awareness and resilience

In addition to these short-listed options a number of non-structural options and good practice FRM measures have been investigated and recommended for implementation by Scottish Borders Council. Some of these are already in place elsewhere and could be implemented either in the short term or alongside a Flood Protection Scheme. These include the following:

- Flood warning on the Eddleston Water is already in place but the gauge should be upgraded to a flow gauge if possible. A review of the data available from other gauges in the catchment installed as part of the Eddleston Water Project should be carried out and the potential for this data to be collated by SEPA investigated. Consideration of the preferred option should be given as flood gate closure may be an implication of the preferred scheme and therefore a consideration of any future gauge recalibration.

- Flood action groups, in partnership with the Community Council should seek to establish a network of support between members of the community, Scottish Borders Council, Tweed Forum and emergency services. Community engagement should be continued to raise awareness of flood risk and potential short- and longer-term solutions.
- At risk properties could make use of the Council's PLP discount scheme in advance of any possible Flood Protection Scheme on the watercourse.
- Resilient Communities and general community sandbag stores are available in Peebles. The Council should consider if these are suitably located to assist residents along Cuddyside, St Michaels Bank and Greenside. Furthermore, the use of a flood 'pod' system that can also be used by the community closer to the Eddleston Water should be considered. Flood 'pods' are community storage boxes which contain flood sacks; purpose designed bags filled with absorbent material. The key advantage of this approach is that they can be distributed before a flood and are ideal for locations with limited warning or response times. It may also save the Council time in filling, distributing and delivering sandbags to communities when sandbag stores run out.
- Scottish Planning Policy should be leveraged to provide the potential for future implementation of other options that are currently not possible or to avoid unnecessary development on the floodplain upstream of Peebles.

Expected benefits

A flood damage assessment has been undertaken for the present-day Do Nothing and Do Minimum scenarios and each of the above options. The Present Value flood damages calculated for the Do Nothing and Do Minimum scenarios are estimated to be £4,1m and £2.9m, respectively. The damages avoided for each option are in the range of £2.2-2.8m (depending on the option assessed). Total damages avoided for each option are provided in the investment appraisal summary table.

Number of properties protected (DD = Direct defences):

	PLP	DD & weir removal	DD	DD, weir removal & bridge raising
Standard of Protection (SOP) (years)	5	30	30	75
Damages avoided (£k)	2,463	2,154	2,154	2,750
Residential properties benefitting	45	14	14	23
Non-residential properties benefitting	4	5	5	7
Total no. properties benefitting	49	19	19	30

Working with natural processes

The Eddleston Water Project is an ongoing research project using the Eddleston Water catchment to investigate the impact of different means of Natural Flood Management (NFM) and catchment management. As well as measures to improve channel morphology and its suitability for a range of flora and fauna this project has involved the removal of embankments, installation of 'high flow restrictors' to encourage out of bank flow in the headwaters, and leaky ponds to store water during intense rainfall events. A great deal of woodland planting has also been undertaken across the catchment. Most importantly for the wider Scottish Borders flood studies, the findings of this study should be taken into account in any future plans for flood prevention and catchment management in other catchments. Further research outputs are due and should be reviewed to see if the works will significantly impact on the outputs from this study.

The Water Framework Directive (WFD) status of the Eddleston Water has improved over the lifetime of the project from its starting point at 'Bad' to 'Moderate' at present. The next revision of the River Basin Management Plan (RBMP) by SEPA may similarly lead to revision of the 'Poor' RBMP status following the re-meandering works and removal of embankments.

Costs

Costs for each option have been estimated using the Environment Agency's Long Term Costing tool (2012). An optimism bias factor of 60% has been added to the total costs to allow for uncertainties in design at this stage and is typical for schemes at an early stage of appraisal. Whole life present value costs range from £1.8m to £6.3m. Total costs for each option are provided in the investment appraisal summary table below.

Investment appraisal

The investment appraisal is provided below. None of the structural defence options are estimated to be cost effective but the PLP option is. PLP achieves the highest benefit cost ratio at 1.4, with a net present value of £682k but offers an inconsistent standard of protection. Option 3 offers the highest standard of protection using direct defences, weir removal and bridge raising could only achieve a benefit cost ratio of 0.4. If combined with the preferred option on the River Tweed, a similar 75 year direct defences option, an overall benefit cost ratio of 1.3 could be achieved. Due to the overlap in flood risk between the River Tweed and Eddleston Water, a combined scheme is likely to be the most effective means of reducing flood risk in Peebles. A combined Tweed-Eddleston flood protection scheme requires further investigation but could be put forward by the Council for funding in the next FRM cycle.

Investment appraisal summary table:

	Do Nothing	Do Minimum	PLP	Option 1	Option 2	Option 3
Total PV Costs (£k)	-	-	1,781	4,403	5,105	6,338
PV damage (£k)	4,121	2,886	1,189	1,967	1,967	1,372
PV damage avoided (£k)	-	1,235	2,463	2,154	2,154	2,750
Net present value (£k)	-	1,235	682	-2,249	-2,951	-3,588
Benefit-cost ratio	-	-	1.4	0.5	0.4	0.4

Residual risks and planning for future flooding

A number of measures could be implemented to reduce the residual risk brought by above design standard flood events, particularly likely with climate change:

- Direct defences could be designed to protect against future climate change increases in flow now, or be adaptable through the use of demountable defences to be added on top of the proposed defences in the future. The cost and infrastructure required to implement demountable defences are substantial and should be avoided if possible. Alternatively, designing defences that can be easily raised in the future would be a more preferable option.
- Property Level Protection (PLP) would increase property resistance to flood waters and if implemented alongside a flood protection scheme could be an effective means of further reducing property flood damages.
- Scottish Planning Policy should be leveraged to avoid development on the floodplain of the Eddleston Water.

Conclusions and recommendations

Although the PLP option is cost-effective its inconsistent standard of protection mean that it is not a long-term solution to flood risk. If combined with a highly cost-beneficial option on the River Tweed the structural options, which offer longer-term benefit and an even standard of protection, are likely to be viable. Of these structural options Option 3, offering a 75 year standard of protection is best aligned with the needs of the community and the critical success factors identified for flood protection schemes in the Scottish Borders. Ongoing findings from the Eddleston Water Project should be incorporated into the outline design and detailed design phases of scheme development.

Option (Standard of protection)	Properties protected	Environmental implications	Working with natural processes	Constraints/ limitations	Mitigating residual risks	Improved public awareness	Best use of public money	Wider benefits
Direct Defences with weir removal (3.33% AP - 30 year)	19	Some implications for RBMP due to walls on riverside. Minimal in-channel works but some bank reinforcement likely to be needed.	NFM measures have been implemented on the Eddleston Water as part of the Eddleston Water Project. Improvements in watercourse condition have already been witnessed and initial findings suggest positive flood risk management benefits are being realised.	Large flood defences for the number of properties protected. 1.5m height on Cuddyside likely to be at the limit of acceptability.	Not likely to be possible to increase wall heights further to account for climate change. Some residual risk mitigated by Eddleston Water Project NFM measures.	Options should be presented to public for comment. Signage relating to flooding and sand bag stores and work with Peebles residents alongside 'Resilient communities' programme. Flood Warning should be continued on the Eddleston Water and updated if necessary.	Not cost effective due to expense of defences.	Minimal impacts to community beyond visual impacts.
Direct Defences (3.33% AP - 30 year)	19							
Direct Defences with weir removal and bridge raising (1.33% AP – 75 year)	30			High flood walls required, particularly on Cuddyside. Bridge removal and replacement required which will cause disturbance and flood gates needed across bridge following works.				Maintain existing businesses and employment locally to greater extent than Option 1 & 2.
PLP (20% AP – 5 year)	49 at the 0.5% AP (200 year) flood event	Little to no impact.		Little improvement in standard of protection for some properties. Intrusive for owners of properties selected and reinstallation required every 25 years. Roads not protected.	NFM measures already introduced or structural flood defences likely to be the only means of increasing resistance to flooding.		The only option with a benefit cost ratio over 1 unless combined with the River Tweed scheme.	Aside from individual property works wider community not affected. Minimal community disruption and change to the affected area of the town.
Combined Direct Defences, weir and bridge raising option with River Tweed scheme (1.33% AP – 75 year)	66	Minimal in-channel works but some riverside walls. Set back defences on River Tweed where possible.	Opportunities to set back Tweed defences, remove embankments and install further NFM measures in Tweed sub-catchments.	Large number of gates required on the River Tweed scheme.	River Tweed walls could be raised further to reduce future flood risk.	Flood Warning should be continued on the River Tweed as well as the Eddleston Water.	Highest standard of protection for a scheme that is cost-beneficial on the Eddleston Water.	Equal standard of protection across Peebles, providing long-term reduction in flooding and maintenance of businesses and community.

Negative			Neutral			Positive

Contents

List of Figures

List of Tables

Abbreviations

346g272g1D ..... One Dimensional (modelling)
2D ..... Two Dimensional (modelling)
BCR ..... Benefit Cost Ratio
CCTV ..... Closed Circuit Television
DTM ..... Digital Terrain Model
EA ..... Environment Agency
FCERM ..... Flood and Coastal Erosion Risk Management (R&D programme)

FEH	Flood Estimation Handbook
FPS	Flood Protection Scheme
FRM	Flood Risk Management
GIS	Geographical Information System
mAOD	metres Above Ordnance Datum
OS	Ordnance Survey
PLP	Property Level Protection
PV	Present Value
PVb	Present Value benefits
PVc	Present Value costs
QMED	Median Annual Flood (with return period 2 years)
Ramsar	The intergovernmental Convention on Wetlands, signed in Ramsar, Iran, in 1971
RBMP	River Basin Management Plan
SAC	Special Area of Conservation, protected under the EU Habitats Directive
SEPA	Scottish Environment Protection Agency
SPA	Special Protection Area for birds, protected under the EU Habitats Directive
SSSI	Site of Special Scientific Interest
TPO	Tree Preservation Order
TUFLOW	Two-dimensional Unsteady FLOW (a hydraulic model)

Return period and probability

For flood frequency analysis the probability of an event occurring is often expressed as a return period. A return period is the average interval (number of years) between two years containing one or more floods of a given magnitude or greater. As an example, the flood magnitude with a return period of 200 is referred to as the 200 year flood.

Another useful term closely linked to return period is a floods annual probability, AP. This is the probability of a flood greater than a given magnitude occurring in any year and calculates as the inverse of the return period. For example, there is a 1 in 200 chance of a flood exceeding the 200 year flood in any one year so the AP is calculated by 1/200 giving a 0.5% AP for the 200 year flood event.

Supporting Documents

Hydrology report - AEM-JBAU-PB-00-RP-A-0003-Peebles_Hydrology_Report-S4-P03.pdf

Asset condition assessment report - AEM-JBAU-PB-00-RP-A-0002-Asset_condition_assessment-S0-P01.02.pdf

RBMP & NFM report - AEM-JBAU-PB-00-RP-E-0002-Peebles_NFM_Report-S4-P02.pdf

Preliminary Ecological Appraisal - AEM-JBAU-PB-00-RP-E-0001-PEA-S1-P01.pdf

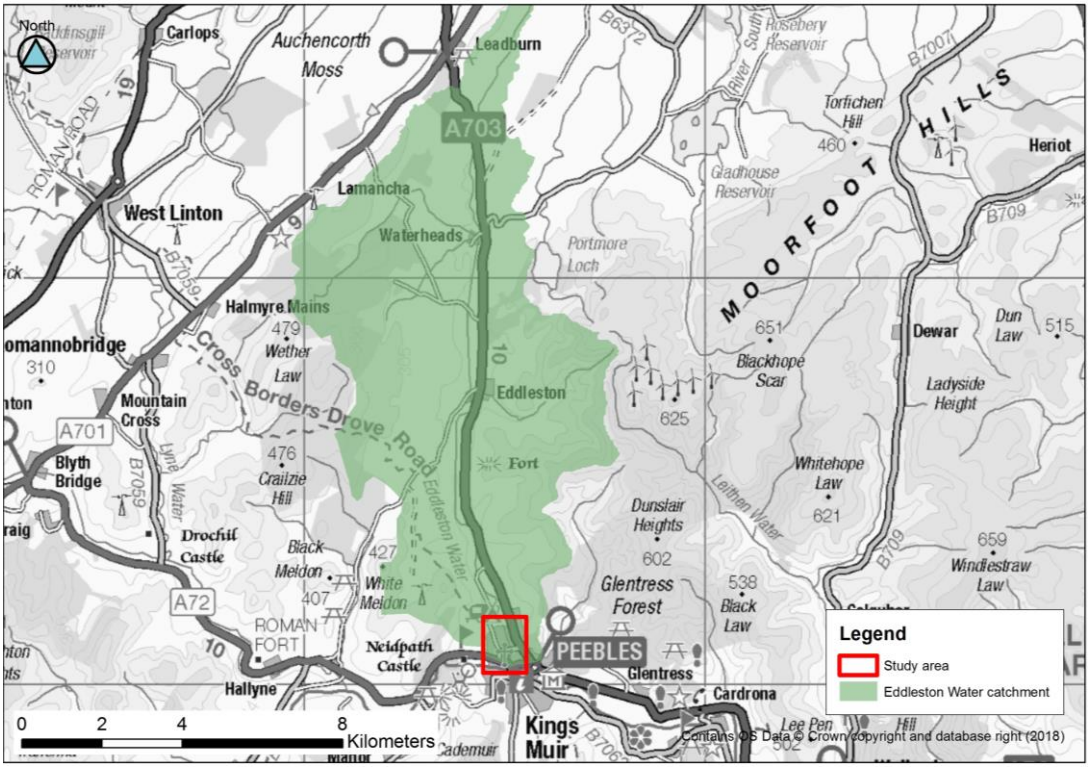
Modelling report - AEM-JBAU-PB-00-RP-A-0006-Eddleston_Modelling_Report-S4-P01.pdf

Flood maps - supplied as PDF's for return periods 2-1000 years including climate change runs and for the Do Nothing and Do Minimum scenarios.

1 Introduction

The Eddleston Water, locally known as the 'Cuddy', is a tributary of the River Tweed that enters the Borders town of Peebles from the north before discharging into the River Tweed. It has three distinct sub-catchments (Middle Burn, Shiplaw Burn and Longcote Burn) and typically flows in a straight channel from its source in the rolling hills to the north. In its middle reaches it flows in a gradually sloping wide floodplain in an artificially straightened channel flanked by steep slopes. It passes through the village of Eddleston before continuing in agricultural grazing land upstream of Peebles. As it enters Peebles the channel becomes steeper and is forced into an engineered channel with walls either side. Properties line the banks throughout Peebles along with several bridge crossings, access roads such as Cuddyside and small tracts of greenspace. At Peebles the river has a catchment area of approximately 70km^2, and has a moderately fast response to rainfall. The location of the watercourses is shown in Figure 1-1.

Figure 1-1: Study area and Eddleston Water catchment



The reach within Peebles is the main topic of this study. Particularly regularly affected are properties on Cuddyside and Greenside where there is little to separate low lying properties from any water leaving the river.

The catchment mainly comprises moorland, rough grazing and forestry with few dwellings on the floodplain outside Eddleston and Peebles. The catchment is the subject of an international research study, the Eddleston Water Project into the effectiveness of different catchment interventions which seek to reduce flood risk and restore upland habitats and the water environment. The study is managed by a partnership between Tweed Forum, Scottish Government, SEPA and University of Dundee and has involved several other organisations.

At present there are no formal flood defences along the Eddleston Water that mitigate flood risk.

1.1 Flooding from the Eddleston Water

SEPA flood maps show that there is a high (10% AP - 10 year) probability of flooding to some areas from the Eddleston Water with low likelihood events (0.1% AP - 1000 year) likely to affect greater numbers of properties within Peebles. Peebles forms part of the Tweed Local Plan District and is within Potentially Vulnerable Area (PVA) 13/04 which also includes Eddleston, Innerleithen, Selkirk, Stow and Galashiels. Within this PVA there are estimated to be 1,900 residential properties and 1,000 non-residential properties at risk of flooding.

There is a long history of flooding from the Eddleston Water from the 1700's through to the present day with the Cuddyside often the first to be affected.

Land use is not expected to change significantly with climate change and thus the relationship between the watercourse and surrounding land is not expected to vary to a major extent. Nevertheless, the increases in flows expected from climate change make good land management practices - potentially capable of influencing river levels - particularly important in this largely rural landscape. Section 2.2.1 details how climate change has been approached within this study.

1.1.1 Previous studies

The Eddleston Water was the subject of a previous flood study carried out by Montgomery Watson Harza for Scottish Borders Council in 2002. The outcome of the study was that flood defence walls could be constructed for the 0.5% AP (200 year) flood event. However, the hydrological estimates used to inform the proposals are significantly lower than the estimates produced in the present study, suggesting that this may not in fact be possible. The proposals of this study were not taken forward by the Council and the present study now adds updated methods and greater detail to improve on this earlier work.

1.1.2 Watercourse condition and catchment opportunities

The catchment of the Eddleston Water is dominated by rural land uses and provides scope for improvements in watercourse condition and flood risk management by means of emulation of natural processes that slow the passage of flood waters. Natural means of land and watercourse management are of particular importance here since the Eddleston Water is designated a Special Area of Conservation (SAC) as far upstream as the hamlet of Waterheads.

The river's condition was graded as 'Poor' by SEPA under the River Basin Management Plan (RBMP) 2014 study and since then a number of measures have been undertaken to improve this status. Re-meandering upstream of Cringletie House Hotel is one such example and this has been seen to have increased the diversity of habitats and potential spawning habitats for salmon. These changes have been sufficient to improve the EU's Water Framework Directive status of the watercourse from 'Bad' to 'Moderate'.

Within the Eddleston Water catchment SEPA's NFM maps show that there is medium to high potential for floodplain storage, medium potential for runoff reduction, opportunities for sediment management and erosion in much of the catchment. These opportunities have been incorporated into many of the works carried out as part of the Eddleston Water Project, a multidisciplinary study into catchment and watercourse behaviour in response to proposed improvements. A brief overview of the Eddleston Water Project can be found in section 2.5.

1.2 Aims and objectives

The options appraisal seeks to provide information appropriate to Scottish Borders Council to inform their decision on the most sustainable catchment-wide strategy for flood risk management to the east of Peebles that contributes, where possible, to achieving RBMP objectives and is acceptable to key stakeholders and the community. This report describes the information used to form conclusions on the suitability, feasibility and economic viability of different options for flood risk mitigation.

Proposals and conceptual designs have been developed to:

a. Provide protection from a 0.5% AP (200 year) magnitude flood event if feasible or a lower magnitude event in other cases.
b. Deliver multiple benefits to the wider Eddleston Water and River Tweed catchments and local communities.
c. Review the work being undertaken in the upper catchment with regard to NFM.

2 Preliminary investigations

2.1 Flood history

A comprehensive review of historic flood events in Peebles has been carried out and is included in the Hydrology report referenced in the Supporting Documents section at the start of this report.

The Eddleston Water has historically experienced frequent out of bank flooding but in recent history this flooding has not lead to significant property flooding. The area around Greenside is subjected to flooding when the River Tweed is in flood rather than solely the Eddleston Water. The most recent flood events are summarised below.

Table 2-1: Eddleston Water recent flood history

Date	Flood Record
29/30 December 2015	Smaller impact on the Eddleston Water than the earlier December 2015 flood and not known to have flooded any properties.
6 December 2015	Water spilling onto Cuddyside and Greenside but no reports of property flooding.
26 September 2012	Highest water level recorded on the Eddleston Water March Street gauge since its installation in 2008.
October 2005	Out of bank flooding of the Eddleston Water.

Across Peebles and the wider area there is a history of flooding with much of this flooding originating from other watercourses and being dealt with in separate reports produced as part of this study.

2.2 Flood estimation

The methodology used to derive flood estimates for the Eddleston Water catchment is explained in the Hydrology report referenced in the Supporting Documents section at the start of this report.

Hydrological analysis was conducted to obtain information about flow characteristics in the reach of interest. Due to the short reach of interest only one location for flow estimation was chosen. Analyses were based on the total catchment area of the Eddleston Water at its confluence with the River Tweed.

Since 2008 a level gauge has been operated by SEPA at March Street, close to the downstream extent of the Eddleston Water but since no rating is available this catchment had to be treated like an ungauged catchment. As such a pooling group of hydrologically similar catchments was used to derive a growth curve for the FEH Statistical Method and the Tweed at Peebles gauging station (station number 21003) was used as the donor for QMED (resulting in an adjusted QMED value of 18.64 m^3/s). This method was appropriate due to the relatively large, rural nature of the catchment and this decision was approved by SEPA during a review of the hydrology work carried out for the wider Scottish Borders flood studies. This methodology was used to derive peak river flows for a range of Annual Probability events. As agreed with SEPA the hydrograph used in the modelling was generated using a ReFH unit within the 1D model, which was scaled to appropriate peak flows. The peak flow estimates for the Eddleston Water upstream of the confluence with the Tweed (National Grid Reference: NT 2492 4031) for a range of Annual Probability (AP) events are presented in Table 2-2.

Table 2-2: Peak flow estimates for the Eddleston Water (Statistical Method)

Return Period (Years)	Annual Probability (AP) (%)	Eddleston Water Flow (m^3/s)
2	50	18.64
5	20	27.21
10	10	33.92
25	4	44.24
30	3.33	46.56
50	2	53.7
75	1.33	60.0
100	1	64.9
200	0.5	78.3
500	0.2	100.3
1000	0.1	120.9
30+CC	3.33+CC	61.9
200+CC	0.5+CC	104.1

2.2.1 Climate change

SEPA's summary report on Flood Risk Management and climate change[1] concludes that climate change impacts are likely to vary spatially across Scotland. In summarising the different increases in river flows predicted by climate models as we move towards the 2080's a number of estimates for the Eddleston Water were provided. The high emissions scenario, 'unlikely to be exceeded' uplift estimate of 33% has been used to enable the impacts of climate change to be integrated into the overall assessment.

This uplift was applied to the 3.33% AP (30 year) and 0.5% AP (200 year) magnitude events only.

A 33% uplift in river flows by the year 2080 would mean that larger floods will be expected to occur more regularly. For example, a flood with an annual probability of 10% (likely to occur every 10 years) in the present day would increase to having a probability of 17% (likely to occur every 6 years) by 2080. For the larger magnitude events this is likely to be more concerning, with a present-day 1% AP (100 year) event, for example, being expected to occur with an annual probability of 2% (every 54 years) by 2080. These future changes are something that must be considered when designing flood protection measures and is explored further during the options appraisal later in the report.

2.3 Survey data

A topographic channel survey was conducted in March 2002 as part of an original flood study on the Eddleston Water. This data covers the full study reach within Peebles. An on-site review of the watercourse condition and an assessment of the likelihood that the channel has changed since 2002 lead to the decision to not re-survey this watercourse for this current study. LIDAR data provided by the Council were used to extend the model cross sections to incorporate the full floodplain. These data were used to build a 1D hydraulic model. Additionally, property threshold levels were provided by Scottish Borders Council for some properties and collected by JBA for others. These data were required for the economic appraisal which followed hydraulic modelling.

Several site visits were conducted to provide context to the data, to photograph key areas and to provide an assessment of the condition of the watercourse, particularly at structures such as bridges, as is summarised below.

1 Flood Risk Management and Climate Change, SEPA, https://www.sepa.org.uk/media/219494/ceh-cc-report-wp1-overview-final.pdf

2.3.1 Asset condition assessment

A full report into the condition of assets along the Eddleston Water is provided in the Asset Condition Assessment report, referenced in the Supporting Documents section at the beginning of this report. This is summarised for some key assets as follows.

There are several bridges and weirs along the reach of interest. All structures assessed in the asset review were graded as being in 'Good' condition with no major maintenance issues identified. Bridgegate Bridge has a low soffit and is expected to reach full capacity during relatively small flood events, causing flooding to Cuddyside and the surrounding areas. Sensitivity to bridge blockage for relevant structures was assessed as part of the hydraulic modelling study.

Bridgegate Bridge

Upstream face of bridge

Type: Single span vehicular bridge
Upstream Grid Ref: NT 25192 40539
Opening Width (m): 12.33
Opening Height (m): 1.86
Soffit Level (m): 160.69
Material: Iron
Condition: Grade 2 (Good)
Comments:

- Vegetation on right bank partially overgrown
- No Scour on abutments
- Bridge ties into wall on left bank.

Footbridge and weir downstream of March Street

Downstream face of bridge from the left bank

Type: Footbridge and weir
Upstream Grid Ref: NT 25204 40802
Opening Width (m): 10.16
Opening Height (m): 1.44
Soffit Level (m): 161.59
Material: Steel deck, piers and railings
Condition: Grade 2 (Good)
Part of FPS: No
Comments:

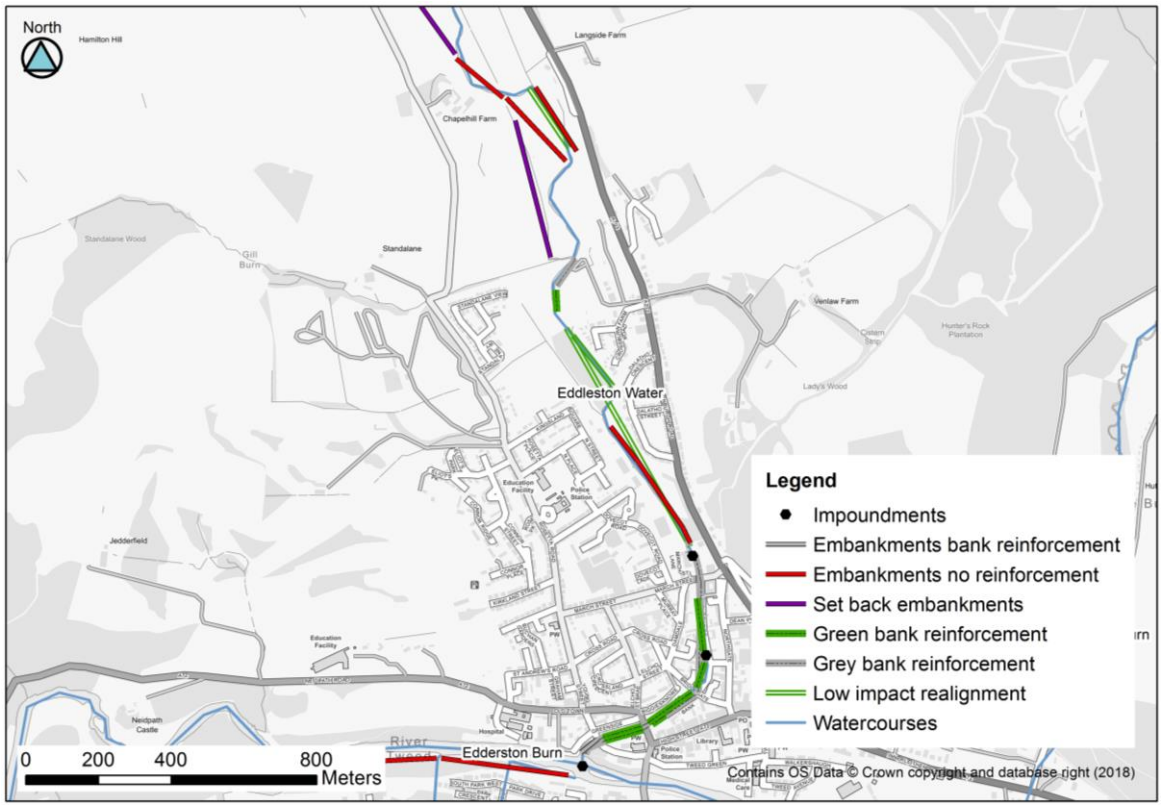
- Good condition
- Partially overgrown vegetation around banks
- Abutments in good condition with no scour
- Concrete weir directly underneath bridge in good condition with minor evidence of erosion
- Ford just upstream of bridge
- Bridge has previous history of blockage by a motor vehicle during a flood.

2.4 River Basin Management plan – Summary

A full report into the condition of the watercourse is provided in the Natural Flood Risk Management and River Basin Management Plan report, referenced in the Supporting Documents section at the beginning of this report.

The Eddleston Water was classified as being in 'Poor' condition in the RBMP report, due to the history of land and channel management that has caused significant morphological pressures on the watercourse. Recently, works as part of the Eddleston Water Project have sought to improve this status through re-meandering and introduction of morphological features more akin with a natural channel. It is recommended that any additional actions to improve the morphological status are investigated as part of any wider NFM/RBMP studies in the wider Tweed catchment or as part of ongoing works associated with the Eddleston Water Project.

Figure 2-1: Physical pressures within the scheme extent



2.5 Natural Flood Management – The Eddleston Water Project

A full report into the NFM opportunities within the Tweed catchment is provided in the Natural Flood Risk Management and River Basin Management Plan report, referenced in the Supporting Documents section at the beginning of this report. A site walkover and NFM assessment were not carried out for the Eddleston catchment due to the ongoing Eddleston Water Project in the catchment which is approaching this topic in greater detail.

The Eddleston Water Project involves the implementation of various land and watercourse management measures and subsequent monitoring in an attempt to better understand their impacts. The Eddleston catchment is a chosen catchment within a wider international research project. The project is headed by Tweed Forum in association with SEPA, Scottish Government and University of Dundee. As the project goes into greater depth than the assessments made as part of the present study no NFM assessment was carried out for the Eddleston Water catchment. Thus far the main findings of the project are as follows:

- There have been substantial delays in peak flow along watercourses where in-stream debris dams have been emplaced, but no overall reduction in peak flow magnitude.
- Broadleaf woodland planting has the greatest soil permeability benefits with infiltration 5-8 times higher than grazed pasture.
- Riparian tree planting is more favourable with farmers as there is no loss to agricultural land. Additionally, riparian woodland planting has important multiple benefits including enhanced water quality, carbon sequestration and biodiversity improvements.
- The project has shown multiple benefits with NFM measures not only reducing flood risk but also providing ecological and habitat improvements.

Further investigation is ongoing by the research team. It is recommended that the Council reviews the outcomes of this, as and when it is available to determine if significant reductions in flood flows in Peebles is likely and whether this would materially influence the options and scheme designs proposed as part of this study.

2.6 Preliminary Ecological Appraisal – Summary

A full report into the presence and importance of different habitats along the River Tweed is provided in the Preliminary Ecological Appraisal report, referenced in the Supporting Documents section at the beginning of this report.

The Eddleston Water is protected under a Special Area of Conservation (SAC) as it is a tributary to the River Tweed and therefore has the potential to be home to Atlantic Salmon, Lamprey and Otters. A Habitat Regulation Appraisal (HRA) should be undertaken to identify any significant effects/impacts on the protected species. An Appropriate Assessment (AA) needs to be conducted if possible impacts are identified.

The proposed flood alleviation works are likely to be undertaken in-channel however the presence of Atlantic Salmon and Lamprey means that works should not be scheduled in the spawning season for these species which leaves the months of August and September as potential working windows for in-channel works. Night time working should be avoided as bats are most active at night and works on trees should be avoided between February and September when red squirrels' kits are born and dependant on their mother.

A further Water Vole survey should be carried out if finalised works are likely to have an adverse impact on the banks of the tributaries, and an Otter Survey of the area may be necessary once the location of the works is known and the impact they may have on holt sites and resting places.

Peebles and the immediate surrounding area is a designated Conservation Area and all trees within it are designated with Tree Protection Orders (TPO's). If arboricultural works to trees cannot be avoided, it might be necessary to apply for the TPO to be lifted to allow for the works to proceed.

No non-native invasive species were found along the Eddleston Water.

2.7 Hydraulic modelling

A hydraulic model was developed, informed by the above-mentioned datasets, to estimate water levels during simulated floods. Below is a summary of the model structure and the results used to generate flood maps and to calculate the cost of flood damages in the later stages of the appraisal. Further details of the modelling approach, including calibration and sensitivity analysis, is provided in the Model Audit report referenced in the Supporting Documents section at the beginning of this report.

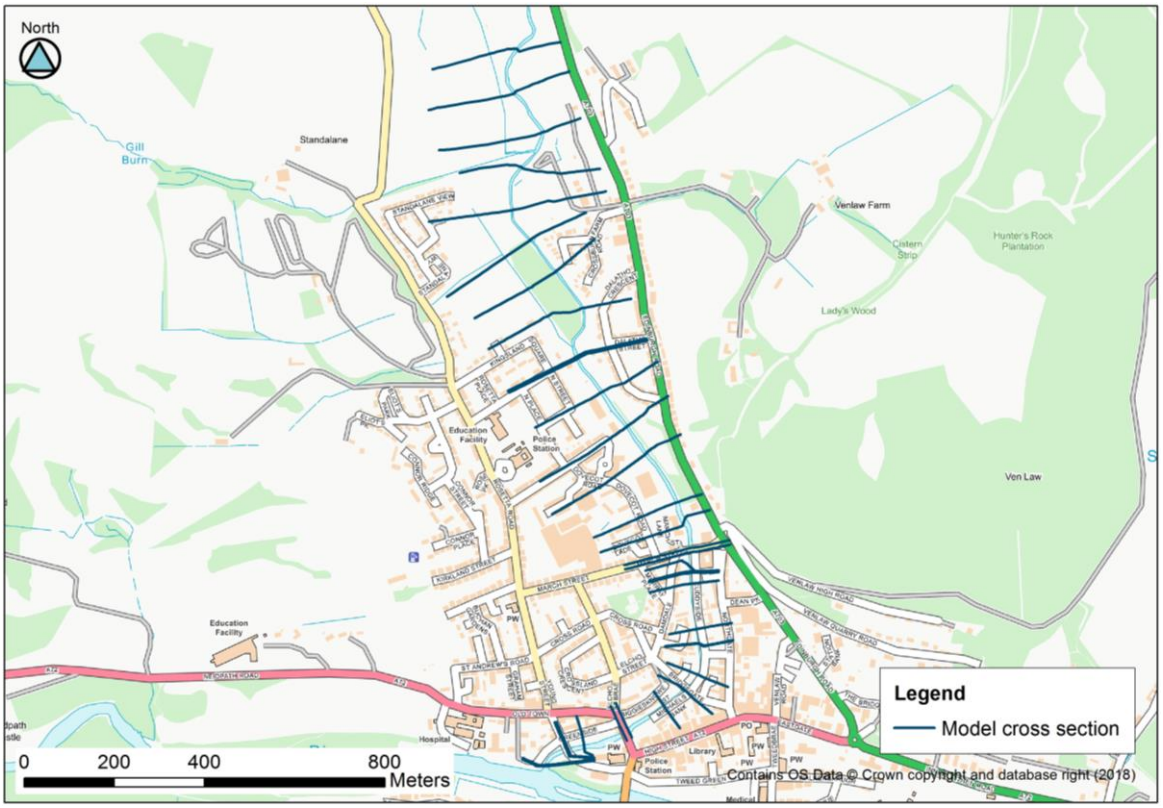
2.7.1 Model setup

The modelling package Flood Modeller was used to develop the hydraulic model, a 1D-only model using extended river cross sections to represent the floodplain. Complicated floodplain flowpaths were not expected so this approach was justified. The model extends from upstream of Peebles to its confluence with the River Tweed.

Survey data for the 1D model was collected in 2002 by Scottish Borders Council and no further survey was collected for the present study since the watercourse morphology through Peebles is not expected to have changed. Most cross sections were extended using 1m resolution LIDAR data in order to fully capture the ground profile in areas likely to be flooded during the largest magnitude flood events.

The downstream boundary of the model was controlled by estimated river levels from a flood model of the River Tweed developed for this study. A 3.33% AP (30 year) flood event on the River Tweed was calculated to have a joint probability of occurring at the same time as the 0.5% AP (200 year) flood event on the Eddleston Water. This flood event was used for all annual probability events on the Eddleston Water as a conservative approach.

Figure 2-2: Eddleston Water model overview schematic



The model was proved against photographs taken during past flood events and a post-flood survey carried out in the Scottish Borders following the 5th December 2015 floods. The flow paths predicted by the model appear to be representative of those experienced to date and also agree with those predicted in the SEPA flood risk maps. More definitive calibration and validation was not possible without surveyed post-flood wrack marks and definitive flow estimates from a suitable flow gauge. It is recommended that the gauge is upgraded and the Council survey post flood surveys (if flooding occurs) to enable a more rigorous calibration in the future; preferably prior to any scheme development and further design works.

2.7.2 Model scenarios

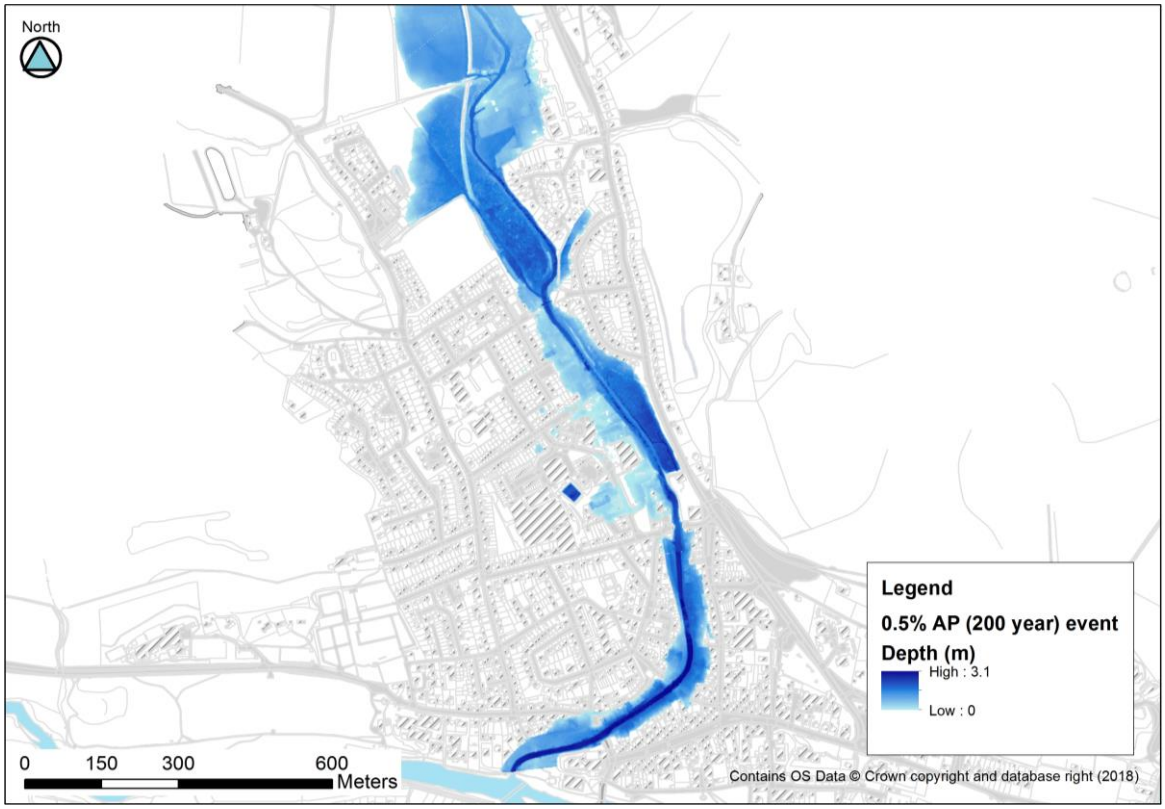
A full range of model simulations were performed covering the full range of AP events for a worst case 'Do Nothing' and present day 'Do Minimum' scenario, with the model being modified slightly between scenarios. A description of the differences between these model scenarios is provided in section 3.2 below. A full suite of sensitivity tests were also carried out to test the models response to changes in roughness, bridge blockage, inflows and downstream boundary conditions.

Additional model scenarios were used to test the feasibility and successes of different flood protection options that emerged during the options long-listing process described in section 4.5.

2.7.3 Model results

Figure 2-3 below shows the estimated flood depths for the 0.5% AP (200 year) flood event on the Eddleston Water. The remaining flood depth maps are included in Appendix A.1.

Figure 2-3: 0.5% AP (200 year) flood depth map for the Do Minimum scenario



In all flood events simulated flooding from the Eddleston Water tends to originate in the open areas of floodplain upstream of March Street and later flow onto Cuddyside, St. Michaels Bank and Greenside as flows increase. There are no complicated flow pathways predicted by the model, with water able to spill out of the channel and re-enter the channel relatively close-by as waters recede.

2.7.4 Current standard of protection

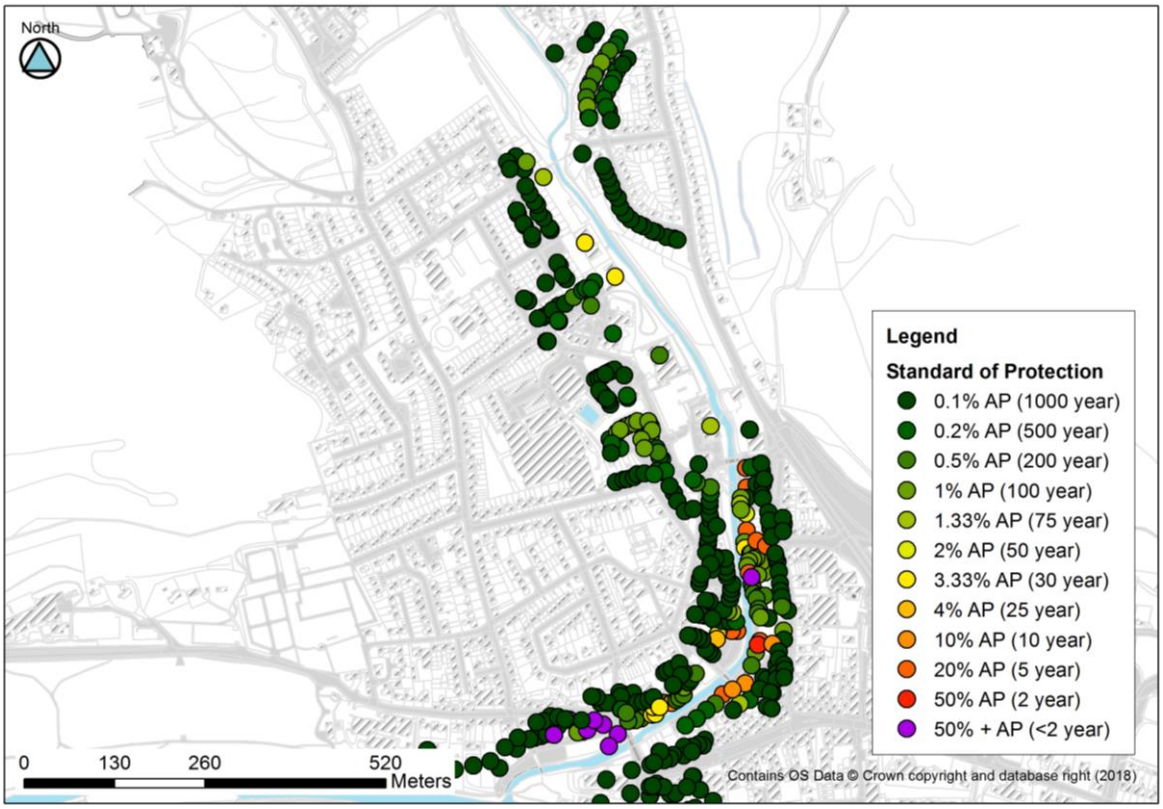
The figures below show the present-day level of protection each property in Peebles has from flooding of the Eddleston Water. 'Standard of protection' is the largest flood event which is not expected to cause flooding to a property, larger magnitude events would be expected to cause property flooding. For example, a property with a 4% AP (25 year) standard of protection would be expected to flood at the 3.33% AP (30 year) flood. Flooding is said to occur when the modelled flood level exceeds the building floor level. Floor level (threshold) data for most properties was collected by surveyors.

Figure 2-4 shows that most of the properties at high risk of flooding are immediately adjacent to the watercourse whilst properties with a lower risk (1.33% AP (75 year) and upwards) are further from the banks or have a higher threshold level. Adjacent properties could have different standards of protection due to them having slightly different threshold levels.

A group of 7 properties at the southern extent of the watercourse, on Greenside, are estimated to flood at the 50% AP (2 year) flood event but these properties are at joint risk of flooding from the River Tweed and Eddleston Water. Flooding is considered to be most serious from the River Tweed so flood protection measures offering a standard of protection of 75 years are proposed in the River Tweed options appraisal report[2] rather than in this report.

2 AEM-JBAU-PB-00-RP-A-0020-Tweed_Appraisal_Report (2018) Scottish Borders Council

Figure 2-4: Standard of protection for the properties at risk in the Do Minimum scenario

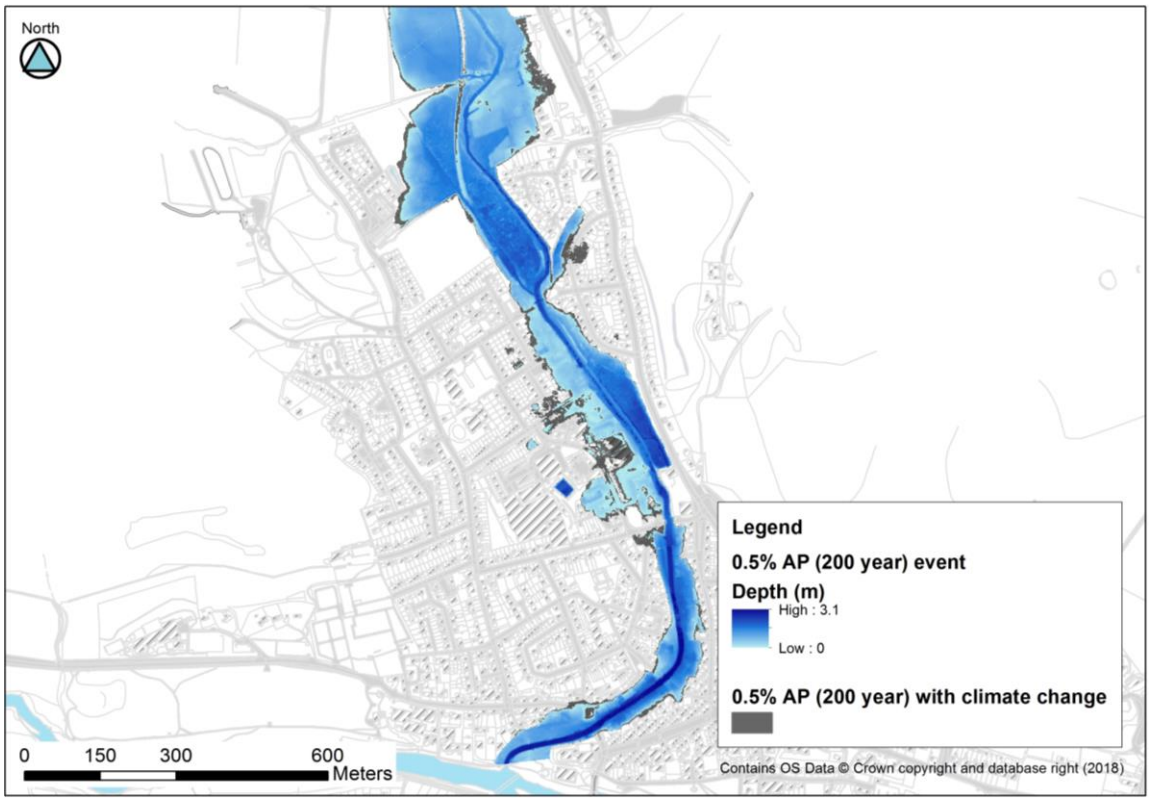


2.7.5 The effects of climate change on flood extents

Climate change is expected to increase both the peak flow of design floods and the frequency of flood events which will mean that an event statistically expected to occur every 2 years at present might be expected to occur every 1 year, for example. Similarly, this might mean a flood currently expected to occur every 200 years flood might be expected to occur nearer to every 100 years in the future.

The 0.5% AP (200 year) event with a 33% increase for climate change produces a more extensive flood outline with greater flood depths. Figure 2-5 shows the difference between the present day 0.5% AP (200 year) flood outline and the flood outline expected with climate change. The climate change simulation results in a slightly enlarged flood extent and increased flood depths in the order of 0.5m upstream of the A72 bridge and near Kingsland Road. The floodplain is relatively constrained through Peebles and therefore increased flows tend to result in increased flood depths rather than much larger flood extents.

Figure 2-5: 0.5% AP (200 year) flood outlines with and without an allowance for climate change



3 Appraisal approach

3.1 Overview

The economic appraisal phase of the project requires analysis of the flood damages as calculated from the hydraulic modelling study and identification of problem areas. Through a long and short-listing process flood risk management options for these areas are reviewed and ultimately a short list of viable options is proposed. Comparison of the flood damages with and without the proposed flood risk mitigation options gives the flood damage 'benefit' of that option. Engineering costs are applied to each of the proposed options and this allows calculation of the benefit-cost ratio (BCR). The next sections detail this process and present the findings.

3.2 Problem definition

There are 73 properties in Peebles at risk from the Eddleston Water at the 0.5% AP (200 year) event. Flooding is estimated to begin at the 50% AP (2 year) flood event or smaller under existing conditions and can therefore be considered a frequent and serious problem. There are at present no defences in place along the burn and there has been limited uptake of Property Level Protection (PLP) products by residents.

3.2.1 Consequences of Doing Nothing

The starting point for a scheme appraisal is always to develop a suitable Do Nothing and Do Minimum option that can be used as a consistent baseline against which other options are compared. The Do Nothing represents the 'walk-away' option; cease all maintenance and repairs to existing defences and watercourse activities. This therefore represents a scenario with no intervention in the natural processes and serves as a baseline against which all other options are compared.

Assessing the level of risk for both the Do Nothing and Do Minimum options needs to consider how the watercourse will change and how any flow controlling assets or flood defences will react or deteriorate over the appraisal period. The following recommendations are therefore used for the Do Nothing and Do Minimum options:

3.2.2 Do Nothing

Under the Do Nothing scenario the watercourses would not be maintained; leading to a gradual degradation of the banks and vegetation growth. However, as the floodplain within Peebles (the modelled reach) is relatively urban and used recreationally, it is likely to remain well maintained for non-flood reasons; thus the bank and floodplain roughness is not anticipated to increase significantly. The Do Nothing scenario is represented in the model as a 10% increase in Manning's *n* roughness throughout the appraisal period.

There are no other structures, the deterioration of which would impact on flood risk within the Eddleston Water. There are a number of weirs, but these are in good condition and not anticipated to deteriorate significantly over the appraisal period. The main road bridges present along the urban area of the Eddleston Water are predominantly single span without piers; bridge blockage is therefore assumed to be zero. The footbridges are generally smaller structures and may be more prone to blockage. Therefore, for these structures the deck levels have been reduced by 300mm to reflect the risk of debris being caught on the deck of these structures.

3.2.3 Do Minimum

The Do Minimum scenario effectively represents the present-day in which the watercourse and all structures are maintained and replaced if they deteriorate to a point that is unacceptable. Manning's *n* roughness represents current conditions and no bridge blockage is assumed.

3.2.4 Accounting for climate change

Under the Climate Change (Scotland) Act (2009) local authorities have a duty to use an evidence-based approach to develop means to reduce the impact of climate change through mitigation measures (reducing emissions), planning to adapt to a changing climate and acting sustainably. This project appraisal fulfils the ‘adaptation’ and ‘acting sustainably’ duties.

4 Flood risk management options

4.1 Critical success factors (objectives)

The long list of options has been assessed against a number of critical success factors:

1. Options whether in isolation or combination must reduce flood risk providing an appropriate level of protection to people, property, business, community assets and natural environment.
2. Option must be technically appropriate and feasible.
3. Option should help to deliver sustainable flood risk management (e.g. help contribute to amenity and urban regeneration, improve the environment and biodiversity and improve or reduce existing maintenance regimes).
4. Options should not have insurmountable or legal constraints (e.g. land ownership, health and safety or environmental protection constraints).
5. Options should represent best value for money and minimise the maintenance burden and costs as much as possible.
6. Desirable BCR when measured in parallel with other success criteria.
7. Should incorporate National, Regional and Local agendas/objectives.
8. Should be deliverable by 2028 or a future agreed funding period when assessed with other success criteria.

4.2 Guideline standard of protection

The Scottish Government do not specify design standards for flood protection schemes. However, the standard of protection against flooding typically used in Scotland is the 0.5% AP flood (1 in 200 year). This standard is the level of protection required for most types of residential and commercial/industrial development as defined by Scottish Planning Policy (SPP).

Whilst design standards are a useful tool in terms of engineering goals and useful benchmarks, as well as in clear communication to stakeholders and the public, there is a general move in Scotland away from design standards to a risk based approach. Restricting options to desired standards of protection can limit consideration of factors that influence defence effectiveness and can limit future responses to external factors.

It is expected that a variety of protection levels are considered during the design process including the 0.5% and 1% annual probabilities and in some cases a lesser level. The guidance also states that options should be tested against a 1% annual probability plus allowances for climate change. Ministerial guidance[3] recommends appraising against the 1% AP (100 year) standard with an allowance for climate change but where the 0.5% AP standard is not achievable the focus has been on appraising to an appropriate lower standard rather than specifically the 1% AP standard with an allowance for climate change.

Based on the above guidance the aim of the scheme will be to assess options up to the 0.5% AP (200 year) plus climate change flood if possible, but to test lower return period events if appropriate.

Based on the fact that other schemes within the Scottish Borders deliver a standard of protection in excess or to the 1:33% AP (75 year) plus climate change, it is not anticipated that a standard of protection less than this is deemed to be appropriate in terms of the critical success factors for this study. Nevertheless, initial outcomes of the Eddleston Water Project suggest that some flood attenuation may have resulted from the NFM measures put in place within the catchment. This may make a lower standard of protection acceptable for this specific watercourse.

4.3 Short term structural and maintenance recommendations and quick wins

Several measures or short term 'quick wins' have been identified that cover a range of aspects from maintenance to small scale works. Due to the relatively short reach of interest and the lack of structures on the burn there are relatively few of these actions recommended. They are summarised in Table 4-1.

3 Scottish Government (2011) Delivering sustainable flood risk management. Guidance document. Scottish Government, Edinburgh. http://www.gov.scot/Publications/2011/06/15150211/0

4.3.1 Short term structural and channel maintenance and quick wins

Table 4-1: Short term structural and channel maintenance and quick wins for Eddleston Water.

Problem	Actions	Photo
Vegetation partially overgrown in parts of the watercourse. A fallen tree across the width of the river downstream of the A72 has the potential to block flows.	General vegetation maintenance. Remove fallen tree and consider an in-channel coarse debris screen but placement and maintenance would require careful consideration.	 ***Fallen tree across entire width of channel downstream of A72 bridge.***
Minor evidence of erosion on the weir.	Monitoring of erosion.	 ***Ford upstream of pedestrian bridge.***
Vegetation partially overgrown on the left bank and opportunity to tie gabion in.	Consider tying gabion into left bank to act as flood defence.	 ***Upstream face of bridge with vegetation in the river along the left bank.***

Problem	Actions	Photo
Uneven flow underneath bridge due to deformation in weir. Upstream of bridge trees leaning into river.	Monitor and consider removal of trees upstream of bridge. Consider an in-channel coarse debris screen but careful consideration needed for placement and maintenance.	 ***View from left bank, downstream face of bridge***  ***Marshy land and bypass channel running parallel to Eddleston Water on left bank downstream of bridge***
Lack of public awareness	Provision of signage at key locations such as on Cuddyside with contact details for emergency response teams and details of how to access the Peebles sandbag store. Install stage boards around frequently flooded sites such as Cuddyside, St Michaels Bank and Greenside to assist in emergency response and assist in future model calibration.	

4.4 Non-structural flood risk management recommendations

4.4.1 Flood warning

The Eddleston Water is covered by a SEPA flood warning which should be maintained going forward. A rating should be developed for the March Street gauge to add value to the hydrometric data it records, increasing the accuracy of future hydrological estimates calculated for studies such as this.

Scottish Borders Council should continue to monitor the systems performance, particularly during high flow events. Ongoing actions should include:

- Review warnings given and feedback to SEPA if events are missed or come too late to enable action.
- Improve and increase the uptake of flood warning in the community.

- Record flood levels against stage boards and survey wrack marks for flood events to help build up a long-term record of flood events that can be used for future flood forecasting system calibration.
- Recalibrate forecasting model with new data on flooding since installation and original calibration.

4.4.2 Emergency action plans

The Council's Emergency Action Plan is the Severe Weather Plan which was updated in July 2018. This describes the Council's emergency response procedures, flood gate procedures and flood warning procedures. It has been designed to run as a standalone plan but can be run in conjunction with other emergency plans such as the Media & Communications Plan and the Care for People Plan. The emergency plan is initiated by Met Office weather warnings and SEPA flood warning information. The plan is coordinated through all Category 1 and Category 2 responders including Scottish Water, voluntary groups (community flood action groups) and public utility companies through the Joint Agency Control Centre (Bunker) at Scottish Borders Council.

This emergency plan is updated regularly as new information becomes available. It is recommended, if it has not already been done, that this is updated with the findings of this study, in particular the revised flood mapping. Regular reviews and preparation of community level emergency plans may be necessary to ensure that the following are up to date:

- Flood maps,
- Properties at risk (and any protected by PLP),
- Safe access and egress routes,
- Flood warning actions and escalation plans,
- Locations of community sandbag stores,
- Dissemination roles and responsibilities,
- Evacuation procedures,
- Onsite and/or temporary refuge locations/planning, and
- Back-up planning.

Emergency planning should encourage communication at a community level to ensure good response rates during a flood. Examples of this include flood group leaders, flood wardens and buddy schemes that encourage communities to act together and to help provide assistance to those needing additional help (e.g. vulnerable residents).

4.4.3 Raising public awareness and community flood action groups

Responsible Authorities have a duty to raise public awareness of flood risk. Helping individuals understand the risks from which they are most vulnerable is the first step in this process.

Everyone is responsible for protecting themselves and their property from flooding. Property and business owners can take simple steps to reduce damage and disruption to their homes and businesses should flooding happen. This includes preparing a flood plan and flood kit, installing property level protection, signing up to the Resilient Communities Initiative, and ensuring that properties and businesses are insured against flood damage. Flood Action Groups are well known to assist with this awareness raising and resilience.

Scottish Borders Council have a well-established resilient communities programme, of which 43 of 70 community areas are signed up to in the Scottish Borders. These are resilience groups which operate during times of emergency, including flooding. A resilient community group is located in Peebles. As an ongoing action, Scottish Borders Council will continue to work closely with these resilient community groups, other local groups and members of the public to raise awareness of flood risk. It is recommended that the outputs from this study are shared with the resilience group to ensure that they are aware of the new flood maps and to assist with emergency procedures.

Council awareness raising activities are to be combined with on-going public meetings and consultation for proposed flood schemes as part of further developments associated with this study. Information from the Council is also expected to be disseminated through website, social media and other community engagement activity as appropriate.

4.4.4 Community sandbag stores

Scottish Borders Council continues to use community sandbag stores located at publicly accessible areas including fire stations and school grounds. Resilient Communities sandbag stores are also now widely distributed across the Scottish Borders in areas that have signed up to the Resilient Communities Initiative - this includes Peebles. A community sandbag store is located at Peebles fire station, holding approximately 300 sand bags and a resilient communities store holds an estimated 60 sandbags but no stores are located close to the Eddleston Water. The Council should review the location of the stores and investigate if a secondary store should be located near the Eddleston Water.

It is recommended that the Council considers the use of the flood 'pod' system: community storage boxes, which contain flood sacks which are purpose designed bags filled with absorbent material. The key advantage of this approach is that they can be distributed before a flood and are ideal for locations with limited warning or response times. It may also save the Council time in filling, distributing and delivering sandbags to communities when sandbag stores run out. Instead residents whose homes are at risk of flooding can access the boxes and can help themselves prior to and during a flood. Whilst careful review of the siting and number of these pods would be required, they may offer a useful approach in Peebles. This approach would need to be combined with the existing flood warning and flood awareness campaign provided by SEPA (i.e. flood alerts).

4.4.5 Property level protection (PLP)

Scottish Borders Council currently offer a discounted PLP scheme to properties at risk of flooding, selling discounted PLP products to residents through a capped council-funded subsidy. The scheme makes manual PLP products more affordable than they would otherwise be and there has been some uptake to date in Peebles. Manual PLP products that must be installed in advance of a flood event are in general seen as a short-term solution. Nevertheless, a full PLP scheme using passive (or 'automatic') products will be considered alongside the other options in the investment appraisal. Whether full funding would be provided through a flood protection scheme or if resident contributions would be sought is not considered at this stage.

There has been limited uptake of PLP along the Eddleston Water with only one property known to have purchased products through the Scottish Borders PLP scheme offered by the Council.

4.4.6 Natural Flood Management

The Eddleston Water Project offers a great opportunity for the residents of the Eddleston Water to benefit from the flood risk management and catchment-wide potential benefits that NFM seeks to achieve. The project is ongoing and likely to produce useful findings for other catchments. Further work is likely needed to join up knowledge that is being developed for the different portions of the catchment as more conclusive data emerges. This may entail integrated catchment modelling and could allow future opportunities and catchment changes to be simulated.

4.4.7 Planning policy

The Scottish Government laid out several measures to promote sustainable flood risk management in the Scottish Planning Policy[4] published in 2014. The Policy aims to ensure that the planning system promotes a precautionary approach to flood risk from all sources, taking the likely impacts of climate change into account. Further, new developments must not reduce floodplain storage or conveyance, achieved by locating new developments outside of the functional floodplain and away from medium to high flood risk areas. Opportunities are expected to be sought for reducing flood magnitude such as through river restoration, enhancing flood storage capacity and reducing the length of culverted watercourses. New developments must comply with requirements for Sustainable Drainage Systems (SuDS) to ensure that surface runoff does not increase as a result of the increase in man-made surfaces common to developments.

Specifically, this means that future developments in Peebles should not increase the number of properties at risk from flooding. The flood maps produced and in particular the climate change mapping produced should be used when reviewing planning policies by the Council.

The Local Development Plan for Peebles[5] does not highlight any areas at serious flood risk from the Eddleston Water that are expected to be developed.

4 Scottish Planning Policy (2014) Scottish Government: https://www.gov.scot/Resource/0045/00453827.pdf

5 Peebles Local Development Plan, Scottish Borders Council: https://www.scotborders.gov.uk/downloads/file/893/peebles

4.5 Long list of options

The following table provides an overview of potential flood alleviation options targeting flood risk from the Eddleston Water in Peebles. Those with the potential to alleviate flood risk from high magnitude flood events or which offer multiple catchment-wide benefits have been assessed further in the following sections.

Table 4-2: Long list of options for the Eddleston Water

Measure	Discussion
Relocation	**Technical**: Relocation or abandonment of properties not politically or socially viable. Option not cost effective as purchase costs will be same as capped damages. **Environmental**: No significant environmental or RBMP benefits or impacts. **Constraints**: Multiple objections likely if carried out via a FPS. **Decision: Option discounted**
Planning	Avoid development on land identified in this project as being at risk of flooding. This option should be actioned by the planning authorities regardless of other measures to avoid a future increase in flood risk.
Flood warning	**Technical**: Flood warning currently in place for Eddleston Water in Peebles. **Environmental**: No environmental or RBMP benefits or impacts. **Constraints**: None **Decision: Option discounted with the assumption that Flood Warning will be continued alongside other shortlisted options.**
Resistance - means of reducing water ingress into a property to enable faster recovery	**Technical**: All Scottish Borders properties at risk of flooding have access to the Flood Protection Products Discount scheme operated by the council. Further properties moving from reliance on the council emergency sandbag store in Peebles to retrofit Property Level Protection (PLP) products is likely to reduce property inundation during flood events. Some properties are likely to experience greater flood depths than the 600mm recommended as a maximum for property resistance measures. **Environmental**: No significant environmental or RBMP benefits or impacts. **Constraints**: Unlikely to be accepted by the community as the only flood protection measure. **Decision: Viable option for some properties, option taken forward**
Resilience - means of reducing the impacts of flood water ingress on a property to enable faster recovery	**Technical**: Extremely costly due to the number of properties at risk of flooding. **Environmental**: No significant environmental or RBMP benefits or impacts. **Constraints**: Multiple objections likely if carried out via a FPS. **Decision: Unlikely to be economically viable at this stage. Option not progressed further.**
Watercourse maintenance	**Technical**: Maintenance unlikely to reduce flood risk to a useful degree but maintenance schedule should be adhered to. Could play a minor role in reducing flood risk if combined with more substantial options. **Environmental**: Minor channel maintenance may have negative impacts if spawning areas are disrupted but these are unlikely to be significant. Shoring of banks or more significant dredging are likely to have larger impacts. **Constraints**: Possible stretching of council resources if further inspection/maintenance is proposed. **Decision: Option discounted but maintenance activities should continue to be undertaken**
Natural Flood Management (NFM)	Natural Flood Management is not considered in detail for the Eddleston Water due to the ongoing Eddleston Water Project which is assessing the successes of different NFM measures within the catchment. No further assessment is carried out as part of this report but it is expected that the Eddleston Water Project will thoroughly appraise the benefits brought by these measures and that all benefits are capitalised upon.
Storage	**Technical:** Potential storage location between Chapelhill Farm and Crossburn Caravan site, although this would require construction of an embankment to attenuate flows. Smaller scale storage in the upper

Measure	Discussion
	catchment in tandem with natural flood management options may be viable but are not considered in the below storage assessment. **Environmental**: Special Area of Conservation (SAC) designations along Eddleston Water as far as the confluence with the Shiplaw Burn. **Constraints:** Land ownership constraints likely to be encountered. **Decision: Option carried forward for further review in Section 4.6.1**
Control structures	**Technical:** Flows during flood events are generally small, so it is likely that the cost of installation and maintenance of control structures would outweigh any potential benefits. Likely to provide more problems than solutions in terms of overall flood conveyance. **Environmental:** Could provide wetland habitats but likely to impede movement of flora, fauna and sediment along the watercourse thus having a net negative impact on the watercourse. **Constraints:** Unlikely to be cost effective due to the lack of floodplain space for useful volumes of water to be held back, and potential objections from residents. **Decision: Option discounted**
Demountable defences	**Technical:** Ensuring constant availability of trained personnel capable of deploying defences may put excessive pressure on council. Residents may be able to assist but reliability of defence deployment may be reduced. **Environmental:** No significant environmental or RBMP benefits or impacts although likely to be preferred from an environmental standpoint when compared to direct defences. **Constraints:** Not enough lead time for deployment on this watercourse with a fast time to peak. Sites for demountable defence installation would need to be identified and integrated with any other mitigation options carried forward. **Decision: Option discounted**
Direct defences	**Technical**: Direct defences in the form of walls or embankments may be feasible along sections of both banks of the watercourse. Walls are more appropriate than embankments in most locations and should be made adaptable where possible to accommodate future storm intensification due to climate change. **Environmental**: Direct defences likely to have negative RBMP impact through increased morphological pressure on the watercourse although natural morphology is already compromised through Peebles due to engineered channel. **Constraints**: Some objections likely at public consultation but in general likely to be an acceptable option. **Decision: Option carried forward**
Channel modification	**Technical**: Channel deepening possible but not a sustainable option due to likely infilling with sediment over time. This is unlikely to provide sufficient flood protection as an independent measure. **Environmental**: Considerable environmental impacts including destruction of sensitive habitats e.g. fish spawning grounds. Works would need to be carried out outside of Lamprey and Atlantic Salmon spawning seasons. A Habitats Regulations Appraisal would be necessary to identify whether dredging would have a negative impact to the interest features of the Special Area of Conservation (SAC) covering the Eddleston Water. The works would only be allowed to proceed if no negative impacts to the integrity of the SAC were identified. **Constraints**: Special Area of Conservation (SAC) designations along Eddleston Water as far as the confluence with Shiplaw Burn. Dredging of the deepened channel would be an ongoing maintenance burden. **Decision: Option carried forward for further review in Section 4.6.2**
Diversion	**Technical**: There is no scope for channel diversion due to topographic constrictions and the number of properties within the lower catchment. **Decision: Option discounted**
Bridge and weir modification	**Technical**: Bridge conveyance is good as structures are in good condition and most have no piers or other obstructions to flow (March Street Bridge has a pier but it is located on the bank making it less of an obstruction to

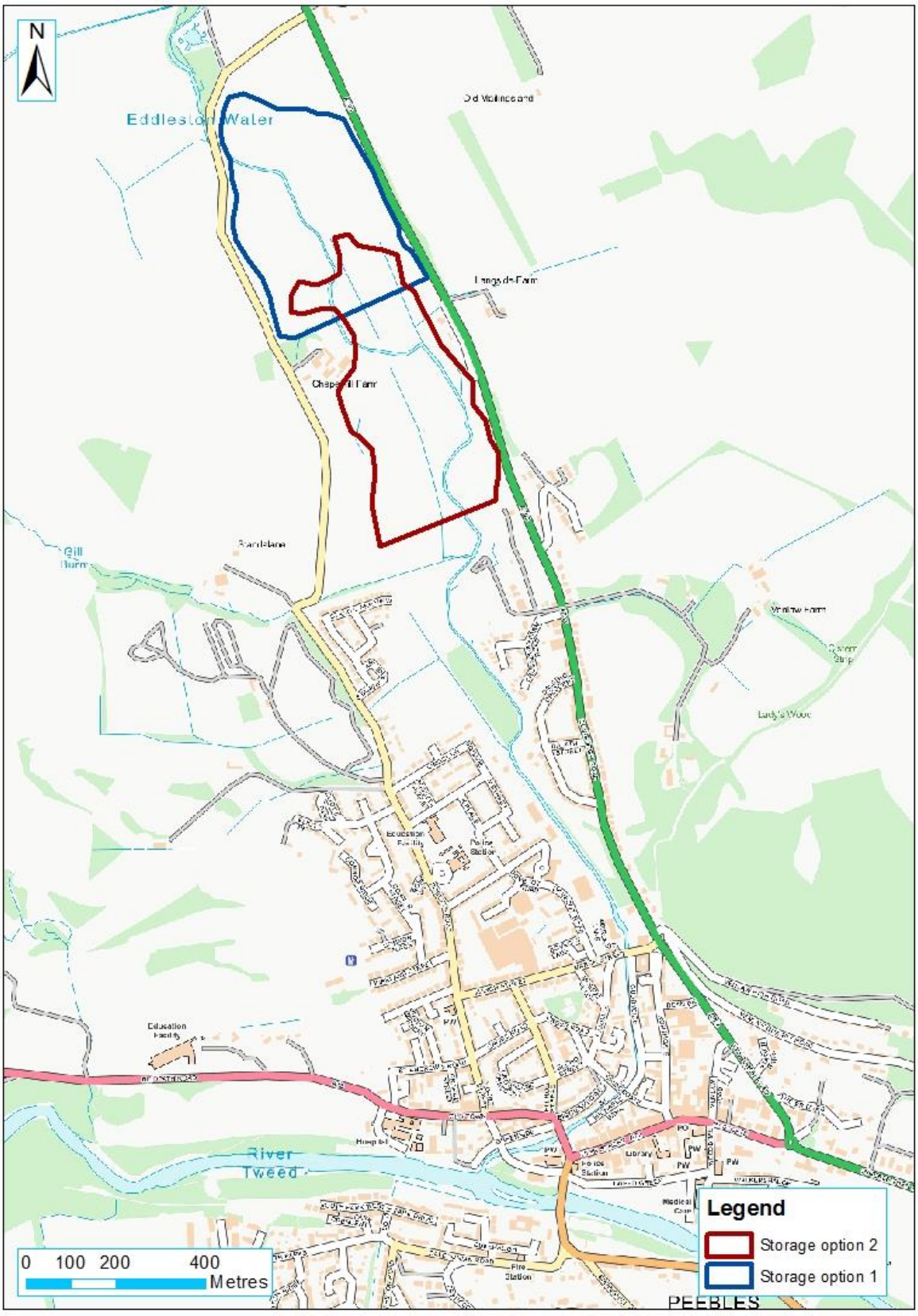
Measure	Discussion
	flow). The Bridgegate Bridge has a very low soffit that is predicted to be reached in the 20% AP event, therefore there is scope to improve the capacity of this structure. There is the potential for weir removal at several locations which may improve conveyance through the urbanised reaches. Bank stability issues will need to be considered in this scenario. **Environmental**: Net improvement in RMBP status likely if bridges are widened or raised or if weirs are removed, but changes are unlikely to be significant. **Constraints**: Removal or modification of bridges is likely to be objected to due to infrastructure value of these structures. **Decision: Option carried forward**

4.6 Feasibility study

4.6.1 Storage analysis

The possibility of attenuating floodwater upstream of Peebles was considered. Two locations have been selected for testing, as shown in Figure 4-1.

Figure 4-1: Location of storage areas tested on the Eddleston Water



A basic Flood Modeller model was built to test the attenuation of flows at each location by creating an orifice opening through a theoretical dam structure. The storage behind the dam was based on an area/elevation relationship extracted from 5m resolution NEXTMap data.

The model was tested with an orifice area that limits flow to 18.6m^3/s in the downstream urban reach (the flow that the current watercourse can convey before out of bank flooding occurs in Peebles,

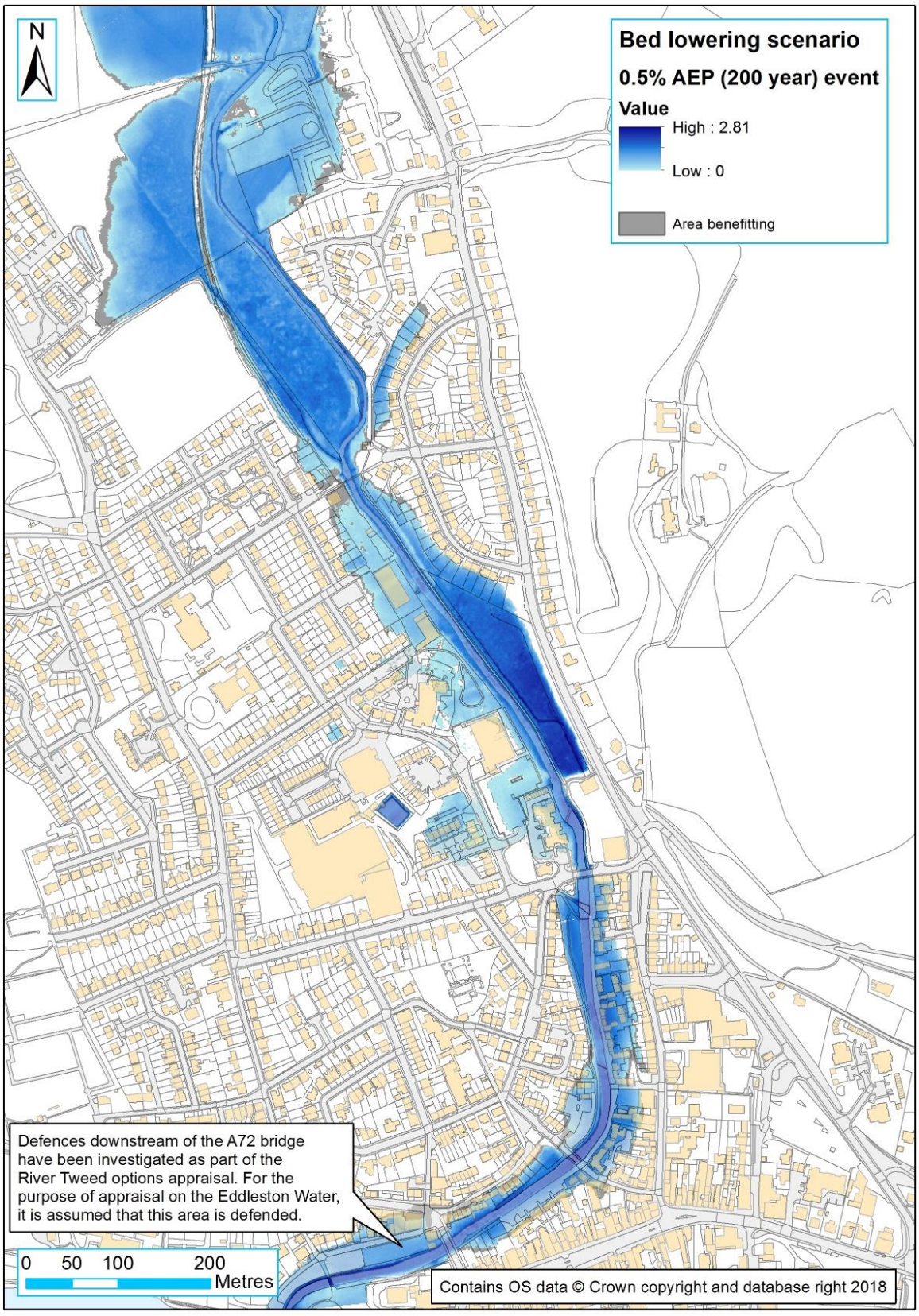
equivalent to the 50% AP (2 year) event). However, it was found in both scenarios that the maximum embankment height possible would be 3m due to the constraints of the roads on either side of the watercourse and the properties at Chapelhill Farm. Following testing, it was established that this height of embankment is only sufficient to attenuate the 50% AEP (2 year) flow event before the roads and properties become flooded from stored water, thus giving no benefit to properties downstream. On this basis storage in these locations has been discounted. Other locations further upstream were also deemed to have similar constraints. Storage on the tributaries was also considered but discounted due to the minimal inflow from these when compared to the main river.

Aside from the problems with the flooding of roads and properties the occasional storage of large volumes of water directly upstream of an urbanised area would also represent a new risk and a critical maintenance burden for the Council due to upkeep of the embankment and regular removal of sediment build up behind the structure. It is likely that the cost of the construction and maintenance of the embankment would outweigh any benefits in terms of flood risk. There are also environmental constraints due to the SAC designation on the Eddleston Water highlighting the importance of this watercourse. For these reasons, the option for storage on the Eddleston Water has been discounted and is not appraised further.

4.6.2 Channel deepening analysis on the Eddleston Water

The possibility of increasing channel capacity through deepening the channel (i.e. by removal of sediment and construction of a lowered concrete channel) was considered. This option was tested in the hydraulic model and involved reducing the bed level of the channel by 0.5m along the full modelled reach. The results of the analysis when compared to the Do Minimum 0.5% AP flood extent are shown in Figure 4-2.

Figure 4-2: Impact of channel deepening on flood extent in the 0.5% AP event



The modelling suggests that although flood extents are reduced in the bed lowering scenario, it is not sufficient to prevent flooding in the 0.5% AP event. The potential environmental impact of this scale of channel modification is considered too great compared to the estimated reduction in flooding. Furthermore, the deepened channel would require regular work to maintain its depth and extensive bank stabilisation works would be required to make this a sustainable option. For these

reasons this option is not seen as a long-term strategy for flood protection and has not been carried forward beyond this stage of analysis.

4.6.3 Weir removal and bridge raising

An investigation was carried out into the impact that weir removal and bridge raising has on flood levels. The three weirs were removed from the hydraulic model and Bridgegate Bridge raised to a level above the 10% AP (10 year) water surface. Whilst this resulted in an increase in standard of protection its effects were not uniform, protecting some properties at risk from the 10% AP (10 year) flood event but not others. Due to the small change in standard of protection and the fact that some properties would continue to be at risk from small, frequent flood events this is not deemed to be suitable as a flood risk management option and is not taken forward further.

4.7 Short list of options

4.7.1 Designing for climate change

In line with Scottish Planning Policy a 0.5% AP (200 year) standard of protection for any scheme was the goal throughout the short listing process. Wherever possible, options have been short-listed that at least aim to mitigate flooding to this standard and strive to meet the design standard for this event with an allowance for climate change, a 33% increase in the peak river flow.

Where a 0.5% AP (200 year) standard is not feasible interventions have been designed to allow for the greatest flood risk benefit possible after consideration of technical, environmental and social limitations and opportunities. River flood flows are expected to rise and where possible this has been accounted for in the design, for example by allowing for adaptable defences or by targeting a slightly higher standard of protection than may be ideal at the current time.

In the Eddleston catchment the opportunities for Natural Flood Management are many, as evidenced by the measures already in place. A growing body of evidence suggests that that these measures are positively attenuating flows during some flood events which may to some extent counteract climate change increases in river flows. Further evidence is required to determine if this is the case and to what extent; and whether this will be sufficient to mitigate the need for additional works within the catchment.

4.8 Flood Mitigation Options - Eddleston Water

The following section details the constraints and benefits of the shortlisted options on the Eddleston Water. The options are based around a combination of the following proposed measures:

- Direct defences.
- Weir removal.
- Modification of Bridgegate Bridge.
- Property Level Protection (PLP).

4.8.1 Option 1 - Construction of direct defences and weir removal

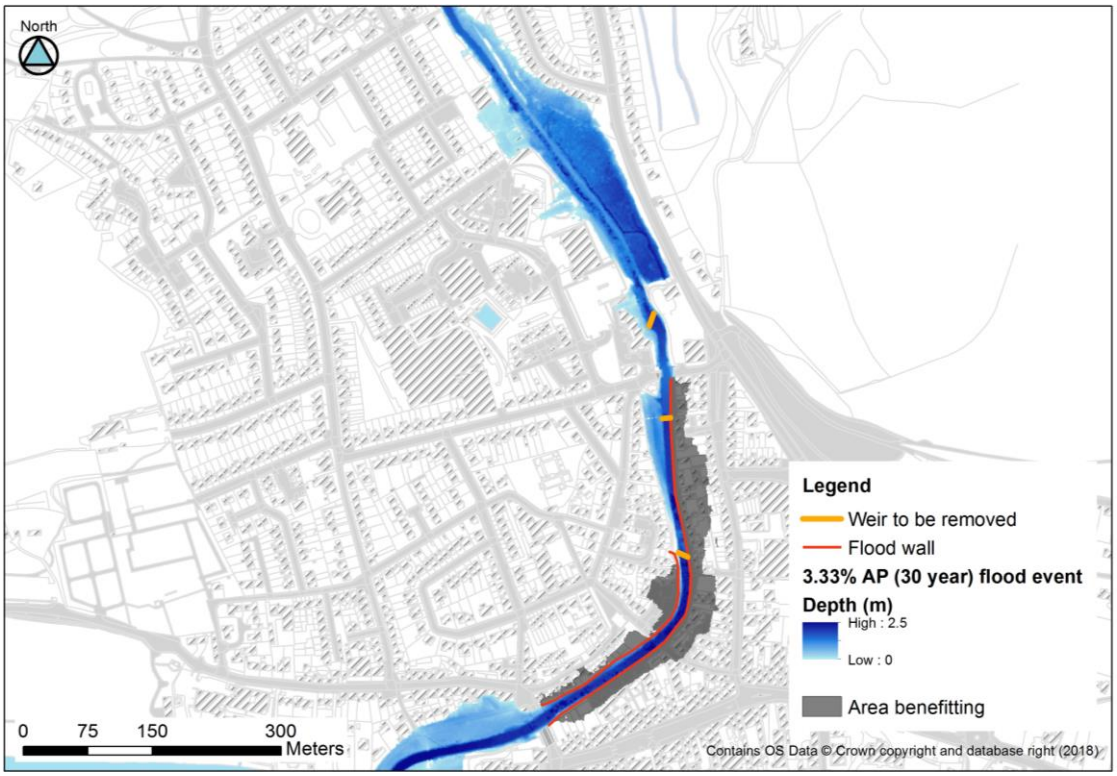
Option 1 - Construction of direct defences and weir removal

Description

This option aims to provide a high standard of protection through a combination of embankment raising, wall installation and weir removal along the Eddleston Water through Peebles. The work includes the following:

- Install a flood wall along the left bank for a distance of approximately 490m, between the March Street road bridge and the A72 road bridge (Cuddy bridge). Maximum wall height will be up to 1.5m above current ground level, including a 300mm freeboard.
- Raise existing walls/embankments and install new flood walls where necessary along the right bank, for a distance of approximately 265m, between the March Street road bridge and the A72 road bridge. Maximum wall height will be up to 1.5m above current ground/wall level, including a 300mm freeboard.
- Install flood gates at either end of Bridgegate Bridge, tying in to flood walls.
- Remove weirs at the following locations and reprofile channel to give a smooth negative gradient:

1. Upstream of March Street bridge
2. Under Cuddyside footbridge
3. Cuddyside opposite Damcroft.



A technical drawing relating to this option has been produced and is provided alongside this report, named as follows:

'AEM-JBAU-PB-EW-SK-C-1301-Opt14_30Yr_DD_&_weir_removal-S3-P01'.

Standard of Protection (SOP)

Modelling of the above option suggests that a standard of protection of a 3.3% AP (30 year) flood is achievable. This equates to flow of 47m^3/s.

Alternative quick wins / Preliminary investigations

Weir removal could be carried out on its own but would reduce flood risk by a limited extent as discussed in Section 4.6.3. Smaller wall raising would offer a lesser standard of protection but for a lower cost. There is also potential to remove the existing ca.300m long embankment along the left bank of the watercourse to the rear of properties on Dalatho Crescent, allowing floodplain reconnection and wetland creation. This will have environmental benefits of habitat creation whilst also attenuating some flow on the watercourse.

Geotechnical issues

- A full GI will be required at a later stage in the project and bank stability, particularly near the flats on March Street Lane where a weir is to be removed, will need to be investigated.
- A cut-off is likely to be needed. Piling may be difficult in this material and other forms of cut-off may need to be considered.

Services

Overhead and underground services have been identified and their location is shown on drawing AEM-JBAU-PB-EW-SK-C-1302-EW_Plan _Opt14 _Def_&_Serv.

- Surface water sewer and electrical cables close to proposed Damcroft Wall.
- A combined sewer parallel to the proposed Cuddyside wall and to Damcroft wall downstream, starting approximately 62m upstream of A72 bridge.
- Electricity cables and surface water sewer close to Cuddyside Wall.

Construction access

Construction access has been considered and not considered too difficult.

- Construction access to Damcroft Wall: Possible access from Bridgegate – Temporary closure of footpath.
- Construction access to Cuddyside Wall: Possible access from Cuddyside.
- Construction access to Bridgegate flood gates: From Bridgegate – Temporary closure of bridge.
- Construction access to March Street flood gate: Access from March Street.

Waste

- Expected quantity of waste material: Approximately 407m^3.
- Nature (inert, non-hazardous, hazardous): It is known that very limited industry was present in Peebles – soil expected to be inert.
- Proposed disposal: All waste produced during construction should be contained and prevented from entering the watercourse. Stock piles of soil and non-toxic spoil and construction waste should be located away from the river (at least c.10m) and covered. SEPA pollution prevention guidelines should be adhered to throughout the works.

Proximity of defence to other structures

- Private and Public: Public road and footpath next to proposed Cuddyside and Damcroft Walls.
- Bridges: Bridgegate bridge and A72 bridge in close proximity to Damcroft and Cuddyside Walls.
- Walls: A wall is present on the left bank of the Eddleston Water, approximately 50m upstream of the A72 bridge.
- Houses: Houses close to all proposed defences.

Environmental issues

- Statutory Environmental Designations: Eddleston Water is part of the River Tweed Special Area of Conservation (SAC) and the River Tweed is also a designated SSSI. Habitats Regulations Appraisal (HRA) and Appropriate Assessment are required
- Additional surveys and assessments may be required for otter, fish, habitat (with reference to Ranunculion fluitantis and Callitricho-Batrachion vegetation), bats (works affecting trees, walls, built structures and bridges), breeding birds, water quality, flow and hydromorphology
- Consultation required with SNH and SEPA.
- During weir removal, the immediate release of sediment built up behind the structure can have a smothering effect on riverine fauna downstream, therefore sediment must be extracted prior to weir removal. Long term impacts may also be encountered due to changes in the flow regime post-weir removal. These should be investigated in more detail prior to removal.
- Listed Buildings: There are listed buildings on the right bank of Eddleston Water, in close proximity to the proposed Damcroft Wall.
- The proposed wall lies within the Peebles Conservation Area and so detailed design would need to be undertaken with cognisance of the character and aesthetics of the area.

Health and safety hazards noted

- Geotechnical and excavation works - In channel works, falling into excavations, collapse of the sides of excavation, damage to underground services, undermining of nearby structures.
- Construction – flooding of works.

Social and community issues

Some aesthetic issues as this option has been designed to mitigate flood risk to large flood events and therefore has some visual impact near the watercourse due to the construction of 1.5m high flood defence walls. Land take is minimal, but a substantial length of flood wall is proposed in a public space.

Impact on other reaches

The works will increase the flow in the channel downstream of the works as a result of the reduction in out of bank flows but this is estimated to increase water levels at the River Tweed confluence by only 1mm relative to the Do Minimum scenario, an insignificant rise that is well within the bounds of modelling error.

Additional information required

- A detailed topographic survey.
- Detailed buried services survey, plotting their position with regards to site works.
- Ground investigation.

Additional works required to account for increase in 200 year flow due to climate change

A 200 year standard of protection is not achievable due to the defence heights that would be required. A 30 year standard plus climate change would similarly require extremely large flood defences approaching 3m in height upstream of Bridgegate Bridge where the watercourse is constrained. Although that increased flood wall heights would likely not be acceptable for the community the Council could consider building walls in a manner that allows them to be raised in the future.

4.8.2 Option 2 - Construction of direct defences

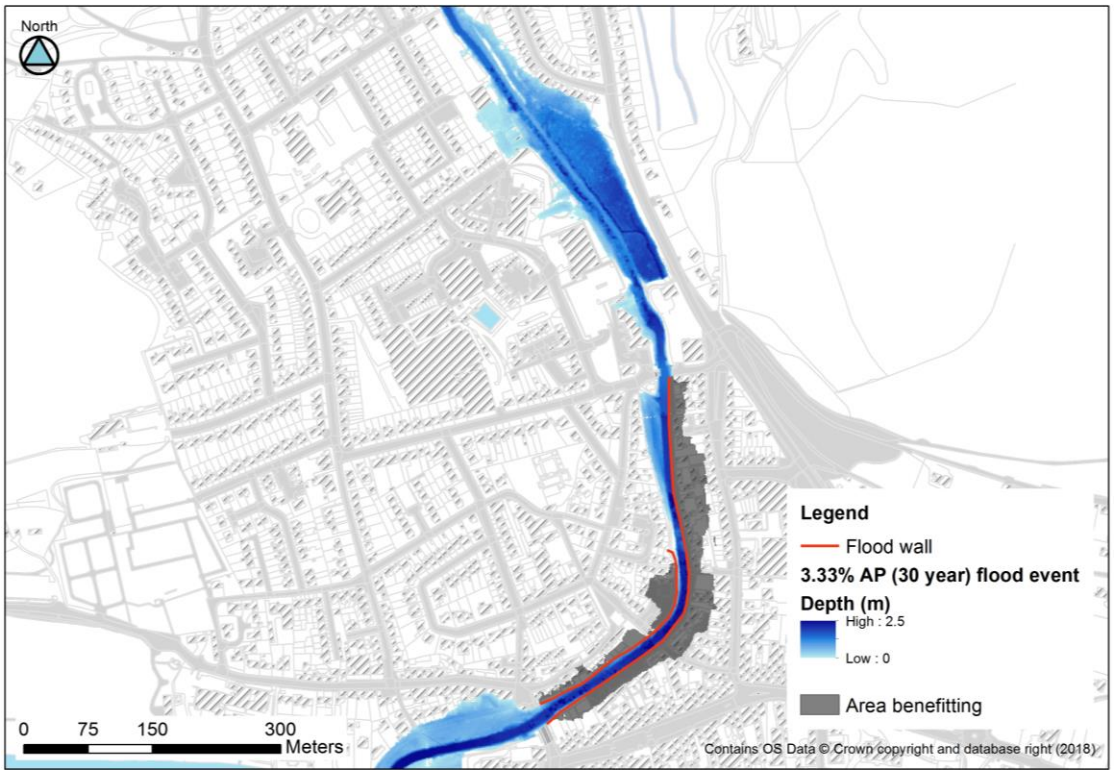
Option 2 - Construction of direct defences

Description

This option involves the installation of flood walls along the Eddleston Water through Peebles and no other interventions. The work includes the following:

- Install a flood wall along the left bank for a distance of approximately 490m, between the March Street road bridge and the A72 road bridge. Maximum wall height will be 1.5m, including a 300mm freeboard.
- Install new flood walls where necessary along the right bank, for a distance of approximately 265m, between Damcroft and the A72 road bridge. Maximum wall height will be 1.5m, including a 300mm freeboard.
- Install flood gates at either end of Bridgegate Bridge, tying in to flood walls.

Note that these walls are slightly higher than those required in Option 1 where weirs are removed, but the differences are expected to be within 0.1m in height. The wall near George Street is additional and is not required as part of Option 1.



A technical drawing relating to this option has been produced and is provided alongside this report, named as follows:

'AEM-JBAU-PB-EW-SK-C-1101-Opt7_30Yr_Direct_Defences-S3-P01'.

Standard of Protection (SOP)

Modelling of the above option suggests that a standard of protection of a 3.3% AP (30 year) flood is achievable. This equates to flow of 47m^3/s.

Alternative quick wins / Preliminary investigations

Smaller wall raising would offer a lesser standard of protection but for a lower cost. There is also potential to remove the existing ca.300m long embankment along the left bank of the watercourse to the rear of properties on Dalatho Crescent, allowing floodplain reconnection and wetland creation. This will have environmental benefits of habitat creation whilst also attenuating some flow on the watercourse.

Geotechnical issues

- A full GI will be required at a later stage in the project.
- A cut-off is likely to be needed. Piling may be difficult in this material and other forms of cut-off may need to be considered.

Services

Overhead and underground services have been identified and their location is shown on drawing AEM-JBAU-PB-EW-SK-C-1102-EW_Plan_Opt7_Def_&_Serv

- Surface water sewer and electrical cables close to proposed Damcroft Wall.
- A combined sewer parallel to the proposed Cuddyside wall and to Damcroft wall downstream, starting approximately 62m upstream of A72 bridge.
- Electricity cables and surface water sewer close to Cuddyside Wall.

Construction access

Construction access has been considered and not considered too difficult.

- Construction access to Dovecot Wall: Access from Dovecot Road.
- Construction access to Damcroft Wall: Possible access from Bridgegate – Temporary closure of footpath.
- Construction access to Cuddyside Wall: Possible access from Cuddyside.
- Construction access to flood gates: From Bridgegate – Temporary closure of bridge.

Waste

- Expected quantity of waste material: Approximately 447m^3.
- Nature (inert, non-hazardous, hazardous): It is known that very limited industry was present in Peebles – soil expected to be inert.
- Proposed disposal: All waste produced during construction should be contained and prevented from entering the watercourse. Stock piles of soil and non-toxic spoil and construction waste should be located away from the river (at least c.10m) and covered. SEPA pollution prevention guidelines should be adhered to throughout the works.

Proximity of defence to other structures

- Private and Public: Public road and footpath next to proposed Cuddyside and Damcroft Walls.
- Bridges: Bridgegate bridge and A72 bridge in close proximity to Damcroft and Cuddyside Walls.
- Walls: A wall is present on the left bank of the Eddleston Water, approximately 50m upstream of the A72 bridge.
- Houses: Houses close to all proposed defences.

Environmental issues

- Statutory Environmental Designations: Eddleston Water is part of the River Tweed Special Area of Conservation (SAC) and the River Tweed is also a designated SSSI. Habitats Regulations Appraisal (HRA) and Appropriate Assessment are required
- Additional surveys and assessments may be required for otter, fish, habitat (with reference to Ranunculion fluitantis and Callitricho-Batrachion vegetation), bats (works affecting trees, walls, built structures and bridges), breeding birds, water quality, flow and hydromorphology
- Consultation required with SNH and SEPA.
- Habitat: The area around the proposed Dovecot Wall is a National Forest Inventory.
- Listed Buildings: There are listed buildings at the right bank of Eddleston Water, in close proximity to the proposed Damcroft Wall.

- The proposed wall lies within the Peebles Conservation Area and so detailed design would need to be undertaken with cognisance of the character and aesthetics of the area.

Health and safety hazards noted

- Geotechnical and excavation works - In channel works, falling into excavations, collapse of the sides of excavation, damage to underground services, undermining of nearby structures.
- Construction – flooding of works.

Social and community issues

Some aesthetic issues as this option has been designed to mitigate flood risk to large flood events and therefore has some visual impact near the watercourse due to the construction of up to 1.5m high flood defence walls. Land take is minimal but a substantial length of flood wall is proposed.

Impact on other reaches

The works will increase the flow in the channel downstream of the works as a result of the reduction in out of bank flows but this is estimated to increase water levels at the River Tweed confluence by only 1mm relative to the Do Minimum scenario, an insignificant rise that is well within the bounds of modelling error.

Additional information required

- A detailed topographic survey.
- Detailed buried services survey, plotting their position with regards to site works.
- Ground investigation.

Additional works required to account for increase in flow due to climate change

A 200 year standard of protection is not achievable due to the defence heights that would be required. A 30 year standard plus climate change would similarly require extremely large flood defences approaching 3m in height on the banks of the watercourse. Although that increased flood wall heights would likely not be acceptable for the community the Council could consider building walls in a manner that allows them to be raised in the future.

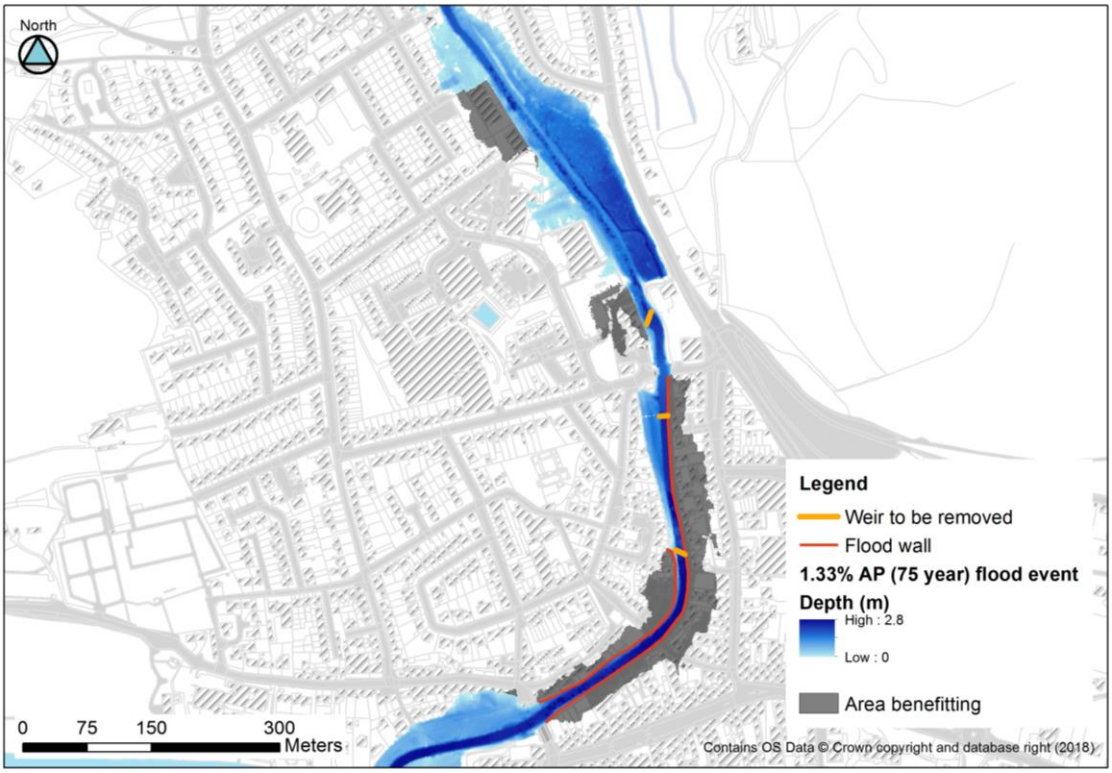
4.8.3 Option 3 - Construction of direct defences, weir removal and raising of Bridgegate bridge

Option 3 - Construction of direct defences, weir removal and raising of Bridgegate bridge

Description

This option aims to provide protection through a combination of embankment raising, wall installation, weir removal and bridge raising along the Eddleston Water through Peebles. Raising of Bridgegate Bridge will remove a key constraint and reduce water levels for floods that would reach the soffit level of the current bridge. The work includes the following:

- Install a flood wall for a distance of approximately 200m along the right bank near George Street. Maximum wall height will be 163mAOD (1.1m above current ground level), including a 300mm freeboard.
- Install a flood wall along the left bank for a distance of approximately 490m, between the March Street road bridge and the A72 road bridge. Maximum wall height will be 161.6mAOD (up to 1.6m above current ground level), including a 300mm freeboard.
- Raise existing walls and install new flood walls where necessary along the right bank, for a distance of approximately 265m, between the March Street road bridge and the A72 road bridge. Maximum wall height will be 161.6mAOD (up to 1.8m above current ground/wall level), including a 300mm freeboard.
- Removal of the Bridgegate bridge and replace with a structure with a soffit above the predicted water level (predicted to be 161.1mAOD in the 1.33% AEP event) current soffit is 160.5mAOD).
- Install flood gates at either end of Bridgegate Bridge, tying in to flood walls.
- Remove weirs at the following locations and reprofile channel to give a smooth negative gradient:
  1. Upstream of March Street bridge
  2. Under Cuddyside footbridge.
  3. Cuddyside opposite Damcroft.



A technical drawing relating to this option has been produced and is provided alongside this report, named as follows:

'AEM-JBAU-PB-EW-SK-C-1201-Opt10_75Yr_DD_&_b&w_rem-S3-P01'.

Standard of Protection (SOP)

Modelling of the above option suggests that a standard of protection of a 1.33% AP (75 year) flood is achievable. This equates to flow of 60m^3/s. This is the highest standard of protection offered by any of the shortlisted options.

Alternative quick wins / Preliminary investigations

There is potential to remove the existing ca.300m long embankment along the left bank of the watercourse to the rear of properties on Dalatho Crescent, allowing floodplain reconnection and wetland creation. This would have environmental benefits of habitat creation whilst also attenuating some flow on the watercourse.

Options 1 and 2 are essentially scaled back versions of this option that offer a lower standard of protection for a lower cost and could therefore be seen as an alternative.

Geotechnical issues

- A full GI will be required at a later stage in the project.
- A cut-off is likely to be needed to avoid seepage beneath the defences. Piling may be difficult in this material and other forms of cut-off may need to be considered.
- The structural integrity of the banks and existing walls/embankments in the vicinity of the defences have not been assessed. The flats on March Street Lane are close to the watercourse, therefore removal of the weir at this location may affect bank stability. This will need to be investigated prior to weir removal.

Services

Overhead and underground services have been identified and their location is shown on drawing AEM-JBAU-PB-EW-SK-C-1202-EW_Plan_Opt10_Def_&_Serv:

- Surface water sewer and electrical cables close to proposed Damcroft Wall.
- A combined sewer parallel to the proposed Cuddyside wall and to Damcroft wall downstream, starting approximately 62m upstream of A72 bridge.
- Electricity cables and surface water sewer close to Cuddyside Wall.

Construction access

Construction access has been considered and appears straightforward:

- Construction access to Dovecot Wall: Access from Dovecot Road.
- Construction access to Damcroft Wall: Possible access from Bridgegate – Temporary closure of footpath.
- Construction access to Cuddyside Wall: Possible access from Cuddyside.
- Construction access to flood gates: From Bridgegate – Temporary closure of bridge.

Waste

- Expected quantity of waste material: Approximately 516m^3.
- Nature (inert, non-hazardous, hazardous): It is known that very limited industry was present in Peebles – soil expected to be inert.
- Proposed disposal: All waste produced during construction should be contained and prevented from entering the watercourse. Stock piles of soil and non-toxic spoil and construction waste should be located away from the river (at least c.10m) and covered. SEPA pollution prevention guidelines should be adhered to throughout the works.

Proximity of defence to other structures

- Private and Public: Public road and footpath next to proposed Cuddyside and Damcroft Walls.
- Bridges: Bridgegate bridge and A72 bridge in close proximity to Damcroft and Cuddyside Walls.
- Walls: A wall is present on the left bank of the Eddleston Water, approximately 50m upstream of the A72 bridge.
- Houses: Houses close to all proposed defences.

Environmental issues

- Statutory Environmental Designations: Eddleston Water is part of the River Tweed Special Area of Conservation (SAC) and the River Tweed is also a designated SSSI. Habitats Regulations Appraisal (HRA) and Appropriate Assessment are required
- Additional surveys and assessments may be required for otter, fish, habitat (with reference to Ranunculion fluitantis and Callitricho-Batrachion vegetation), bats (works affecting trees, walls, built structures and bridges), breeding birds, water quality, flow and hydromorphology
- Consultation required with SNH and SEPA.
- Habitat: The area around the proposed Dovecot Wall is a National Forest Inventory.
- During weir removal, the immediate release of sediment built up behind the structure can have a smothering effect on riverine fauna downstream, therefore sediment must be extracted prior to weir removal. Long term impacts may also be encountered due to changes in the flow regime post-weir removal.
- Listed Buildings: There are listed buildings at the right bank of Eddleston Water, in close proximity to the proposed Damcroft Wall.
- Some of the proposals for this option lie within the Peebles Conservation Area and so detailed design would need to be undertaken with cognisance of the character and aesthetics of the area.

Social and community issues

Some aesthetic issues as this option has been designed to mitigate flood risk to large flood events and therefore has some visual impact near the watercourse due to the construction of up to 1.8m high flood defence walls along the riverside on the right bank opposite St Michaels Bank and 1.3m on the left bank. These defences achieve a good standard of protection whilst being at the upper limit of what is acceptable in terms of wall heights in a community space thanks to the removal of the weirs and raising of Bridgegate Bridge. Land take is minimal but a substantial length of flood wall is proposed.

Damdale footbridge on Cuddyside is a Grade C listed structure, therefore permission may be required to remove the weir running underneath it.

Impact on other reaches

The works will increase the flow in the channel downstream of the works as a result of the reduction in out of bank flows but this is estimated to increase water levels at the River Tweed confluence by only 2mm relative to the Do Minimum scenario, an insignificant rise that is well within the bounds of modelling error.

Additional information required

- A detailed topographic survey.
- Detailed buried services survey, plotting their position with regards to site works.
- Ground investigation.

Additional works required to account for increase in 200 year flow due to climate change

- Consider building walls that can be raised in the future.

4.8.4 Property Level Protection (PLP)

Property Level Protection (PLP)

Description

This option aims to provide an increase in standard of protection for all properties where possible by protecting them up to a maximum flood depth of 0.6m. Beyond this water depth a building's integrity can potentially be compromised. This option includes the survey, design and implementation of relevant PLP products to each property experiencing flooding.

The number of properties expected to benefit from PLP:

- 49 properties at the 0.5% AP (200 year) event.
- 23 properties at the 1% AP (100 year) event.
- 18 properties at the 1.33% AP (75 year) event.

Across all return periods that properties would be protected a total of 73 properties could benefit from PLP.

Standard of Protection (SOP)

PLP offers a variable standard of protection dependent on the property and expected flood depths. Importantly, the property with the lowest standard would be protected to a maximum of the 10% AP (10 year) event, at which point water levels would overtop standard 600mm high PLP products. At each consecutive return period there is a steady increase in the number of properties experiencing flooding to depths that would overcome PLP products.

Technical issues

All properties would require surveying by competent parties to determine which products are appropriate. Properties with non-standard or large entrances may require bespoke options which can significant increase costs.

The Scottish Government's Blueprint on PLP[6] should be considered when implementing this option.

Construction issues

Some commercial properties may require bespoke PLP products and building remedial works to ensure the products work effectively.

The installation and periodic replacement of PLP products on multiple properties may become a maintenance burden for the Council.

Environmental issues

None identified.

Social and community issues

Due to the prevalence of flooding and highly engaged community PLP alone may not be an acceptable option. Residents are likely to expect more significant measures to be undertaken.

Impact on other reaches

There will be negligible impact on other reaches due to the small volume that would otherwise flow through properties.

Additional information required

- A property threshold survey for any properties not already surveyed.
- Public engagement meetings.
- Flood risk reviews on each property.

6 Scottish Government (2014). Assessing the Flood Risk Management Benefits of Property Level; Blueprint for Local Authorities and Scottish Water. Final Report v2.0. 13 November 2014

Additional works required to account for increase in flow due to climate change

- Some properties identified as suitable for PLP may become unsuitable with increasing river flows. Additionally, some properties that are not expected to flood frequently enough to make PLP worthwhile at present may be expected to flood more frequently in the future.

4.9 Residual risk

Greenside is at joint flood risk from the Eddleston Water and the River Tweed. Options to manage this risk have been proposed in the appraisal report for the River Tweed rather than this report and thus none of the shortlisted options will attempt to mitigate this risk.

An additional measure which may also be considered is to move the existing embankment on the left bank upstream of the March Street road bridge back, in order to allow flooding of the wetland area to the rear of properties on Dalatho Crescent. Although this measure is not modelled to have a significant effect on flood levels, it may be implemented to improve habitats for wildlife and other RBMP benefits. This option is shown in Figure 4-3.

PLP could be procured to mitigate the varying levels of residual risk with options 1 to 3. Including PLP with any of the engineered measures discussed above would potentially reduce the benefit cost-ratio but may provide a more robust scheme.

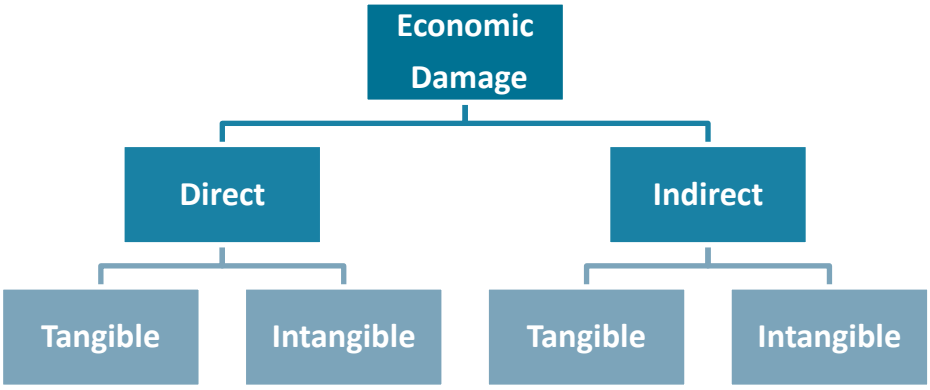
Figure 4-3: Floodplain reconnection on the Eddleston Water to the rear of Dalatho Crescent

5 Investment appraisal

5.1 Damage methodology

Flood damage assessment can include direct, indirect, tangible and intangible aspects of flooding, as shown in the Figure 5-1. Direct damages are the most significant in monetary terms, although the MCM and additional research provide additional methodologies, recommendations and estimates to account for the indirect and intangible aspects of flood damage.

Figure 5-1: Aspects of flood damage



Flood damage estimates have been derived for the following items:

1. Direct damages to residential properties;
2. Direct damages to commercial and industrial properties;
3. Indirect damages (emergency services);
4. Intangible damages associated with the impact of flooding;
5. Damage to vehicles;
6. Emergency evacuation and temporary accommodation costs.

The assumptions and additional data used to calculate the flood damages is provided in Appendix A.1.

5.2 Baseline Damages

Baseline damage results are presented for the Do Nothing and Do Minimum options overleaf.

Do Nothing

Assumptions:

Maintenance ceased, increasing hydraulic roughness due to vegetation growth and degradation of banks.

Road bridges are single span structures not expected to block but footbridges have smaller capacity and are therefore blocked by lowering the soffit level by 300mm.

Properties at risk:

The total number of properties inundated above threshold level for the Do Nothing Scenario on the Eddleston Water has been assessed and is provided in the table below.

Return period (years)	2	5	10	25	30	50	75	100	200	500	1000
Residential	1	10	13	16	17	32	49	53	90	115	161
Non-residential	1	2	5	5	5	8	8	8	10	11	21
Total	2	12	18	21	22	40	57	61	100	126	182

Key beneficiaries:

The flood damages derived have been ranked and assessed in terms of the proportion of flood damages per property. This highlights key beneficiaries of the scheme and is a useful auditing tool. The top ten properties are listed in the table below.

Rank	Property address	Pvd (£k)	Percentage of total Pvd
1	2 Cuddyside, EH45 8EN	287	8%
2	Castle Warehouse, 29 Northgate, EH45 8RX	265	8%
3	7 March Street, EH45 8DF	220	6%
4	20 Cuddyside, EH45 8EN	171	5%
5	19 Cuddyside, EH45 8EN	149	4%
6	11 Bridgegate, EH45 8RZ	147	4%
6	9 Cuddyside, EH45 8EN	147	4%
6	77 Northgate, EH45 8BU	147	4%
6	16 Provost Walker Court, EH45 8SG	147	4%
10	Brown Brothers Citroen, George Street	119	3%

Event property damages:

JBA's damage calculation method provides event damages based on MCM depth damage curves. Full results are provided in Appendix B. These represent the total potential flood damages based on the modelled flood level. Damages include all direct and indirect property flood damages and are presented in £k.

Return period (years)	2	5	10	25	30	50	75	100	200	500	1000
Residential (£k)	24	182	307	439	438	691	1039	1388	2390	3273	5909
Non-residential (£k)	11	59	89	195	188	354	438	489	671	889	2122
Total (£k)	35	241	397	634	626	1,045	1,476	1,877	3,061	4,162	8,031

The above damages are used to calculate Annual Average Damages (AAD). Plotting the damages against the frequency of flooding (annual probabilities) allows us to determine the AAD.

Intangible & intangible damages:

A summary of the proportion of total damages by each damage component is provided in the table below.

Do Nothing flood damages (£k):

Property PVd	Capped Property PVd	Total AAD	Indirect PVd	Intangible PVd	Total Capped PVd
5,588	3,417	172	280	424	4,121

Do Minimum

Assumptions:

Maintenance continued in the channel and on the banks. No bridge blockage assumed.

Properties at risk:

The total number of properties inundated above threshold level for the Do Minimum Scenario on the Eddleston Water has been assessed and is provided in the table below.

Return period (years)	2	5	10	25	30	50	75	100	200	500	1000
Residential	1	1	10	13	14	20	23	32	64	97	145
Non-residential	0	1	3	5	5	7	7	7	9	10	16
Total	1	2	13	18	19	27	30	39	73	107	161

Key beneficiaries:

The flood damages derived have been ranked and assessed in terms of the proportion of flood damages per property. This highlights key beneficiaries of the scheme and is a useful auditing tool. The top ten properties are listed in the table below.

Rank	Property address	Pvd (£k)	Percentage of total Pvd
1	2 Cuddyside, EH45 8EN	177	7%
2	20 Cuddyside, EH45 8EN	171	7%
3	77 Northgate, EH45 8BU	147	6%
3	16 Provost Walker Court, EH45 8SG	147	6%
5	Castle Warehouse, 29 Northgate, EH45 8RX	139	6%
6	9 Cuddyside, EH45 8EN	134	5%
7	11 Bridgegate, EH45 8RZ	126	5%
8	7 March Street, EH45 8DF	112	5%
9	12 March Street, EH45 8DF	67	3%
10	Brown Brothers Citroen, George Street	66	3%

Event property damages:

JBA's damage calculation method provides event damages based on MCM depth damage curves. Full results are provided in Appendix B. These represent the total potential flood damages based on the modelled flood level. Damages include all direct and indirect property flood damages and are presented in £k.

Return period (years)	2	5	10	25	30	50	75	100	200	500	1000
Residential (£k)	21	26	208	436	477	659	781	969	2,426	3,983	6,640
Non-residential (£k)	3	15	57	77	84	127	147	163	206	312	586
Total (£k)	25	41	265	513	561	786	929	1,132	2,632	4,295	7,226

The above damages are used to calculate Annual Average Damages (AAD). Plotting the damages against the frequency of flooding (annual probabilities) allows us to determine the AAD.

Intangible & intangible damages:

A summary of the proportion of total damages by each damage component is provided in the table below.

Do Minimum flood damages (£k):

Property PVd	Capped Property PVd	Total AAD	Indirect PVd	Intangible PVd	Total Capped PVd
3,620	2,442	112	186	258	2,886

The tables above show that increasing flood levels result in an almost exponential increase in property flood damages under both the Do Nothing and Do Minimum scenarios. Analysis of the frequency that damages are expected to occur shows that the lower return periods have a dominant impact on flood damages, as is often the case. However, events above the 1% AP (100 year) event also make a large contribution to the overall damages, meaning that on the Eddleston Water there would be great benefit in protecting against the largest magnitude flood events. Flood walls capable of protecting against the 200-1000 year flood events are unlikely to be feasible due to the visual impact such high walls would have. Thus, seemingly extreme options including longer-term relocation for residents of the lowest lying properties may be justified as climate influenced increases in flooding are realised and large magnitude events become more frequent.

5.3 Options

The flood damages for each option were calculated for each return period up to the 1% AP (1000 year) event. Average annual flood damages were converted to present value damages using the discount factor and the residual damages for each option were compared against the flood damages estimated for the Do Nothing scenario. This comparison shows the damages avoided as a result of the options' interventions, also known as the benefit.

In line with current guidance[7] the PLP option was factored to account for the effectiveness and performance of measures and availability of homeowners to install and operate the measures. PLP was assumed to be 84% effective.

5.4 Damage benefit summary

The table below summarises the damages avoided for each option. The results show that each of the options assessed significantly reduce flood damages in the order of £2.2m-2.8, leaving comparatively low residual present value damages in the range £1.2-2.0m. The Do Minimum option reduces the Do Nothing damages by over 25% and the defended options reduce this further by varying degrees.

Table 5-1: Damage benefit summary (DD = Direct defences)

	DN	DM	PLP	Option 1	Option 2	Option 3
Option name	Do Nothing	Do Minimum	PLP	DD & weir removal	DD	DD & weir removal & bridge raising
Standard of Protection	<2	<2	5	30	30	75
BENEFITS:						
PV monetised flood damages (£k)	4,121	2,886	1,189	1,967	1,967	1,372
Total PV damages avoided/ benefits (£k)	-	1,235	2,463*	2,154	2,154	2,750
***Note:** PLP benefits are scaled down by 16% to account for the likelihood of PLP products only being 84% effective						

7 Post-Installation Effectiveness of Property Level Flood Protection, Final Report FD2668, (2014) DEFRA

6 Cost estimates

6.1 Price Base Date

The price base date is January 2018. The costs and benefits have been discounted over the 100 year life of the scheme to determine present values.

6.2 Whole life cost estimates

Whole life costs are typically compiled from the following four key cost categories:

1. Enabling costs. These costs relate to the next stage of appraisal, design, site investigation, consultation, planning and procurement of contractors.
2. Capital costs. These costs relate to the construction of the flood mitigation measures and include all relevant costs such as project management, construction and materials, licences, administration, supervision and land purchase costs (if relevant).
3. Operation and maintenance costs. Maintenance of assets is essential to ensure that the assets remain fit for purpose and to limit asset deterioration. Costs may include inspections, maintenance and intermittent asset repairs/replacement.
4. End of life replacement or decommissioning costs. These costs are only required when the design life of assets is less than the appraisal period. Most assets are likely to have a design life in excess of the 100 year financial period but PLP is expected to have a 25 year design life so this has been included in the cost estimate for PLP.

The Environment Agency's 'Long Term Costing' tool (2012) was the basis of all costs for this assessment to provide a uniform approach to costing across the flood studies.

Whole life (present value) costs have been estimated based on the above enabling, capital and maintenance costs. The following assumptions have been made:

1. The life span of the scheme and appraisal period is 100 years.
2. Discounting of costs are based on the standard Treasury discount rates as recommended by the 2003 revision to the HM Green Book (3.5% for years 0-30, 3.0% for years 31-75 and 2.5% for years 76-99).
3. Capital costs are assumed to occur in year 1 (equivalent to 2019).
4. Enabling costs occur in year 0.
5. An optimism bias of 60% has been applied and is representative of a scheme at the appraisal design stage of development. This provides a significant safety factor for cost implications and risks.

6.3 Maintenance costs

The EA Long Term Costing tool was used to calculate maintenance costs. These maintenance costs account for a default set of maintenance regimes for associated annual or frequent operation and maintenance activities.

The costs used assume efforts are made to maintain assets at condition grade 2 (Good) using the grading system described in the Environment Agency's asset condition assessment manual[8]. Average costs were used - between lower and upper bounds reproduced in the report - given the absence of detailed maintenance plans at this early design stage of development.

6.3.1 Optimism bias

An optimism bias of 60% has been applied and is representative of a scheme at the appraisal design stage of development. This provides a significant safety factor for cost implications and risks. This uplift is applied to present value capital and present value maintenance costs after their calculation.

8 Condition Assessment Manual (CAM) (2012) Environment Agency

6.4 Property Level Protection (PLP)

The costs for this option are derived from an estimate of the number of properties of different types that are likely to require PLP. These different property types are shown in Table 6-1. The base cost data is taken from the Scottish Government guidance document on PLP (2014)[9]. The total PV costs are based on PLP products having a design life of 25 years and therefore being replaced at this interval throughout the appraisal period. All properties that first flood during floods of 0.5% AP (200 year) and below are included, up to a maximum flood depth of 0.6m.

Table 6-1: PLP - Unit and total estimated capital costs

Property type	Count	Capital cost - mid range automatic
Detached	3	£25,149
Semi-detached	5	£39,290
Terraced	36	£161,712
Flat	22	£101,376
Shop	7	£84,819
Office	0	-
Total	**73**	**£412,346**

Table 6-2: PLP - Total cash and Present Value (PV) costs

Element	Cash cost (£k)	PV Cost (£k)
Enabling cost	86	86
Capital cost	2,062	797
Maintenance cost	808	230
Total	**2,956**	**1,113**
Total incl. Optimism Bias	-	1,781

6.5 Option 1 - Direct defences with a 30-year standard of protection

This option consists of the following measures:

- Damcroft Wall: A concrete wall, 268m long, height varies between 0.4m and 1.5m (approximately).
- Cuddyside Wall: A concrete wall, 486m long and average height 1.5m.
- March Street Flood gate: A vehicular gate 6m wide by 1m high (assumed height).
- Bridgegate Flood gate right bank: A vehicular gate, 5m wide and 0.4m high.
- Bridgegate Flood gate left bank: A vehicular gate, 5m wide and 1.5m high.
- Weir removal 1: Removal of the weir upstream of March Street, approximately 36m^2 and 1m assumed depth.
- Weir removal 2: Removal of the weir downstream of the March Street, approximately 13m^2 and 1m assumed depth.
- Weir removal 3: Removal of the weir downstream of the March Street, approximately 9m^2 and 1m assumed depth.

Costs are based on achieving a 30-year standard of protection and on near immediate initiation of works.

9 Assessing the Flood Risk Management Benefits of Property Level Protection (2014) Scottish Government

Table 6-3: Option 1 - Unit and total estimated costs

Location	Typical defence height	Length / Volume	Unit cost	Total Cost (Rounded)
Damcroft Wall	0.4-1.5m	268m	£2,191	£587,188
Cuddyside Wall	1.5m	486m	£3,432	£1,667,710
Bridgegate Flood Gate (right bank)	5 x 0.4m	-	£14,427	£14,427
Bridgegate Flood Gate (left bank)	5 x 1.5m	-	£60,000	£60,000
Flood Gate March Street	6 x 1m	-	£23,000	£23,000
Weir Removal 1	1m	36m^3	£710	£25,560
Weir Removal 2	1m	13m^3	£980	£12,740
Weir Removal 3	1m	9m^3	£980	£8,820
Excavation and tipping	-	407m^3	£125	£50,920
			Total Capital cost	£2,450,365

Table 6-4: Option 1 - Total cash and Present Value (PV) costs

Element	Cash cost (£k)	PV Cost (£k)
Enabling cost	227	227
Capital cost	2,450	2,368
Maintenance cost	554	158
Total	**3,232**	**2,752**
Total incl. Optimism Bias	-	4,403

6.6 Option 2 - Direct defences with a 30-year standard of protection

This option consists of the following measures:

- Damcroft Wall: A concrete wall, 193m long, height varies between 0.5m and 1.5m (approximately).
- Cuddyside Wall: A concrete wall, approximately 485m long and an average height of 1.5m.
- Bridgegate Floodgates: Vehicular gates, 5m wide and 0.4-1.5m high.
- March Street Flood Gate: A vehicular gate, approximately 6m wide. The required height is assumed to be 1m.
- Removal of footbridge downstream of March Street: Further investigation needed or installation of flood gate (not costed).

Costs are based on achieving a 30-year standard of protection and on near immediate initiation of works.

Table 6-5: Option 2 - Unit and total estimated costs

Location	Typical defence height	Length / Volume	Unit cost	Total Cost (Rounded)
Damcroft Wall	0.5-1.5m	193m	£2,362	£455,866
Cuddyside Wall	1.5m	485m	£4,725	£2,291,470
Bridgegate Flood Gate (right bank)	5 x 0.4m	-	£21,640	£21,640
Bridgegate Flood Gate (left bank)	5 x 1.5m	-	£21,640	£21,640
March Street Flood Gate	6 x 1m		£23,000	£23,000
Excavation and tipping	-	447.1m^3	£125.05	£55,910
			Total Capital cost	£3,684,382

Table 6-6: Option 2 - Total cash and Present Value (PV) costs

Element	Cash cost (£k)	PV Cost (£k)
Enabling cost	261	261
Capital cost	2,870	2,772
Maintenance cost	554	158
Total	**3,684**	**3,191**
Total incl. Optimism Bias	-	5,105

6.7 Option 3 - Direct defences with a 75-year standard of protection

This option consists of the following measures:

- Damcroft Wall: A concrete wall, 268m long, height varies between 0.4m and 1.8m (approximately).
- Cuddyside Wall: A concrete wall, 486m long and maximum height 1.3m.
- Dovecot Wall: A concrete wall, 202m long and maximum height 1.3m.
- Bridge raising: Raising of a 10m long road bridge and approximately 115m^2 deck area. Associated flood gates on each side of the bridge.
- Flood gate right bank: A vehicular gate, 5m wide and 0.4m high.
- Flood gate left bank: A vehicular gate, 5m wide and 1.5m high.
- March Street Flood Gate: A flood gate approximately 6m wide and 1m assumed height.
- Weir removal: Removal of the weir downstream of the March Street, approximately 13m^2 and 1m assumed depth.

Costs are based on achieving a 75-year standard of protection and on near immediate initiation of works.

Table 6-7: Option 3 - Unit and total estimated costs

Location	Typical defence height	Length / Volume	Unit cost	Total Cost (Rounded)
Damcroft Wall	0.4-1.8m	268m	£2,191	£587,188
Cuddyside Wall	1.3m	486m	£3,432	£1,667,710
Dovecot Wall	1.3m	202m	£3,432	£693,163
Bridgegate Flood Gate (right bank)	5 x 0.4m	-	£14,427	£14,427
Bridgegate Flood Gate (left bank)	5 x 1.5m	-	£60,000	£60,000
Bridge raising	-	115m^2	£3,732	£429,180
Weir Removal 1	1m	36m^3	£710	£25,560
Weir Removal 2	1m	13m^3	£980	£12,740
Weir Removal 3	1m	9m^3	£980	£8,820
Excavation and tipping	-	516.3m^3	£125.05	£64,563
			Total Capital cost	£3,551,972

Table 6-8: Option 3 - Total cash and Present Value (PV) costs

Element	Cash cost (£k)	PV Cost (£k)
Enabling cost	372	372
Capital cost	3,552	3,432
Maintenance cost	554	158
Total	**4,478**	**3,961**
Total incl. Optimism Bias	-	6,338

6.8 Summary of whole life costs

The table below summarises all Present Value costs for all of the short-listed options:

Table 6-9: Summary of PV costs for all options

Option	PV Cost (£k)
Property Level Protection	1,781
1 - Direct defences with weir removal	4,403
2 - Direct defences	5,105
3 - Direct defences with weir removal and bridge raising	6,338

7 Benefit-cost analysis

7.1 Introduction

This section discusses the economic appraisal carried out during this study. The methods of calculating the benefits and costs are outlined together with an assessment of the benefit-cost ratios for the range of options assessed. Benefit cost analysis looks at a flood risk management strategy or practice and compares all the benefits that will be gained by its implementation to all the costs that will be incurred during the lifetime of the project. In accordance with the FCERM appraisal guidance, benefits are taken as annual average damages avoided, expressed as their present value using Treasury discount rates. These are compared with the whole life cost of the capital and maintenance costs of selected options, expressed as present value. If the benefits exceed the costs for the option, the scheme is deemed to be cost effective and worthwhile for promotion.

Benefits are assessed as the flood damages that will be avoided by the implementation of a project. To calculate the benefits it is necessary to assess the damages that are likely to occur under both the Do Nothing and Do Something scenarios. The benefits of any particular Do Something option can then be calculated by deducting the Do Something damages from the Do Nothing damages.

7.2 Benefit-cost results

The benefit cost results for the shortlisted options are provided in the table below. All three 'Do Something' options have been found to be cost effective.

Table 7-1: Benefit cost ratio for options on the Eddleston Water (£k)

	Do Nothing	Do Minimum	PLP	Option 1	Option 2	Option 3
PV Costs (£k)	-	-	1,113	2,752	3,191	3,961
Optimism Bias (60%)	-	-	668	1,651	1,914	2,399
Total PV Costs (£k)	-	-	1,781	4,403	5,105	6,338
PV damage (£k)	4,121	2,886	1,189	1,967	1,967	1,372
PV damage avoided (£k)	-	1,235	2,463	2,154	2,154	2,750
Net present value (£k)	-	1,235	682	-2,249	-2,951	-3,588
Benefit-cost ratio	-	-	1.4	0.5	0.4	0.4
Incremental benefit-cost ratio	-	-	0.7	-0.1	-	1.6

The results show that the PLP option is cost effective but the structural defence options are not. Despite being cost-effective the PLP option offers an inconsistent standard of protection and does not provide a holistic long-term form of flood protection. Of the structural options Option 1, which involves removal of the three weirs alongside direct defences, is the most cost-effective. Due to the small difference in benefit-cost ratio between Options 1, 2 and 3 it is recommended that Option 3 is progressed alongside the preferred option for the River Tweed which similarly has a 75 year standard of protection.

Particularly at the downstream extent, flooding from the River Tweed and Eddleston Water are not wholly independent. It is therefore recommended that a combined option is developed through a combined 1D-2D hydraulic model of the two watercourses at the next stage. A combination of Option 3 and a 75 year scheme on the River Tweed was economically assessed and the high benefit cost ratio of the River Tweed scheme means that the combined scheme is cost effective. The combined scheme achieves a benefit-cost ratio of 1.3, making an overall 75 year scheme protecting

against flooding on both watercourses economically viable and the best long-term option for Peebles as a whole.

7.3 Residual risks

As suggested above if it is possible to combine one of the structural options with a cost-effective River Tweed option the properties along the Eddleston Water could be provided with a standard of protection in line with other flood protection schemes delivered elsewhere in the Scottish Borders, such as Hawick. NFM measures are already in place on the watercourse and as they mature it is possible that some of the flood risk to these properties will be reduced regardless of other flood risk management practices.

Since it is unlikely to be possible to protect against flooding during large magnitude events on the Eddleston Water due to the high defences that would be required, a scaled abandonment of the lowest lying properties could be an option as climate change increases peak river flows.

8 Public consultation

A public consultation event was held in Peebles during November 2018 to gauge opinion on the flood mitigation options proposed as part of this study. Residents in attendance were asked to complete questionnaires with their views on the study and proposals made. In total six residents completed questionnaires relating to the Eddleston Water. In general, the residents in attendance were in approval of the scheme as a whole but expressed strong opinion that the feel of Peebles should be maintained wherever possible through careful consideration of defence types, position and the visual appearance of the structures themselves.

There was a feeling among the community that the NFM features introduced further upstream as part of the Eddleston Water Project have substantially reduced the flood risk to them and that these measures are more proven at reducing flood risk than given credit for in this study. In response, residents were told that the benefits of NFM measures are difficult to quantify and therefore were not robust enough to be compared directly with more easily modelled flood defence structures. Work is already underway to better derive the benefits of NFM within the Eddleston catchment so it may be possible to revisit the standard of protection along the Eddleston Water at outline design stage with more in-depth knowledge. Some residents wondered why additional measures were needed on top of the 'natural' measures already in place. One questionnaire respondent commented that in their opinion the structuring of the agricultural grant system means that poor land management is incentivised. They suggested that when the Common Agricultural Policy is replaced there is an opportunity to build grants from the bottom up to incentivise better land management. In summary this respondent suggested Flood Risk Management from a government perspective should seek to treat the causes and not the symptoms by only building flood defences.

Those that have flooded in the past were keen to ensure their future risk of flooding is reduced and could accept that flood walls may be a necessary step in achieving this. Wall heights for the 75 year option were acceptable to most residents, particularly those that have flooded.

The proposal to remove the weir upstream of March Street met some opposition from a resident of the flats adjacent to this structure. The resident suggested that this might negatively affect a heron that fishes from the weir. The long term benefits of removing the weir are likely to outweigh the short term localised impacts suggested by the resident.

9 Conclusions and recommendations

9.1 Summary

This report presents the results of a detailed flood risk appraisal for the area of Peebles at risk from the Eddleston Water. There has been out of bank flooding along Cuddyside, St Michaels Bank and Greenside in the recent past and sandbags are regularly used to provide some protection to riverside properties. 73 properties are estimated to be at risk of flooding from the 0.5% AP (200 year) flood event excluding properties downstream of the A72 which are also at risk of flooding from the River Tweed.

A detailed set of preliminary investigations was carried out in precedence to this appraisal such that it was possible to inform discussion of flood protection options for this area of Peebles. These investigations involved a review of Peebles' flood history, an assessment of the hydrological inputs to the Eddleston Water, collection and review of survey data, a River Basin Management Plan review, comments on the Eddleston Water Project which is delivering Natural Flood Management measures within the catchment, a Preliminary Ecological Appraisal, asset condition assessment and hydraulic modelling of the watercourse.

The hydraulic model, consisting of a 1D Flood Modeller Pro model covering the reach from the upstream extent of Peebles to the confluence with the River Tweed, allowed generation of flood inundation maps for a range of Annual Probability (AP) flood events ranging from 50% AP (2 year) to 0.1% AP (1000 year). A number of scenarios were modelled to provide sufficient information on which to base the economic appraisal at a later stage in the study. These included the Do Nothing and Do Minimum scenarios with the former representing a 'walkaway' scenario where maintenance of the watercourse ceases, and the latter representing the present-day watercourse condition. Once these maps were produced it was possible to review flood flow pathways and progress from a wide-ranging long-list of potential flood protection options to a short-list of feasible solutions tailored to Peebles' flood risk problem.

Several short-term measures were proposed which may assist in reducing flood risk to some properties. The Eddleston Water benefits from flood warning, providing residents with advanced warning of forecast flood events. The Council should focus on increasing the uptake of flood warning and SEPA should review river gauge ratings to bring added value to the data recorded. Data gathering during and after future flood events will also help to increase the accuracy of future studies. Natural Flood Management (NFM) is a method whereby wider catchment benefits could be achieved alongside potentially reducing flows in the burn. The Eddleston Water already has a number of NFM measures in action within the wider catchment which are likely to increasingly provide flood risk management benefits as features such as planted forestry mature. The Eddleston Water Project lead by Tweed Forum will continue to monitor the successes of the different measures undertaken. Integration of the data produced by gauges installed as part of the project with SEPA's existing gauge data would allow significant increases in flood warning and flood estimation accuracy. Property Level Protection (PLP) has been adopted by a limited number of residents but other properties at risk could purchase products with the aid of the Scottish Borders Council PLP discount scheme in advance of any possible flood protection scheme that might be implemented in the next flood risk management funding cycle or beyond.

A shortlist of flood protection options was produced and reviewed by comparing the expected benefit of the scheme (property damages avoided) with the estimated costs for scheme implementation and maintenance. Three of the options are based on constructing flood walls alongside the watercourse and set back to provide some floodplain. The options variously include removal of the three weirs within the urbanised reach of the watercourse and the raising of Bridgegate Bridge which currently has a low soffit. These options provide a standard of protection of between 30 (3.33% AP) and 75 (1.33% AP) years. A final option to provide property level protection to properties that are expected to experience flooding up to a depth of 0.6m was also included. This option is less favourable than a direct defences option since it carries greater risk of defence failure and does not protect all properties against the same magnitude flood event. Indeed, one property would only benefit from a 5 year standard of protection using PLP whilst others are protected to larger magnitude events.

A benefit-cost analysis has been undertaken for the present-day (Do Minimum) scenario and each of the above options. The Present Value flood damages calculated for the Do Minimum scenario are estimated to be £2,886,000. Costs for each option have been estimated using the Environment

Agency's Long Term Costing tool (2012). An optimism bias factor of 60% has been added to the total capital costs to allow for uncertainties in design at this level of appraisal and is typical for schemes at an early stage of appraisal.

Although the PLP option is cost effective, none of the short-listed structural options are cost-effective due to the small number of properties expected to flood from low magnitude events and the high cost of the interventions. The best chance of implementing a scheme on the Eddleston Water that provides a high standard of protection in line with the critical success factors identified by the Council is to combine Option 3 with a 75 or 100 year standard scheme on the River Tweed. Option 3 seeks to provide a 75 year standard of protection through construction of flood walls, removing the three weirs within the watercourse and raising Bridgegate Bridge such that the 1.33% AP (75 year) flood event will not reach its soffit. The most cost-effective option identified in the River Tweed appraisal was a 75 year option which involves the construction of flood walls throughout Peebles. These options will have some visual impact but wall levels are to be kept to a minimum whilst providing protection to substantial flood events, making them a good option for reducing flood risk in Peebles.

9.2 Recommendations

The above assessments have led to the following key recommendations for this area of Peebles:

Option 3 should be taken forward by the Council alongside the 75 or 100 year option on the River Tweed. Combined, these two schemes provide sufficient economic benefit to protect all properties at risk from the two watercourses up to the 1.33% AP (75 year) flood event. In any other case a scheme on the Eddleston Water is not likely to be economically viable on its own and PLP is not seen to be a long-term solution to the flood risk problem. Further analysis should be carried out at outline design stage to confirm the viability of a combined scheme and defences should be built to protect against climate change if defence heights can be accepted by the public.

In the short term flood warning and PLP should be marketed to those at flood risk in the wider community. Flood action groups, in partnership with the Community Council should seek to establish a network of support between members of the community, Scottish Borders Council, Tweed Forum and emergency services. Community engagement should be continued to raise awareness of flood risk and potential short- and longer-term solutions.

Data provision in relation to the Eddleston Water Project should be reviewed to ensure that SEPA are able to make best use of the data being generated and are able to integrate it with their own gauge data to provide high accuracy flood warning to the community. The ongoing findings of the study should be communicated to the public to ensure there is an appreciation of the benefits of the works being undertaken and the likely impacts on flood risk to their properties. Similarly, data generated as part of this flood study should be shared by the Council with the Eddleston Water Project as required. This may allow linking of the 1D model used in this study with the model developed for the project upstream. New data made available through the Eddleston Water Project should be incorporated with any outline or detailed design works to ensure catchment changes are accounted for.

Wherever possible, Scottish Planning Policy should be leveraged to provide the potential for future implementation of other options that are currently not possible due to the sporadic presence of properties on the floodplain. It is unlikely that a high standard of protection can be achieved on the Eddleston Water through Peebles which may mean that a more robust option is the phased abandonment of certain low-lying properties as and when they are sold.

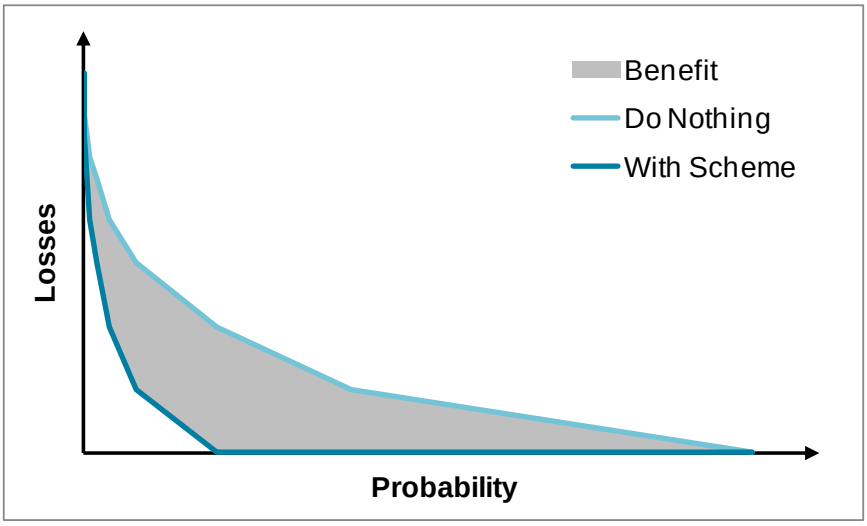
Appendices

A Appendix A - Damage Methodology

A.1 Direct damages - methodology

The process to estimate the benefits of an intervention option is to plot the two loss-probability curves: that for the situation now, and that with the proposed option as shown in Figure A-1. The scale on the y axis is the event loss (£); the scale on the x axis is the probability of the flood events being considered. When the two curves are plotted the difference in the areas beneath the curve is the annual reduction in flood losses to be expected from the scheme or mitigation approach.

Figure A-1: Loss Probability Curve



To derive these two curves, straight lines are drawn between the floods for which there are data from the threshold event (the most extreme flood which does not cause any damage) to an extreme flood above the intended standard of protection. The greater the number of flood event probabilities, the more accurately the curves can be plotted.

A.1.1 Flood damage calculation and data

The FHRC Multi Coloured Manual (MCM) provides standard flood depth/direct damage datasets for a range of property types, both residential and commercial. This standard depth/damage data for direct and indirect damages has been utilised in this study to assess the potential damages that could occur under each of the options. Flood depths within each property have been calculated from the hydraulic modelling by comparing predicted water levels at each property to the surveyed threshold levels.

A flood damage estimate was generated using JBA's in-house flood damage tools. These estimate flood damages using FHRC data and the modelled flood level data. Each property data point was mapped on to its building's footprint. A mean, minimum and maximum flood level within each property is derived using GIS tools based on the range of flood levels around the building footprint. The inundation depth is calculated by comparing water levels with the surveyed threshold level. The mean (based on mean flood water level across the buildings floor area) flood damage estimates have been calculated and are presented in section 5.2.

The following assumptions, presented in the Table A-1, were used to generate direct flood damage estimates.

Table A-1: Damage considerations and method

Aspect	Values used	Justification
Flood duration	<12hrs	Flood water is not anticipated to inundate properties for prolonged periods.
Residential property type	MCM codes broken down by type and age.	Appropriate for this level of analysis.
Non-residential property type	Standard 2016 MCM codes applied.	Best available data used.
Upper floor flats	Upper floor flats have been removed from the flood damage estimates.	Whilst homeowners may be affected it is assumed that no direct flood damages are applicable.
MCM damage type	MCM 2016 data with no basements.	Most up to date economic analysis data used. Basements are not appropriate for the type of properties within the study area.
MCM flood type	MCM 2016 fluvial depth damages for combined fluvial-tidal scenario.	Best available data used.
Threshold level	Thresholds surveyed by surveyor for the majority of properties in area of interest.	Best available data used.
Property areas	OS MasterMap used to define property areas	Best available data used.
Capping value	Residential properties based on house prices from Zoopla. Commercial properties valued from rateable values for individual properties (supplied by SAA).	Best available data used.

A.1.2 Property data set

The property dataset was compiled for all residential and commercial properties. The majority of these properties were visited by a JBA Surveyor during the threshold survey.

A.1.3 Capping

The FHRC and appraisal guidance suggests that care should be exercised for properties with high total (Present Value) damages which might exceed the market value of the property. In most cases it is prudent to assume that the long-term economic losses cannot exceed the capital value of the property. The present value flood damages for each property were capped at the market value using average property values obtained from internet sources (e.g. Zoopla).

Market values for non-residential properties were initially estimated from a properties rateable value based on the following equation:

Capital Valuation = (100/Equivalent Yield) x Rateable Value

Rateable values for all available properties in Peebles were obtained from the Scottish Assessors Association website[10]. Equivalent yield varies regionally and temporarily, but is recommended to be a value of 10-12.5 for flood defence purposes[11]. A value of 12.5 was used.

However, the resulting property valuations were judged as being undervalued. An alternative approach was used whereby the estimated value is 3 times the max depth damage MCM curve damage value for the commercial property type multiplied by the properties ground floor area.

10 www.saa.gov.uk
11 Environment Agency (2009). Flood and Coastal Erosion Risk Management - Appraisal Guidance.

A.1.4 Updating of Damage Values

The MCM data used are based on January 2017 values and therefore do not need to be brought up to date to compare the costs and benefits.

A.2 Intangible damages

Current guidance indicates that the value of avoiding health impacts of fluvial flooding is of the order of £286 per year per household. This value is equivalent to the reduction in damages associated with moving from a do-nothing option to an option with an annual flood probability of 1:100 year standard. A risk reduction matrix has been used to calculate the value of benefits for different pre-scheme standards and designed scheme protection standards.

A.3 Indirect damages

The multi coloured manual provides guidance on the assessment of indirect damages. It recommends that a value equal to 10.7% of the direct property damages is used to represent emergency costs. These include the response and recovery costs incurred by organisations such as the emergency services, the local authority and SEPA.

A.3.5 Indirect commercial damages

Obtaining accurate data on indirect flood losses is difficult. Indirect losses are of two kinds:

- losses of business to overseas competitors, and
- the additional costs of seeking to respond to the threat of disruption or to disruption itself which fall upon firms when flooded.

The first of these losses is unusual and is limited to highly specialised companies which are unable to transfer their productive activities to a branch site in this country, and which therefore lose to overseas competitors. The second type of loss is likely to be incurred by most Non-Residential Properties (NRPs) which are flooded. They exclude post-flood clean-up costs but include the cost of additional work and other costs associated with inevitable efforts to minimise or avoid disruption. These costs include costs of moving inventories, hiring vehicles and costs of overtime working. These costs also include the costs of moving operations to an alternative site or branch and may include additional transport costs.

Chapter 5, Section 5.7 of the MCM (2013)[12] recommends estimating and including potential indirect costs where these are the additional costs associated with trying to minimise indirect losses. This is by calculating total indirect losses as an uplift factor of 3% of estimated total direct NRP losses at each return period included within the damage estimation process.

12 Penning-Rowsell et al., 2013. Flood and Coastal Erosion Risk Management - A Manual for Economic Appraisal

B Appendix B - Economic appraisal

Project Summary Sheet

Client/Authority				Prepared (date)	22/10/2018
Scottish Borders Council				Printed	10/01/2019
Project name				Prepared by	B. Bedford
Eddleston Water Flood Study - Peebles				Checked by	A. Pettit
Project reference	2017s5526			Checked date	October 18
Base date for estimates (year 0)	Jan-2018				
Scaling factor (e.g. £m, £k, £)	£k	(used for all costs, losses and benefits)			
Year	0	30	75		
Discount Rate	3.5%	3.00%	2.50%		
Optimism bias adjustment factor	60%				

Costs and benefits of options

Option number	Costs and benefits £k					
	Do Nothing	**Do Minimum**	**PLP**	**OP14**	**OP07**	**OP10**
Option name	Do Nothing	Do Minimum	PLP	DD & weir removal	DD	DD & weir removal & bridge raising
AEP or SoP (where relevant)	<2	<2	5	30	30	75
COSTS:						
PV enabling costs	0	0	86	227	261	372
PV capital costs	0	0	797	2,368	2,772	3,432
PV operation and maintenance costs	0	0	230	158	158	158
Optimism bias adjustment	0	0	668	1,651	1,914	2,377
PV contributions						
Total PV Costs £k excluding contributions	0	0	1,781	4,403	5,105	6,338
Total PV Costs £k taking contributions into account	0	0	1,781	4,403	5,105	6,338
BENEFITS:						
PV monetised flood damages	4,121	2,886	1,189	1,967	1,967	1,372
PV monetised flood damages avoided		1,235	2,463	2,154	2,154	2,750
PV monetised erosion damages	0	0	0	0	0	0
PV monetised erosion damages avoided (protected)		0	0	0	0	0
Total monetised PV damages £k	4,121	2,886	1,189	1,967	1,967	1,372
Total monetised PV benefits £k		1,235	2,463	2,154	2,154	2,750
Total PV damages £k	4,121	2,886	1,189	1,967	1,967	1,372
Total PV benefits £k		1,235	2,463	2,154	2,154	2,750
DECISION-MAKING CRITERIA:						
Based on monetised PV benefits (excludes benefits from scoring and weighting and ecosystem services)						
Net Present Value **NPV**		1,235	682	-2,249	-2,951	-3,588
Average benefit/cost ratio **BCR**			1.4	0.5	0.4	0.4
Incremental benefit/cost ratio **IBCR**			0.7	-0.1	-	0.5
			#REF!	#REF!		
Best practicable environmental option (WFD)						

Brief description of options:

Do Nothing	Do Nothing
Do Minimum	Do Minimum
OP07	DD
OP10	DD & weir removal & bridge raising
OP14	DD & weir removal
PLP	PLP

Comments and assumptions:

Summary Annual Average Damage

Sheet Nr.

Client/Authority
Scottish Borders Council

Project name
Eddleston Water Flood Study - Peebles

Option:
Do Nothing

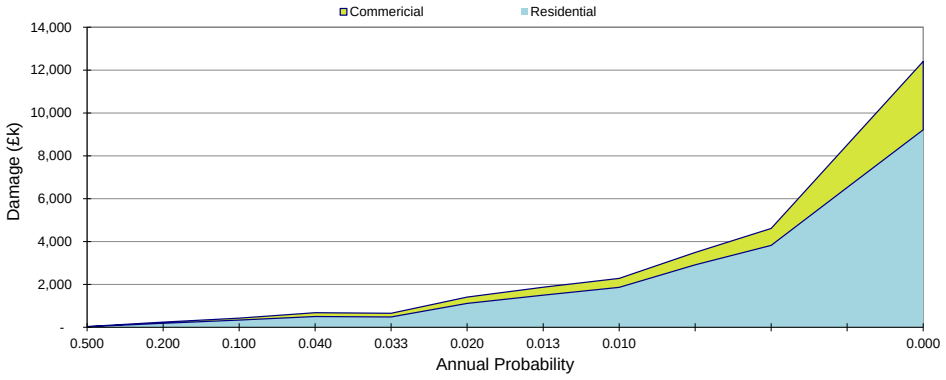
Project reference 2017s5526

Base date for estimates (year 0)	Jan-2018	First year of damage:	0	Prepared (date)		22/10/2018
Scaling factor (e.g. £m, £k, £)	£k	Last year of period:	99	Printed		10/01/2019
Discount rate	3.5%	PV factor for mid-year 0:	29.813	Prepared by		B. Bedford
				Checked by		A. Pettit
Applicable year (if time varying)				Checked date		October 18

	Average waiting time (yrs) between events/frequency per year												Total PV	Capped PV
	2	5	10	25	30	50	75	100	200	500	1000	Infinity	£k	£k
	0.500	0.200	0.100	0.040	0.033	0.020	0.013	0.010	0.005	0.002	0.001	0		
Damage category	Damage £k													
Residential property	24	183	337	503	480	1,110	1,500	1,865	2,910	3,822	6,519	9,217	4,337	2,774
Ind/commercial (direct)	11	58	85	180	174	295	370	417	582	789	1,988	3,188	1,250	643
Ind/comm (indirect)	0	2	3	5	5	9	11	13	17	24	60	96	38	38
Traffic related												-	-	
Emergency services	1	10	19	28	27	62	84	104	163	214	365	516	243	243
Other	-	-	-	-	-	-	-	-	-	-	-	-	-	
Intangible damages												-	424	424
												-	-	
Total damage £k	37	253	444	716	686	1,476	1,965	2,399	3,672	4,848	8,932	13,017		
Area (damagexfrequency)		43	35	35	5	14	11	7	15	13	7	11		
Total area, as above					197									
PV Factor, as above					29.813									
Present value (assuming no change in damage or event frequency)					5,868								6,292	4,121

Notes
Area calculations assume drop to zero at maximum frequency.
Default value for the highest possible damage assumes continuation of gradient for last two points, an alternative value can be entered, if appropriate.
One form should be completed for each option, including 'without project', and for each representative year if profile changes during scheme life (e.g. sea-level rise)
Residential property, Industrial / commercial (direct), and Other damages are itemised in Asset AAD sheet and automatically linked to this sheet

Project: Eddleston Water Flood Study - Peebles **Option: Do Nothing**



Summary Annual Average Damage

Sheet Nr.

Client/Authority
Scottish Borders Council

Project name
Eddleston Water Flood Study - Peebles

Option:
Do Minimum

Project reference 2017s5526
Base date for estimates (year 0) Jan-2018
Scaling factor (e.g. £m, £k, £) £k
Discount rate 3.5%
Applicable year (if time varying)

First year of damage: 0
Last year of period: 99
PV factor for mid-year 0: 29.813

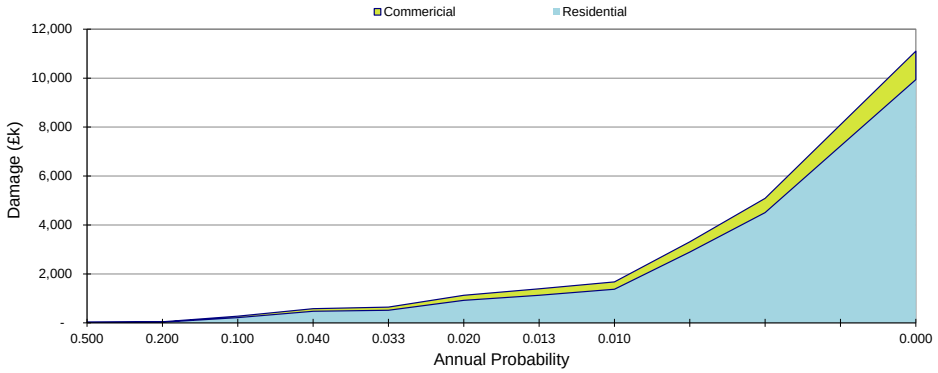
Prepared (date) 22/10/2018
Printed 10/01/2019
Prepared by B. Bedford
Checked by A. Pettit
Checked date October 18

	Average waiting time (yrs) between events/frequency per year												Total PV	Capped PV
	2	5	10	25	30	50	75	100	200	500	1000	Infinity	£k	£k
	0.500	0.200	0.100	0.040	0.033	0.020	0.013	0.010	0.005	0.002	0.001	0		
Damage category	Damage £k													
Residential property	21	26	212	471	515	918	1,128	1,371	2,895	4,505	7,223	9,941	2,965	2,072
Ind/commercial (direct)	3	15	59	106	127	205	263	302	413	586	874	1,162	655	370
Ind/comm (indirect)	0	0	2	3	4	6	8	9	12	18	26	35	20	20
Traffic related												-	-	
Emergency services	1	1	12	26	29	51	63	77	162	252	404	557	166	166
Other	-	-	-	-	-	-	-	-	-	-	-	-	-	
Intangible damages												-	258	258
												-	-	
Total damage £k	26	43	284	607	675	1,181	1,461	1,759	3,482	5,361	8,527	11,694		
Area (damagexfrequency)		10	16	27	4	12	9	5	13	13	7	10		

Total area, as above	128		
PV Factor, as above	29.813		
Present value (assuming no change in damage or event frequency)	3,806	4,064	2,886

Notes
Area calculations assume drop to zero at maximum frequency.
Default value for the highest possible damage assumes continuation of gradient for last two points, an alternative value can be entered, if appropriate.
One form should be completed for each option, including 'without project', and for each representative year if profile changes during scheme life (e.g. sea-level rise)
Residential property, Industrial / commercial (direct), and Other damages are itemised in Asset AAD sheet and automatically linked to this sheet

Project: Eddleston Water Flood Study - Peebles **Option: Do Minimum**



Summary Annual Average Damage

Sheet Nr.

Client/Authority
Scottish Borders Council

Project name
Eddleston Water Flood Study - Peebles

Option:
PLP

Project reference 2017s5526

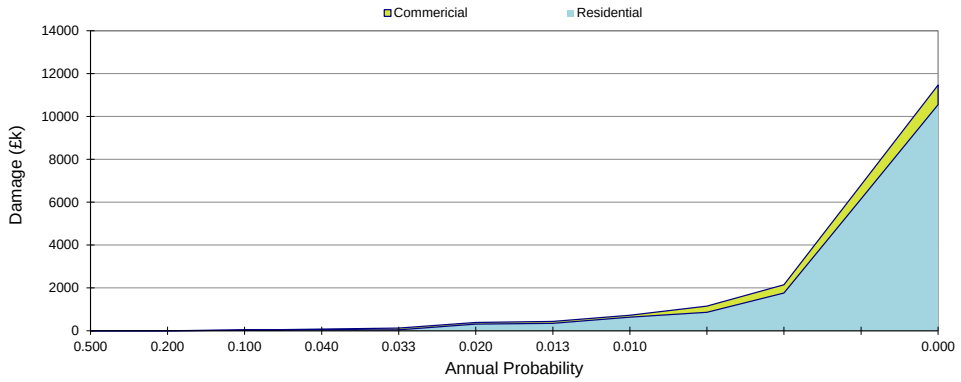
Base date for estimates (year 0)	Jan-2018	First year of damage:	0	Prepared (date)	22/10/2018
Scaling factor (e.g. £m, £k, £)	£k	Last year of period:	99	Printed	10/01/2019
Discount rate	3.5%	PV factor for mid-year 0:	29.813	Prepared by	B. Bedford
				Checked by	A. Pettit
Applicable year (if time varying)				Checked date	October 18

	Average waiting time (yrs) between events/frequency per year											Total PV	Capped PV
	2	5	10	25	30	50	75	100	200	500	1000	Infinity	£k	£k
	0.500	0.200	0.100	0.040	0.033	0.020	0.013	0.010	0.005	0.002	0.001	0		
Damage category	Damage £k													
Residential property	0	0	29	39	48	311	350	639	861	1759	6154	10550	894	845
Ind/commercial (direct)	3	4	2	44	81	79	83	87	290	387	653	918	252	157
Ind/comm (indirect)	0	0	0	1	2	2	2	3	9	12	20	28	8	8
Traffic related												0	0	
Emergency services	0	0	2	2	3	17	20	36	48	99	345	591	50	50
Other	0	0	0	0	0	0	0	0	0	0	0	0	0	
Intangible damages												0	130	130
												0	0	
Total damage £k	4	4	33	86	134	411	456	765	1208	2257	7171	12086		
Area (damagexfrequency)		1	2	4	1	4	3	2	5	5	5	33		

Total area, as above	64		
PV Factor, as above	29.813		
Present value (assuming no change in damage or event frequency)	1908	1334	1189

Notes
Area calculations assume drop to zero at maximum frequency.
Default value for the highest possible damage assumes continuation of gradient for last two points, an alternative value can be entered, if appropriate.
One form should be completed for each option, including 'without project', and for each representative year if profile changes during scheme life (e.g. sea-level rise)
Residential property, Industrial / commercial (direct), and Other damages are itemised in Asset AAD sheet and automatically linked to this sheet

Project: Eddleston Water Flood Study - Peebles **Option: PLP**



Summary Annual Average Damage

Sheet Nr.

Client/Authority
Scottish Borders Council

Project name
Eddleston Water Flood Study - Peebles

Option:
Direct Defences

Project reference 2017s5526

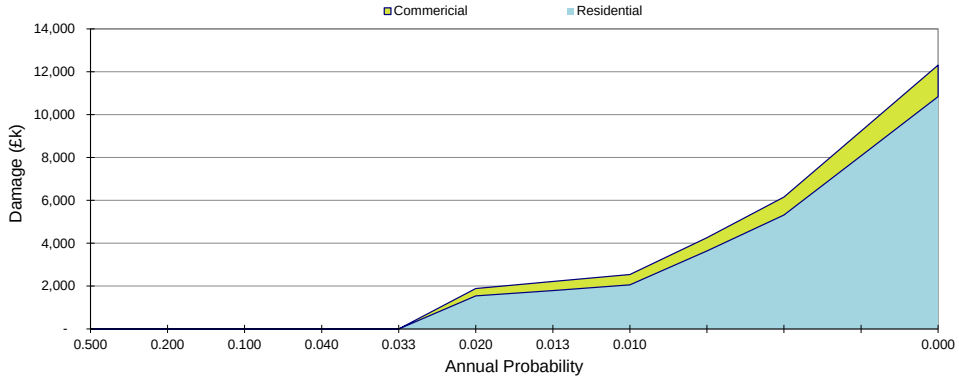
Base date for estimates (year 0)	Jan-2018	First year of damage:	0	Prepared (date)	22/10/2018
Scaling factor (e.g. £m, £k, £)	£k	Last year of period:	99	Printed	10/01/2019
Discount rate	3.5%	PV factor for mid-year 0:	29.813	Prepared by	B. Bedford
				Checked by	A. Pettit
Applicable year (if time varying)				Checked date	October 18

	Average waiting time (yrs) between events/frequency per year												Total PV	Capped PV
	2	5	10	25	30	50	75	100	200	500	1000	Infinity	£k	£k
	0.500	0.200	0.100	0.040	0.033	0.020	0.013	0.010	0.005	0.002	0.001	0		
Damage category	Damage £k													
Residential property	-	-	-	-	-	1,541	1,793	2,060	3,635	5,314	8,076	10,838	2,135	1,296
Ind/commercial (direct)	-	-	-	-	-	344	421	477	621	837	1,154	1,472	405	292
Ind/comm (indirect)	-	-	-	-	-	10	13	14	19	25	35	44	12	12
Traffic related												-	-	
Emergency services	-	-	-	-	-	86	100	115	204	298	452	607	120	120
Other	-	-	-	-	-	-	-	-	-	-	-	-	-	
Intangible damages												-	247	247
												-	-	
Total damage £k	-	-	-	-	-	1,982	2,327	2,668	4,478	6,474	9,717	12,960		
Area (damagexfrequency)		-	-	-	-	13	14	8	18	16	8	11		

Total area, as above	90		
PV Factor, as above	29.813		
Present value (assuming no change in damage or event frequency)	2,672	2,919	1,967

Notes
Area calculations assume drop to zero at maximum frequency.
Default value for the highest possible damage assumes continuation of gradient for last two points, an alternative value can be entered, if appropriate.
One form should be completed for each option, including 'without project', and for each representative year if profile changes during scheme life (e.g. sea-level rise)
Residential property, Industrial / commercial (direct), and Other damages are itemised in Asset AAD sheet and automatically linked to this sheet

Project: Eddleston Water Flood Study - Peebles **Option: Direct Defences**



Summary Annual Average Damage

Sheet Nr.

Client/Authority
Scottish Borders Council

Project name
Eddleston Water Flood Study - Peebles

Option:
Direct Defences

Project reference 2017s5526

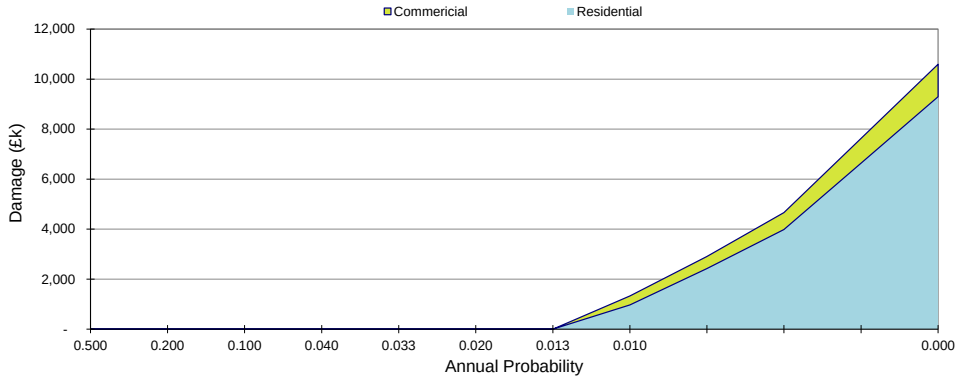
Base date for estimates (year 0)	Jan-2018	First year of damage:	0	Prepared (date)	22/10/2018
Scaling factor (e.g. £m, £k, £)	£k	Last year of period:	99	Printed	10/01/2019
Discount rate	3.5%	PV factor for mid-year 0:	29.813	Prepared by	B. Bedford
				Checked by	A. Pettit
Applicable year (if time varying)				Checked date	October 18

	Average waiting time (yrs) between events/frequency per year												Total PV
	2	5	10	25	30	50	75	100	200	500	1000	Infinity	£k
	0.500	0.200	0.100	0.040	0.033	0.020	0.013	0.010	0.005	0.002	0.001	0	
Damage category	Damage £k												
Residential property	-	-	-	-	-	-	-	969	2,426	3,983	6,640	9,298	984
Ind/commercial (direct)	-	-	-	-	-	-	-	357	482	676	987	1,298	191
Ind/comm (indirect)	-	-	-	-	-	-	-	11	14	20	30	39	6
Traffic related												-	-
Emergency services	-	-	-	-	-	-	-	54	136	223	372	521	55
Other	-	-	-	-	-	-	-	-	-	-	-	-	-
Intangible damages												-	136
												-	-
Total damage £k	-	-	-	-	-	-	-	1,391	3,058	4,902	8,029	11,155	
Area (damagexfrequency)		-	-	-	-	-	-	2	11	12	6	10	

Total area, as above	41	
PV Factor, as above	29.813	
Present value (assuming no change in damage or event frequency)	1,235	1,372

Notes
Area calculations assume drop to zero at maximum frequency.
Default value for the highest possible damage assumes continuation of gradient for last two points, an alternative value can be entered, if appropriate.
One form should be completed for each option, including 'without project', and for each representative year if profile changes during scheme life (e.g. sea-level rise)
Residential property, Industrial / commercial (direct), and Other damages are itemised in Asset AAD sheet and automatically linked to this sheet

Project: Eddleston Water Flood Study - Peebles **Option: Direct Defences**



Summary Annual Average Damage

Sheet Nr.

Client/Authority
Scottish Borders Council

Project name
Eddleston Water Flood Study - Peebles

Option:
Direct Defences

Project reference 2017s5526

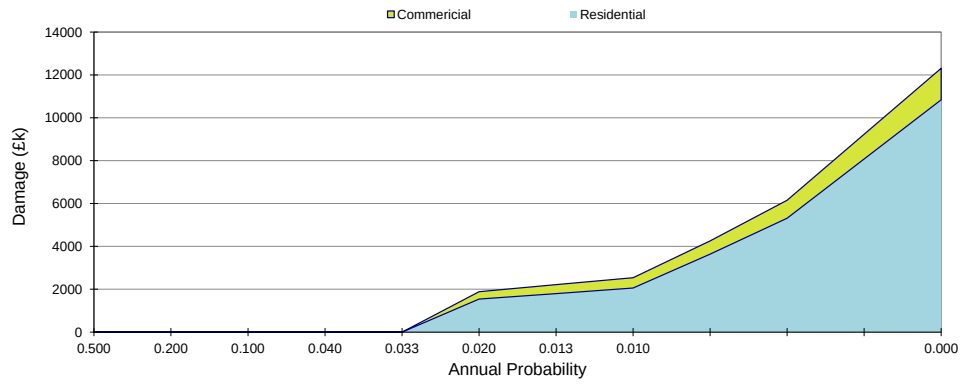
Base date for estimates (year 0)	Jan-2018	First year of damage:	0	Prepared (date)	22/10/2018
Scaling factor (e.g. £m, £k, £)	£k	Last year of period:	99	Printed	10/01/2019
Discount rate	3.5%	PV factor for mid-year 0:	29.813	Prepared by	B. Bedford
				Checked by	A. Pettit
Applicable year (if time varying)				Checked date	October 18

	Average waiting time (yrs) between events/frequency per year												Total PV	Capped PV
	2	5	10	25	30	50	75	100	200	500	1000	Infinity	£k	£k
	0.500	0.200	0.100	0.040	0.033	0.020	0.013	0.010	0.005	0.002	0.001	0		
Damage category	Damage £k													
Residential property	0	0	0	0	0	1541	1793	2060	3635	5314	8076	10838	2135	1296
Ind/commercial (direct)	0	0	0	0	0	344	421	477	621	837	1154	1472	405	292
Ind/comm (indirect)	0	0	0	0	0	10	13	14	19	25	35	44	12	12
Traffic related												0	0	
Emergency services	0	0	0	0	0	86	100	115	204	298	452	607	120	120
Other	0	0	0	0	0	0	0	0	0	0	0	0	0	
Intangible damages												0	247	247
												0	0	
Total damage £k	0	0	0	0	0	1982	2327	2668	4478	6474	9717	12960		
Area (damagexfrequency)		0	0	0	0	13	14	8	18	16	8	11		

Total area, as above	90		
PV Factor, as above	29.813		
Present value (assuming no change in damage or event frequency)	2672	2919	1967

Notes
Area calculations assume drop to zero at maximum frequency.
Default value for the highest possible damage assumes continuation of gradient for last two points, an alternative value can be entered, if appropriate.
One form should be completed for each option, including 'without project', and for each representative year if profile changes during scheme life (e.g. sea-level rise)
Residential property, Industrial / commercial (direct), and Other damages are itemised in Asset AAD sheet and automatically linked to this sheet

Project: Eddleston Water Flood Study - Peebles **Option: Direct Defences**



Summary of costs

Client/Authority		Prepared (date)	September 18	
Scottish Borders Council		Printed	10/01/2019	
Project/Option name		Prepared by	C. Kampanou	
Eddleston Water - Option 14 (DD & weir removal)		Checked by	S. Cooney	
Project reference	2017s5526	Checked date	October 18	
Base date for estimates (year 0)	Jan-2018			
Scaling factor (e.g. £m, £k, £)	£k			
Optimism bias adjustment factor	60%			

PV Cost Summary	
	Costs in £k
Enabling Costs	£227.14
Capital Costs	£2,450.37
O & M Costs	£554.34
Other Costs	£0.00
Total Real Cost	£3,231.84
Total Cost PV	£2,752.15
Total Cost PV + OB	**£4,403.45**

Note: Macros are required to open individual cost modules and the user should ensure they are enabled in the Excel Security Settings.

Note: Cost modules are opened from blank templates by clicking on the pentagons below. If a template exists, the user is sent the module. Only one module per worksheet is permitted.

Note: Costs are automatically summed from all individual cost module sheets every time the user returns to this summary sheet. This process takes into account the above scaling factor.

Note: If multiple measures are used, the optimism bias value used in each module is overridden by that selected above (Cell D10).

Additional user notes:

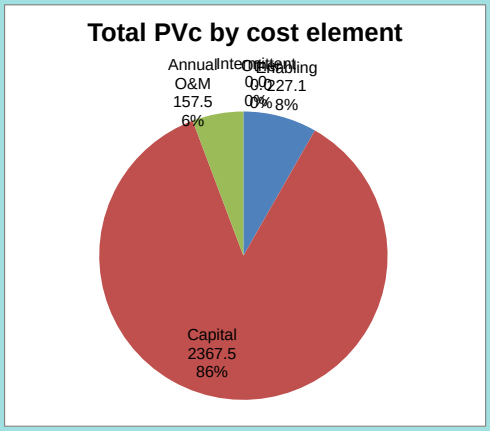
Add additional user notes here.

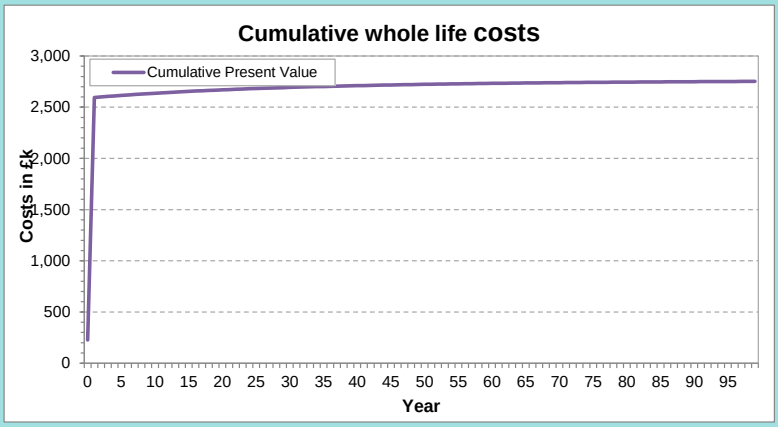
FRM Measure	Asset	Open / Go to Costing Sheet	Delete Sheet	Enabling Costs	Capital Costs	O & M Costs	Other Costs	Total Cost Cash	Total Cost PV
Fluvial raised defence	Embankment								
	Wall			£202.94	£2,254.90	£0.00	£0.00	£2,457.84	£2,381.59
	Sheet Piling								
Channel management	N/A								
Culvert & screen	N/A								
Control assets	Weir								
	Pumping station								
	Flood gate			£19.49	£97.43	£554.34	£0.00	£671.25	£271.13
	Outfall								
	Flow barrier								
Coastal protection	Wall								
	Revetment								
	Groyne								
	Recharge								
Flood storage	N/A								
Flood warning and forecasting	Various								
Temporary & demountable barriers	Various								
Household resistance	Various								
Household resilience	Various								
SUDS and urban drainage	Various								
Managed realignment	Various								
Habitat creation	Various								
Landuse & runoff management	Various								
River Restoration	Various								
User Defined 1	Various			£0.00	£50.92	£0.00	£0.00	£50.92	£49.20
User Defined 2	Various			£4.71	£47.12	£0.00	£0.00	£51.83	£50.24
User Defined 3	Various								

Whole Life and Present Value Cost Analysis		PV factor	29.813				Total PVc (£k):	2752.2	
		Enabling £k	Capital £k	Annual O&M £k	Intermittent O&M £k	Other £k	TOTALS: Current price	PV (£k)	
	Total real cost	227.1	2450.4	554.3	0.0	0.0	3231.84	2752.2	
	Total PV cost	227.1	2367.5	157.5	0.0	0.0		2752.2	Cumulative
year	Discount Factor								PV Costs (£k)
0	1.000	227.1	0.0	0.0	0.0	0.0	227.1	227.1	227.1
1	0.966	0.0	2450.4	0.0	0.0	0.0	2450.4	2367.5	2594.6
2	0.934	0.0	0.0	5.7	0.0	0.0	5.7	5.3	2599.9
3	0.902	0.0	0.0	5.7	0.0	0.0	5.7	5.1	2605.0
4	0.871	0.0	0.0	5.7	0.0	0.0	5.7	4.9	2610.0
5	0.842	0.0	0.0	5.7	0.0	0.0	5.7	4.8	2614.7
6	0.814	0.0	0.0	5.7	0.0	0.0	5.7	4.6	2619.3
7	0.786	0.0	0.0	5.7	0.0	0.0	5.7	4.4	2623.8
8	0.759	0.0	0.0	5.7	0.0	0.0	5.7	4.3	2628.1
9	0.734	0.0	0.0	5.7	0.0	0.0	5.7	4.2	2632.2
10	0.709	0.0	0.0	5.7	0.0	0.0	5.7	4.0	2636.2
11	0.685	0.0	0.0	5.7	0.0	0.0	5.7	3.9	2640.1
12	0.662	0.0	0.0	5.7	0.0	0.0	5.7	3.7	2643.8
13	0.639	0.0	0.0	5.7	0.0	0.0	5.7	3.6	2647.5
14	0.618	0.0	0.0	5.7	0.0	0.0	5.7	3.5	2650.9
15	0.597	0.0	0.0	5.7	0.0	0.0	5.7	3.4	2654.3
16	0.577	0.0	0.0	5.7	0.0	0.0	5.7	3.3	2657.6
17	0.557	0.0	0.0	5.7	0.0	0.0	5.7	3.2	2660.7
18	0.538	0.0	0.0	5.7	0.0	0.0	5.7	3.0	2663.8
19	0.520	0.0	0.0	5.7	0.0	0.0	5.7	2.9	2666.7
20	0.503	0.0	0.0	5.7	0.0	0.0	5.7	2.8	2669.6
21	0.486	0.0	0.0	5.7	0.0	0.0	5.7	2.7	2672.3
22	0.469	0.0	0.0	5.7	0.0	0.0	5.7	2.7	2675.0
23	0.453	0.0	0.0	5.7	0.0	0.0	5.7	2.6	2677.5
24	0.438	0.0	0.0	5.7	0.0	0.0	5.7	2.5	2680.0
25	0.423	0.0	0.0	5.7	0.0	0.0	5.7	2.4	2682.4
26	0.409	0.0	0.0	5.7	0.0	0.0	5.7	2.3	2684.7
27	0.395	0.0	0.0	5.7	0.0	0.0	5.7	2.2	2687.0
28	0.382	0.0	0.0	5.7	0.0	0.0	5.7	2.2	2689.1
29	0.369	0.0	0.0	5.7	0.0	0.0	5.7	2.1	2691.2
30	0.356	0.0	0.0	5.7	0.0	0.0	5.7	2.0	2693.2
31	0.346	0.0	0.0	5.7	0.0	0.0	5.7	2.0	2695.2
32	0.336	0.0	0.0	5.7	0.0	0.0	5.7	1.9	2697.1
33	0.326	0.0	0.0	5.7	0.0	0.0	5.7	1.8	2698.9
34	0.317	0.0	0.0	5.7	0.0	0.0	5.7	1.8	2700.7
35	0.307	0.0	0.0	5.7	0.0	0.0	5.7	1.7	2702.4
36	0.298	0.0	0.0	5.7	0.0	0.0	5.7	1.7	2704.1
37	0.290	0.0	0.0	5.7	0.0	0.0	5.7	1.6	2705.8
38	0.281	0.0	0.0	5.7	0.0	0.0	5.7	1.6	2707.4
39	0.273	0.0	0.0	5.7	0.0	0.0	5.7	1.5	2708.9
40	0.265	0.0	0.0	5.7	0.0	0.0	5.7	1.5	2710.4
41	0.257	0.0	0.0	5.7	0.0	0.0	5.7	1.5	2711.9
42	0.250	0.0	0.0	5.7	0.0	0.0	5.7	1.4	2713.3
43	0.243	0.0	0.0	5.7	0.0	0.0	5.7	1.4	2714.6
44	0.236	0.0	0.0	5.7	0.0	0.0	5.7	1.3	2716.0
45	0.229	0.0	0.0	5.7	0.0	0.0	5.7	1.3	2717.3
46	0.222	0.0	0.0	5.7	0.0	0.0	5.7	1.3	2718.5
47	0.216	0.0	0.0	5.7	0.0	0.0	5.7	1.2	2719.7
48	0.209	0.0	0.0	5.7	0.0	0.0	5.7	1.2	2720.9
49	0.203	0.0	0.0	5.7	0.0	0.0	5.7	1.1	2722.1
50	0.197	0.0	0.0	5.7	0.0	0.0	5.7	1.1	2723.2
51	0.192	0.0	0.0	5.7	0.0	0.0	5.7	1.1	2724.3
52	0.186	0.0	0.0	5.7	0.0	0.0	5.7	1.1	2725.3
53	0.181	0.0	0.0	5.7	0.0	0.0	5.7	1.0	2726.3
54	0.175	0.0	0.0	5.7	0.0	0.0	5.7	1.0	2727.3
55	0.170	0.0	0.0	5.7	0.0	0.0	5.7	1.0	2728.3
56	0.165	0.0	0.0	5.7	0.0	0.0	5.7	0.9	2729.2
57	0.160	0.0	0.0	5.7	0.0	0.0	5.7	0.9	2730.1
58	0.156	0.0	0.0	5.7	0.0	0.0	5.7	0.9	2731.0
59	0.151	0.0	0.0	5.7	0.0	0.0	5.7	0.9	2731.9
60	0.147	0.0	0.0	5.7	0.0	0.0	5.7	0.8	2732.7
61	0.143	0.0	0.0	5.7	0.0	0.0	5.7	0.8	2733.5
62	0.138	0.0	0.0	5.7	0.0	0.0	5.7	0.8	2734.3
63	0.134	0.0	0.0	5.7	0.0	0.0	5.7	0.8	2735.1
64	0.130	0.0	0.0	5.7	0.0	0.0	5.7	0.7	2735.8
65	0.127	0.0	0.0	5.7	0.0	0.0	5.7	0.7	2736.5
66	0.123	0.0	0.0	5.7	0.0	0.0	5.7	0.7	2737.2
67	0.119	0.0	0.0	5.7	0.0	0.0	5.7	0.7	2737.9
68	0.116	0.0	0.0	5.7	0.0	0.0	5.7	0.7	2738.5
69	0.112	0.0	0.0	5.7	0.0	0.0	5.7	0.6	2739.2
70	0.109	0.0	0.0	5.7	0.0	0.0	5.7	0.6	2739.8
71	0.106	0.0	0.0	5.7	0.0	0.0	5.7	0.6	2740.4
72	0.103	0.0	0.0	5.7	0.0	0.0	5.7	0.6	2741.0
73	0.100	0.0	0.0	5.7	0.0	0.0	5.7	0.6	2741.5
74	0.097	0.0	0.0	5.7	0.0	0.0	5.7	0.5	2742.1
75	0.094	0.0	0.0	5.7	0.0	0.0	5.7	0.5	2742.6
76	0.092	0.0	0.0	5.7	0.0	0.0	5.7	0.5	2743.1
77	0.090	0.0	0.0	5.7	0.0	0.0	5.7	0.5	2743.7
78	0.087	0.0	0.0	5.7	0.0	0.0	5.7	0.5	2744.1
79	0.085	0.0	0.0	5.7	0.0	0.0	5.7	0.5	2744.6
80	0.083	0.0	0.0	5.7	0.0	0.0	5.7	0.5	2745.1
81	0.081	0.0	0.0	5.7	0.0	0.0	5.7	0.5	2745.6
82	0.079	0.0	0.0	5.7	0.0	0.0	5.7	0.4	2746.0
83	0.077	0.0	0.0	5.7	0.0	0.0	5.7	0.4	2746.4
84	0.075	0.0	0.0	5.7	0.0	0.0	5.7	0.4	2746.9
85	0.074	0.0	0.0	5.7	0.0	0.0	5.7	0.4	2747.3
86	0.072	0.0	0.0	5.7	0.0	0.0	5.7	0.4	2747.7
87	0.070	0.0	0.0	5.7	0.0	0.0	5.7	0.4	2748.1
88	0.068	0.0	0.0	5.7	0.0	0.0	5.7	0.4	2748.5
89	0.067	0.0	0.0	5.7	0.0	0.0	5.7	0.4	2748.9
90	0.065	0.0	0.0	5.7	0.0	0.0	5.7	0.4	2749.2

91	0.063	0.0	0.0	5.7	0.0	0.0	5.7	0.4	2749.6
92	0.062	0.0	0.0	5.7	0.0	0.0	5.7	0.4	2749.9
93	0.060	0.0	0.0	5.7	0.0	0.0	5.7	0.3	2750.3
94	0.059	0.0	0.0	5.7	0.0	0.0	5.7	0.3	2750.6
95	0.057	0.0	0.0	5.7	0.0	0.0	5.7	0.3	2750.9
96	0.056	0.0	0.0	5.7	0.0	0.0	5.7	0.3	2751.2
97	0.055	0.0	0.0	5.7	0.0	0.0	5.7	0.3	2751.6
98	0.053	0.0	0.0	5.7	0.0	0.0	5.7	0.3	2751.9
99	0.052	0.0	0.0	5.7	0.0	0.0	5.7	0.3	2752.2

Whole life cost charts





Summary of costs

Client/Authority		Prepared (date)	September 18
Scottish Borders Council		Printed	10/01/2019
Project/Option name		Prepared by	C. Kampanou
Eddleston Water - Option 7 (DD)		Checked by	S. Cooney
Project reference	2017s5526	Checked date	October 18
Base date for estimates (year 0)	Jan-2018		
Scaling factor (e.g. £m, £k, £)	£k		
Optimism bias adjustment factor	60%		

PV Cost Summary	Costs in £k
Enabling Costs	£260.52
Capital Costs	£2,869.53
O & M Costs	£554.34
Other Costs	£0.00
Total Real Cost	£3,684.382
Total Cost PV	£3,190.52
Total Cost PV + OB	**£5,104.83**

Note: Macros are required to open individual cost modules and the user should ensure they are enabled in the Excel Security Settings.

Note: Cost modules are opened from blank templates by clicking on the pentagons below. If a template exists, the user is sent the module. Only one module per worksheet is permitted.

Note: Costs are automatically summed from all individual cost module sheets every time the user returns to this summary sheet. This process takes into account the above scaling factor.

Note: If multiple measures are used, the optimism bias value used in each module is overridden by that selected above (Cell D10).

Additional user notes:

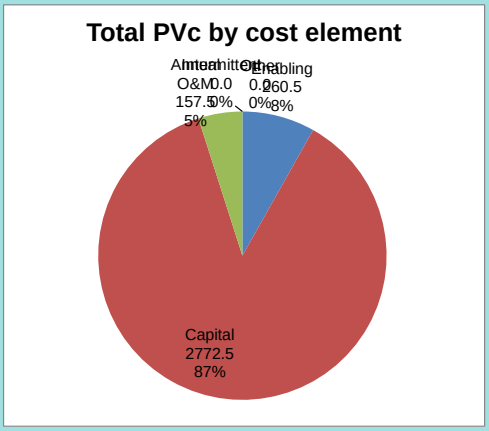
Add additional user notes here.

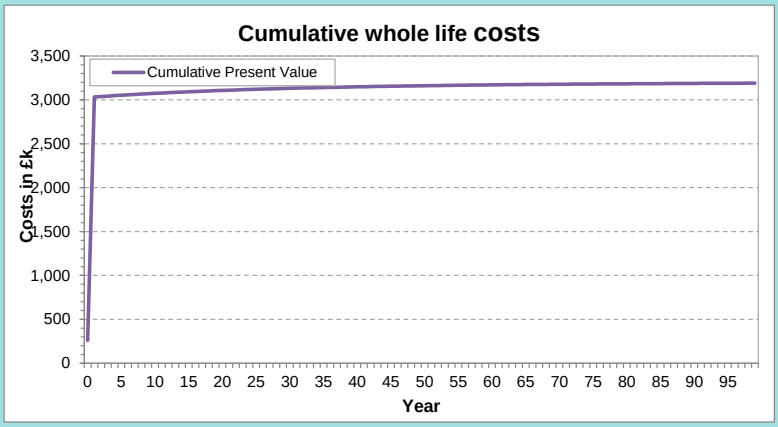
FRM Measure	Asset	Open / Go to Costing Sheet	Delete Sheet	Enabling Costs	Capital Costs	O & M Costs	Other Costs	Total Cost Cash	Total Cost PV
Fluvial raised defence	Embankment								
	Wall			£247.26	£2,747.34	£0.00	£0.00	£2,994.60	£2,901.69
	Sheet Piling								
Channel management	N/A								
Culvert & screen	N/A								
Control assets	Weir								
	Pumping station								
	Flood gate			£13.26	£66.28	£554.34	£0.00	£633.88	£234.81
	Outfall								
	Flow barrier								
Coastal protection	Wall								
	Revetment								
	Groyne								
	Recharge								
Flood storage	N/A								
Flood warning and forecasting	Various								
Temporary & demountable barriers	Various								
Household resistance	Various								
Household resilience	Various								
SUDS and urban drainage	Various								
Managed realignment	Various								
Habitat creation	Various								
Landuse & runoff management	Various								
River Restoration	Various								
User Defined 1	Various			£0.00	£55.91	£0.00	£0.00	£55.91	£54.02
User Defined 2	Various								
User Defined 3	Various								

Whole Life and Present Value Cost Analysis		PV factor	29.813				Total PVc (£k):	3190.5	
		Enabling £k	Capital £k	Annual O&M £k	Intermittent O&M £k	Other £k	TOTALS: Current price	PV (£k)	
	Total real cost	260.5	2869.5	554.3	0.0	0.0	3684.38	3190.5	
	Total PV cost	260.5	2772.5	157.5	0.0	0.0		3190.5	Cumulative
year	Discount Factor								PV Costs (£k)
0	1.000	260.5	0.0	0.0	0.0	0.0	260.5	260.5	260.5
1	0.966	0.0	2869.5	0.0	0.0	0.0	2869.5	2772.5	3033.0
2	0.934	0.0	0.0	5.7	0.0	0.0	5.7	5.3	3038.3
3	0.902	0.0	0.0	5.7	0.0	0.0	5.7	5.1	3043.4
4	0.871	0.0	0.0	5.7	0.0	0.0	5.7	4.9	3048.3
5	0.842	0.0	0.0	5.7	0.0	0.0	5.7	4.8	3053.1
6	0.814	0.0	0.0	5.7	0.0	0.0	5.7	4.6	3057.7
7	0.786	0.0	0.0	5.7	0.0	0.0	5.7	4.4	3062.1
8	0.759	0.0	0.0	5.7	0.0	0.0	5.7	4.3	3066.4
9	0.734	0.0	0.0	5.7	0.0	0.0	5.7	4.2	3070.6
10	0.709	0.0	0.0	5.7	0.0	0.0	5.7	4.0	3074.6
11	0.685	0.0	0.0	5.7	0.0	0.0	5.7	3.9	3078.5
12	0.662	0.0	0.0	5.7	0.0	0.0	5.7	3.7	3082.2
13	0.639	0.0	0.0	5.7	0.0	0.0	5.7	3.6	3085.8
14	0.618	0.0	0.0	5.7	0.0	0.0	5.7	3.5	3089.3
15	0.597	0.0	0.0	5.7	0.0	0.0	5.7	3.4	3092.7
16	0.577	0.0	0.0	5.7	0.0	0.0	5.7	3.3	3096.0
17	0.557	0.0	0.0	5.7	0.0	0.0	5.7	3.2	3099.1
18	0.538	0.0	0.0	5.7	0.0	0.0	5.7	3.0	3102.1
19	0.520	0.0	0.0	5.7	0.0	0.0	5.7	2.9	3105.1
20	0.503	0.0	0.0	5.7	0.0	0.0	5.7	2.8	3107.9
21	0.486	0.0	0.0	5.7	0.0	0.0	5.7	2.7	3110.7
22	0.469	0.0	0.0	5.7	0.0	0.0	5.7	2.7	3113.3
23	0.453	0.0	0.0	5.7	0.0	0.0	5.7	2.6	3115.9
24	0.438	0.0	0.0	5.7	0.0	0.0	5.7	2.5	3118.4
25	0.423	0.0	0.0	5.7	0.0	0.0	5.7	2.4	3120.8
26	0.409	0.0	0.0	5.7	0.0	0.0	5.7	2.3	3123.1
27	0.395	0.0	0.0	5.7	0.0	0.0	5.7	2.2	3125.3
28	0.382	0.0	0.0	5.7	0.0	0.0	5.7	2.2	3127.5
29	0.369	0.0	0.0	5.7	0.0	0.0	5.7	2.1	3129.6
30	0.356	0.0	0.0	5.7	0.0	0.0	5.7	2.0	3131.6
31	0.346	0.0	0.0	5.7	0.0	0.0	5.7	2.0	3133.5
32	0.336	0.0	0.0	5.7	0.0	0.0	5.7	1.9	3135.4
33	0.326	0.0	0.0	5.7	0.0	0.0	5.7	1.8	3137.3
34	0.317	0.0	0.0	5.7	0.0	0.0	5.7	1.8	3139.1
35	0.307	0.0	0.0	5.7	0.0	0.0	5.7	1.7	3140.8
36	0.298	0.0	0.0	5.7	0.0	0.0	5.7	1.7	3142.5
37	0.290	0.0	0.0	5.7	0.0	0.0	5.7	1.6	3144.1
38	0.281	0.0	0.0	5.7	0.0	0.0	5.7	1.6	3145.7
39	0.273	0.0	0.0	5.7	0.0	0.0	5.7	1.5	3147.3
40	0.265	0.0	0.0	5.7	0.0	0.0	5.7	1.5	3148.8
41	0.257	0.0	0.0	5.7	0.0	0.0	5.7	1.5	3150.2
42	0.250	0.0	0.0	5.7	0.0	0.0	5.7	1.4	3151.6
43	0.243	0.0	0.0	5.7	0.0	0.0	5.7	1.4	3153.0
44	0.236	0.0	0.0	5.7	0.0	0.0	5.7	1.3	3154.3
45	0.229	0.0	0.0	5.7	0.0	0.0	5.7	1.3	3155.6
46	0.222	0.0	0.0	5.7	0.0	0.0	5.7	1.3	3156.9
47	0.216	0.0	0.0	5.7	0.0	0.0	5.7	1.2	3158.1
48	0.209	0.0	0.0	5.7	0.0	0.0	5.7	1.2	3159.3
49	0.203	0.0	0.0	5.7	0.0	0.0	5.7	1.1	3160.4
50	0.197	0.0	0.0	5.7	0.0	0.0	5.7	1.1	3161.6
51	0.192	0.0	0.0	5.7	0.0	0.0	5.7	1.1	3162.6
52	0.186	0.0	0.0	5.7	0.0	0.0	5.7	1.1	3163.7
53	0.181	0.0	0.0	5.7	0.0	0.0	5.7	1.0	3164.7
54	0.175	0.0	0.0	5.7	0.0	0.0	5.7	1.0	3165.7
55	0.170	0.0	0.0	5.7	0.0	0.0	5.7	1.0	3166.7
56	0.165	0.0	0.0	5.7	0.0	0.0	5.7	0.9	3167.6
57	0.160	0.0	0.0	5.7	0.0	0.0	5.7	0.9	3168.5
58	0.156	0.0	0.0	5.7	0.0	0.0	5.7	0.9	3169.4
59	0.151	0.0	0.0	5.7	0.0	0.0	5.7	0.9	3170.2
60	0.147	0.0	0.0	5.7	0.0	0.0	5.7	0.8	3171.1
61	0.143	0.0	0.0	5.7	0.0	0.0	5.7	0.8	3171.9
62	0.138	0.0	0.0	5.7	0.0	0.0	5.7	0.8	3172.7
63	0.134	0.0	0.0	5.7	0.0	0.0	5.7	0.8	3173.4
64	0.130	0.0	0.0	5.7	0.0	0.0	5.7	0.7	3174.2
65	0.127	0.0	0.0	5.7	0.0	0.0	5.7	0.7	3174.9
66	0.123	0.0	0.0	5.7	0.0	0.0	5.7	0.7	3175.6
67	0.119	0.0	0.0	5.7	0.0	0.0	5.7	0.7	3176.2
68	0.116	0.0	0.0	5.7	0.0	0.0	5.7	0.7	3176.9
69	0.112	0.0	0.0	5.7	0.0	0.0	5.7	0.6	3177.5
70	0.109	0.0	0.0	5.7	0.0	0.0	5.7	0.6	3178.2
71	0.106	0.0	0.0	5.7	0.0	0.0	5.7	0.6	3178.8
72	0.103	0.0	0.0	5.7	0.0	0.0	5.7	0.6	3179.3
73	0.100	0.0	0.0	5.7	0.0	0.0	5.7	0.6	3179.9
74	0.097	0.0	0.0	5.7	0.0	0.0	5.7	0.5	3180.5
75	0.094	0.0	0.0	5.7	0.0	0.0	5.7	0.5	3181.0
76	0.092	0.0	0.0	5.7	0.0	0.0	5.7	0.5	3181.5
77	0.090	0.0	0.0	5.7	0.0	0.0	5.7	0.5	3182.0
78	0.087	0.0	0.0	5.7	0.0	0.0	5.7	0.5	3182.5
79	0.085	0.0	0.0	5.7	0.0	0.0	5.7	0.5	3183.0
80	0.083	0.0	0.0	5.7	0.0	0.0	5.7	0.5	3183.5
81	0.081	0.0	0.0	5.7	0.0	0.0	5.7	0.5	3183.9
82	0.079	0.0	0.0	5.7	0.0	0.0	5.7	0.4	3184.4
83	0.077	0.0	0.0	5.7	0.0	0.0	5.7	0.4	3184.8
84	0.075	0.0	0.0	5.7	0.0	0.0	5.7	0.4	3185.2
85	0.074	0.0	0.0	5.7	0.0	0.0	5.7	0.4	3185.7
86	0.072	0.0	0.0	5.7	0.0	0.0	5.7	0.4	3186.1
87	0.070	0.0	0.0	5.7	0.0	0.0	5.7	0.4	3186.5
88	0.068	0.0	0.0	5.7	0.0	0.0	5.7	0.4	3186.8
89	0.067	0.0	0.0	5.7	0.0	0.0	5.7	0.4	3187.2
90	0.065	0.0	0.0	5.7	0.0	0.0	5.7	0.4	3187.6

91	0.063	0.0	0.0	5.7	0.0	0.0	5.7	0.4	3187.9
92	0.062	0.0	0.0	5.7	0.0	0.0	5.7	0.4	3188.3
93	0.060	0.0	0.0	5.7	0.0	0.0	5.7	0.3	3188.6
94	0.059	0.0	0.0	5.7	0.0	0.0	5.7	0.3	3189.0
95	0.057	0.0	0.0	5.7	0.0	0.0	5.7	0.3	3189.3
96	0.056	0.0	0.0	5.7	0.0	0.0	5.7	0.3	3189.6
97	0.055	0.0	0.0	5.7	0.0	0.0	5.7	0.3	3189.9
98	0.053	0.0	0.0	5.7	0.0	0.0	5.7	0.3	3190.2
99	0.052	0.0	0.0	5.7	0.0	0.0	5.7	0.3	3190.5

Whole life cost charts





Summary of costs

Client/Authority		Prepared (date)	September 18	
Scottish Borders Council		Printed	10/01/2019	
Project/Option name		Prepared by	C. Kampanou	
Eddleston Water - Option 10 (DD, weir and bridge)		Checked by	S. Cooney	
Project reference	2017s5526	Checked date	October 18	
Base date for estimates (year 0)	Jan-2018			
Scaling factor (e.g. £m, £k, £)	£k			
Optimism bias adjustment factor	60%			

PV Cost Summary	Costs in £k
Enabling Costs	£371.92
Capital Costs	£3,551.97
O & M Costs	£554.34
Other Costs	£0.00
Total Real Cost	£4,478.23
Total Cost PV	£3,961.29
Total Cost PV + OB	**£6,338.07**

Note: Macros are required to open individual cost modules and the user should ensure they are enabled in the Excel Security Settings.

Note: Cost modules are opened from blank templates by clicking on the pentagons below. If a template exists, the user is sent the module. Only one module per worksheet is permitted.

Note: Costs are automatically summed from all individual cost module sheets every time the user returns to this summary sheet. This process takes into account the above scaling factor.

Note: If multiple measures are used, the optimism bias value used in each module is overridden by that selected above (Cell D10).

Additional user notes:

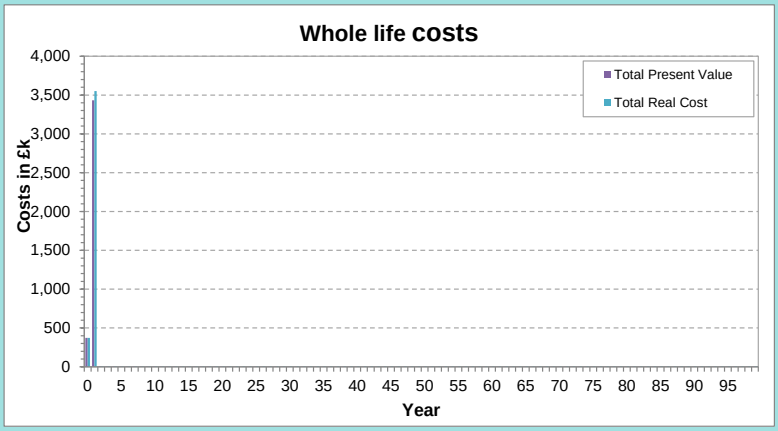
Add additional user notes here.

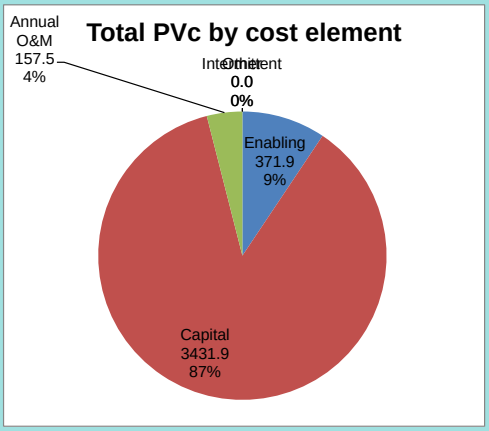
FRM Measure	Asset	Open / Go to Costing Sheet	Delete Sheet	Enabling Costs	Capital Costs	O & M Costs	Other Costs	Total Cost Cash	Total Cost PV
Fluvial raised defence	Embankment								
	Wall			£265.33	£2,948.06	£0.00	£0.00	£3,213.39	£3,113.69
	Sheet Piling								
Channel management	N/A								
Culvert & screen	N/A								
Control assets	Weir								
	Pumping station								
	Flood gate			£19.49	£97.43	£554.34	£0.00	£671.25	£271.13
	Outfall								
	Flow barrier								
Coastal protection	Wall								
	Revetment								
	Groyne								
	Recharge								
Flood storage	N/A								
Flood warning and forecasting	Various								
Temporary & demountable barriers	Various								
Household resistance	Various								
Household resilience	Various								
SUDS and urban drainage	Various								
Managed realignment	Various								
Habitat creation	Various								
Landuse & runoff management	Various								
River Restoration	Various								
User Defined 1	Various			£85.84	£429.18	£0.00	£0.00	£515.02	£500.50
User Defined 2	Various			£1.27	£12.74	£0.00	£0.00	£14.01	£13.58
User Defined 3	Various			£0.00	£64.56	£0.00	£0.00	£64.56	£62.38

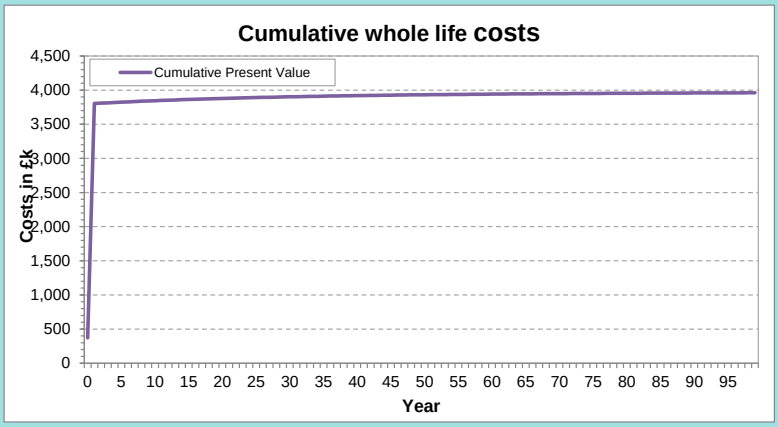
Whole Life and Present Value Cost Analysis		PV factor	29.813				Total PVc (£k):	3961.3	
		Enabling £k	Capital £k	Annual O&M £k	Intermittent O&M £k	Other £k	TOTALS: Current price	PV (£k)	
	Total real cost	371.9	3552.0	554.3	0.0	0.0	4478.23	3961.3	
	Total PV cost	371.9	3431.9	157.5	0.0	0.0		3961.3	Cumulative
year	Discount Factor								PV Costs (£k)
0	1.000	371.9	0.0	0.0	0.0	0.0	371.9	371.9	371.9
1	0.966	0.0	3552.0	0.0	0.0	0.0	3552.0	3431.9	3803.8
2	0.934	0.0	0.0	5.7	0.0	0.0	5.7	5.3	3809.1
3	0.902	0.0	0.0	5.7	0.0	0.0	5.7	5.1	3814.2
4	0.871	0.0	0.0	5.7	0.0	0.0	5.7	4.9	3819.1
5	0.842	0.0	0.0	5.7	0.0	0.0	5.7	4.8	3823.9
6	0.814	0.0	0.0	5.7	0.0	0.0	5.7	4.6	3828.5
7	0.786	0.0	0.0	5.7	0.0	0.0	5.7	4.4	3832.9
8	0.759	0.0	0.0	5.7	0.0	0.0	5.7	4.3	3837.2
9	0.734	0.0	0.0	5.7	0.0	0.0	5.7	4.2	3841.3
10	0.709	0.0	0.0	5.7	0.0	0.0	5.7	4.0	3845.4
11	0.685	0.0	0.0	5.7	0.0	0.0	5.7	3.9	3849.2
12	0.662	0.0	0.0	5.7	0.0	0.0	5.7	3.7	3853.0
13	0.639	0.0	0.0	5.7	0.0	0.0	5.7	3.6	3856.6
14	0.618	0.0	0.0	5.7	0.0	0.0	5.7	3.5	3860.1
15	0.597	0.0	0.0	5.7	0.0	0.0	5.7	3.4	3863.5
16	0.577	0.0	0.0	5.7	0.0	0.0	5.7	3.3	3866.7
17	0.557	0.0	0.0	5.7	0.0	0.0	5.7	3.2	3869.9
18	0.538	0.0	0.0	5.7	0.0	0.0	5.7	3.0	3872.9
19	0.520	0.0	0.0	5.7	0.0	0.0	5.7	2.9	3875.9
20	0.503	0.0	0.0	5.7	0.0	0.0	5.7	2.8	3878.7
21	0.486	0.0	0.0	5.7	0.0	0.0	5.7	2.7	3881.5
22	0.469	0.0	0.0	5.7	0.0	0.0	5.7	2.7	3884.1
23	0.453	0.0	0.0	5.7	0.0	0.0	5.7	2.6	3886.7
24	0.438	0.0	0.0	5.7	0.0	0.0	5.7	2.5	3889.1
25	0.423	0.0	0.0	5.7	0.0	0.0	5.7	2.4	3891.5
26	0.409	0.0	0.0	5.7	0.0	0.0	5.7	2.3	3893.9
27	0.395	0.0	0.0	5.7	0.0	0.0	5.7	2.2	3896.1
28	0.382	0.0	0.0	5.7	0.0	0.0	5.7	2.2	3898.2
29	0.369	0.0	0.0	5.7	0.0	0.0	5.7	2.1	3900.3
30	0.356	0.0	0.0	5.7	0.0	0.0	5.7	2.0	3902.3
31	0.346	0.0	0.0	5.7	0.0	0.0	5.7	2.0	3904.3
32	0.336	0.0	0.0	5.7	0.0	0.0	5.7	1.9	3906.2
33	0.326	0.0	0.0	5.7	0.0	0.0	5.7	1.8	3908.0
34	0.317	0.0	0.0	5.7	0.0	0.0	5.7	1.8	3909.8
35	0.307	0.0	0.0	5.7	0.0	0.0	5.7	1.7	3911.6
36	0.298	0.0	0.0	5.7	0.0	0.0	5.7	1.7	3913.3
37	0.290	0.0	0.0	5.7	0.0	0.0	5.7	1.6	3914.9
38	0.281	0.0	0.0	5.7	0.0	0.0	5.7	1.6	3916.5
39	0.273	0.0	0.0	5.7	0.0	0.0	5.7	1.5	3918.0
40	0.265	0.0	0.0	5.7	0.0	0.0	5.7	1.5	3919.5
41	0.257	0.0	0.0	5.7	0.0	0.0	5.7	1.5	3921.0
42	0.250	0.0	0.0	5.7	0.0	0.0	5.7	1.4	3922.4
43	0.243	0.0	0.0	5.7	0.0	0.0	5.7	1.4	3923.8
44	0.236	0.0	0.0	5.7	0.0	0.0	5.7	1.3	3925.1
45	0.229	0.0	0.0	5.7	0.0	0.0	5.7	1.3	3926.4
46	0.222	0.0	0.0	5.7	0.0	0.0	5.7	1.3	3927.7
47	0.216	0.0	0.0	5.7	0.0	0.0	5.7	1.2	3928.9
48	0.209	0.0	0.0	5.7	0.0	0.0	5.7	1.2	3930.1
49	0.203	0.0	0.0	5.7	0.0	0.0	5.7	1.1	3931.2
50	0.197	0.0	0.0	5.7	0.0	0.0	5.7	1.1	3932.3
51	0.192	0.0	0.0	5.7	0.0	0.0	5.7	1.1	3933.4
52	0.186	0.0	0.0	5.7	0.0	0.0	5.7	1.1	3934.5
53	0.181	0.0	0.0	5.7	0.0	0.0	5.7	1.0	3935.5
54	0.175	0.0	0.0	5.7	0.0	0.0	5.7	1.0	3936.5
55	0.170	0.0	0.0	5.7	0.0	0.0	5.7	1.0	3937.4
56	0.165	0.0	0.0	5.7	0.0	0.0	5.7	0.9	3938.4
57	0.160	0.0	0.0	5.7	0.0	0.0	5.7	0.9	3939.3
58	0.156	0.0	0.0	5.7	0.0	0.0	5.7	0.9	3940.2
59	0.151	0.0	0.0	5.7	0.0	0.0	5.7	0.9	3941.0
60	0.147	0.0	0.0	5.7	0.0	0.0	5.7	0.8	3941.8
61	0.143	0.0	0.0	5.7	0.0	0.0	5.7	0.8	3942.7
62	0.138	0.0	0.0	5.7	0.0	0.0	5.7	0.8	3943.4
63	0.134	0.0	0.0	5.7	0.0	0.0	5.7	0.8	3944.2
64	0.130	0.0	0.0	5.7	0.0	0.0	5.7	0.7	3944.9
65	0.127	0.0	0.0	5.7	0.0	0.0	5.7	0.7	3945.7
66	0.123	0.0	0.0	5.7	0.0	0.0	5.7	0.7	3946.3
67	0.119	0.0	0.0	5.7	0.0	0.0	5.7	0.7	3947.0
68	0.116	0.0	0.0	5.7	0.0	0.0	5.7	0.7	3947.7
69	0.112	0.0	0.0	5.7	0.0	0.0	5.7	0.6	3948.3
70	0.109	0.0	0.0	5.7	0.0	0.0	5.7	0.6	3948.9
71	0.106	0.0	0.0	5.7	0.0	0.0	5.7	0.6	3949.5
72	0.103	0.0	0.0	5.7	0.0	0.0	5.7	0.6	3950.1
73	0.100	0.0	0.0	5.7	0.0	0.0	5.7	0.6	3950.7
74	0.097	0.0	0.0	5.7	0.0	0.0	5.7	0.5	3951.2
75	0.094	0.0	0.0	5.7	0.0	0.0	5.7	0.5	3951.8
76	0.092	0.0	0.0	5.7	0.0	0.0	5.7	0.5	3952.3
77	0.090	0.0	0.0	5.7	0.0	0.0	5.7	0.5	3952.8
78	0.087	0.0	0.0	5.7	0.0	0.0	5.7	0.5	3953.3
79	0.085	0.0	0.0	5.7	0.0	0.0	5.7	0.5	3953.8
80	0.083	0.0	0.0	5.7	0.0	0.0	5.7	0.5	3954.2
81	0.081	0.0	0.0	5.7	0.0	0.0	5.7	0.5	3954.7
82	0.079	0.0	0.0	5.7	0.0	0.0	5.7	0.4	3955.1
83	0.077	0.0	0.0	5.7	0.0	0.0	5.7	0.4	3955.6
84	0.075	0.0	0.0	5.7	0.0	0.0	5.7	0.4	3956.0
85	0.074	0.0	0.0	5.7	0.0	0.0	5.7	0.4	3956.4
86	0.072	0.0	0.0	5.7	0.0	0.0	5.7	0.4	3956.8
87	0.070	0.0	0.0	5.7	0.0	0.0	5.7	0.4	3957.2
88	0.068	0.0	0.0	5.7	0.0	0.0	5.7	0.4	3957.6
89	0.067	0.0	0.0	5.7	0.0	0.0	5.7	0.4	3958.0
90	0.065	0.0	0.0	5.7	0.0	0.0	5.7	0.4	3958.4

91	0.063	0.0	0.0	5.7	0.0	0.0	5.7	0.4	3958.7
92	0.062	0.0	0.0	5.7	0.0	0.0	5.7	0.4	3959.1
93	0.060	0.0	0.0	5.7	0.0	0.0	5.7	0.3	3959.4
94	0.059	0.0	0.0	5.7	0.0	0.0	5.7	0.3	3959.7
95	0.057	0.0	0.0	5.7	0.0	0.0	5.7	0.3	3960.1
96	0.056	0.0	0.0	5.7	0.0	0.0	5.7	0.3	3960.4
97	0.055	0.0	0.0	5.7	0.0	0.0	5.7	0.3	3960.7
98	0.053	0.0	0.0	5.7	0.0	0.0	5.7	0.3	3961.0
99	0.052	0.0	0.0	5.7	0.0	0.0	5.7	0.3	3961.3

Whole life cost charts







Whole life cost and PVc analysis example - with replacement costs

Enter enabling, capital, annual O&M and other costs in table below
Enter frequency of other (or replacement) works in table below

Enabling cost (£k)	£86.4
Year of capital works (year)	1
Capital cost (£k)	£412.3
Annual maintenance cost (£k)	£8.2
Other cost (£k)	£0.0
Other works frequency (years)	1
Other cost (£k)	£0.0
Other works frequency (years)	1
Replacement (£)	412.346
Replacement frequency (years)	20
Optimism Bias	60%

Key	
	Information
	Calculation
	Cost input
	Default

Total PVc (£k) with Optimism Bias: 1781

Initial discount rate 3.5% 29.813 **Total PVc (£k): 1113**

		Cost Elements				PV			TOTALS:	
		Enabling	Capital	Maint.	Interm.	Enabling	Capital	Maint.	Cash	PV
	Cash sum	86	2062	808	0	86	797	230	2956	1113
year	Discount Factor									
0	1.000	86.4			0	86.432			86.4	86.4
1	0.966		412		0		398.4019		412.3	398.4
2	0.934			8	0			7.698588	8.2	7.7
3	0.902			8	0			7.438249	8.2	7.4
4	0.871			8	0			7.186714	8.2	7.2
5	0.842			8	0			6.943685	8.2	6.9
6	0.814			8	0			6.708875	8.2	6.7
7	0.786			8	0			6.482005	8.2	6.5
8	0.759			8	0			6.262806	8.2	6.3
9	0.734			8	0			6.051021	8.2	6.1
10	0.709			8	0			5.846397	8.2	5.8
11	0.685			8	0			5.648693	8.2	5.6
12	0.662			8	0			5.457674	8.2	5.5
13	0.639			8	0			5.273115	8.2	5.3
14	0.618			8	0			5.094797	8.2	5.1
15	0.597			8	0			4.922509	8.2	4.9
16	0.577			8	0			4.756048	8.2	4.8
17	0.557			8	0			4.595215	8.2	4.6
18	0.538			8	0			4.439821	8.2	4.4
19	0.520			8	0			4.289682	8.2	4.3
20	0.503			8	0			4.144621	8.2	4.1
21	0.486		412	8	0		200.2232	4.004464	420.6	204.2
22	0.469			8	0			3.869048	8.2	3.9
23	0.453			8	0			3.73821	8.2	3.7
24	0.438			8	0			3.611797	8.2	3.6
25	0.423			8	0			3.489659	8.2	3.5
26	0.409			8	0			3.371652	8.2	3.4
27	0.395			8	0			3.257634	8.2	3.3
28	0.382			8	0			3.147473	8.2	3.1
29	0.369			8	0			3.041037	8.2	3.0
30	0.356			8	0			2.9382	8.2	2.9
31	0.346			8	0			2.852621	8.2	2.9
32	0.336			8	0			2.769535	8.2	2.8
33	0.326			8	0			2.688869	8.2	2.7
34	0.317			8	0			2.610552	8.2	2.6
35	0.307			8	0			2.534517	8.2	2.5
36	0.298			8	0			2.460696	8.2	2.5
37	0.290			8	0			2.389025	8.2	2.4
38	0.281			8	0			2.319442	8.2	2.3
39	0.273			8	0			2.251885	8.2	2.3
40	0.265			8	0			2.186296	8.2	2.2
41	0.257		412	8	0		106.1309	2.122618	420.6	108.3
42	0.250			8	0			2.060794	8.2	2.1
43	0.243			8	0			2.000771	8.2	2.0

44	0.236			8	0		1.942496	8.2	1.9
45	0.229			8	0		1.885918	8.2	1.9
46	0.222			8	0		1.830989	8.2	1.8
47	0.216			8	0		1.777659	8.2	1.8
48	0.209			8	0		1.725883	8.2	1.7
49	0.203			8	0		1.675614	8.2	1.7
50	0.197			8	0		1.62681	8.2	1.6
51	0.192			8	0		1.579427	8.2	1.6
52	0.186			8	0		1.533424	8.2	1.5
53	0.181			8	0		1.488761	8.2	1.5
54	0.175			8	0		1.445399	8.2	1.4
55	0.170			8	0		1.4033	8.2	1.4
56	0.165			8	0		1.362428	8.2	1.4
57	0.160			8	0		1.322745	8.2	1.3
58	0.156			8	0		1.284219	8.2	1.3
59	0.151			8	0		1.246814	8.2	1.2
60	0.147			8	0		1.210499	8.2	1.2
61	0.143		412	8	0	58.7621	1.175242	420.6	59.9
62	0.138			8	0		1.141012	8.2	1.1
63	0.134			8	0		1.107778	8.2	1.1
64	0.130			8	0		1.075513	8.2	1.1
65	0.127			8	0		1.044187	8.2	1.0
66	0.123			8	0		1.013774	8.2	1.0
67	0.119			8	0		0.984247	8.2	1.0
68	0.116			8	0		0.955579	8.2	1.0
69	0.112			8	0		0.927747	8.2	0.9
70	0.109			8	0		0.900725	8.2	0.9
71	0.106			8	0		0.87449	8.2	0.9
72	0.103			8	0		0.84902	8.2	0.8
73	0.100			8	0		0.824291	8.2	0.8
74	0.097			8	0		0.800283	8.2	0.8
75	0.094			8	0		0.776973	8.2	0.8
76	0.092			8	0		0.758023	8.2	0.8
77	0.090			8	0		0.739535	8.2	0.7
78	0.087			8	0		0.721497	8.2	0.7
79	0.085			8	0		0.7039	8.2	0.7
80	0.083			8	0		0.686731	8.2	0.7
81	0.081		412	8	0	33.49909	0.669982	420.6	34.2
82	0.079			8	0		0.653641	8.2	0.7
83	0.077			8	0		0.637698	8.2	0.6
84	0.075			8	0		0.622145	8.2	0.6
85	0.074			8	0		0.60697	8.2	0.6
86	0.072			8	0		0.592166	8.2	0.6
87	0.070			8	0		0.577723	8.2	0.6
88	0.068			8	0		0.563632	8.2	0.6
89	0.067			8	0		0.549885	8.2	0.5
90	0.065			8	0		0.536473	8.2	0.5
91	0.063			8	0		0.523389	8.2	0.5
92	0.062			8	0		0.510623	8.2	0.5
93	0.060			8	0		0.498169	8.2	0.5
94	0.059			8	0		0.486018	8.2	0.5
95	0.057			8	0		0.474164	8.2	0.5
96	0.056			8	0		0.462599	8.2	0.5
97	0.055			8	0		0.451316	8.2	0.5
98	0.053			8	0		0.440309	8.2	0.4
99	0.052			8	0		0.429569	8.2	0.4

C Appendix C - Public Consultation Questionnaire

Peebles Flood Questionnaire Report

Purpose

In order to gain an insight into the reaction of the public to proposed flood protection schemes, a questionnaire was available to be filled in at the Peebles Flood Study Exhibition on 6th November 2018. Local knowledge and feedback is key to influencing decisions on flood protection schemes and out of 56 people who attended the exhibition, 17 questionnaire responses were received (30%).

Questionnaire Format

The anonymous questionnaires that were available to the local public of Peebles consisted of 10 questions which could be circled 'yes' or 'no' and also included a comments box to elaborate on each answer. This simple layout allowed the questionnaires to be filled in quickly while still giving the option to voice opinions and feedback in greater detail. Below are all the questions which were on the questionnaire sheet:

1. Please name the watercourse(s) which impacts upon you?
2. Have you previously experiences flooding?
3. Do you want to see a flood protection scheme in the site of interest?
4. Do you approve of the approach that we are taking in developing a Flood Protection Scheme in your community?
5. Are there any flood related issues that you feel that we have missed?
6. Do you use the river for recreational purposes?
7. Do you have any concerns about how the flood mitigation options proposed may affect recreation activities at the river?
8. Currently are there any access issues to the existing river infrastructure, including issues which effect individuals with a disability?
9. Are you particularly concerned with any of the proposed options?
10. Do you have any other issues that you would like to raise?

Questionnaire Analysis

****Council responses within red*

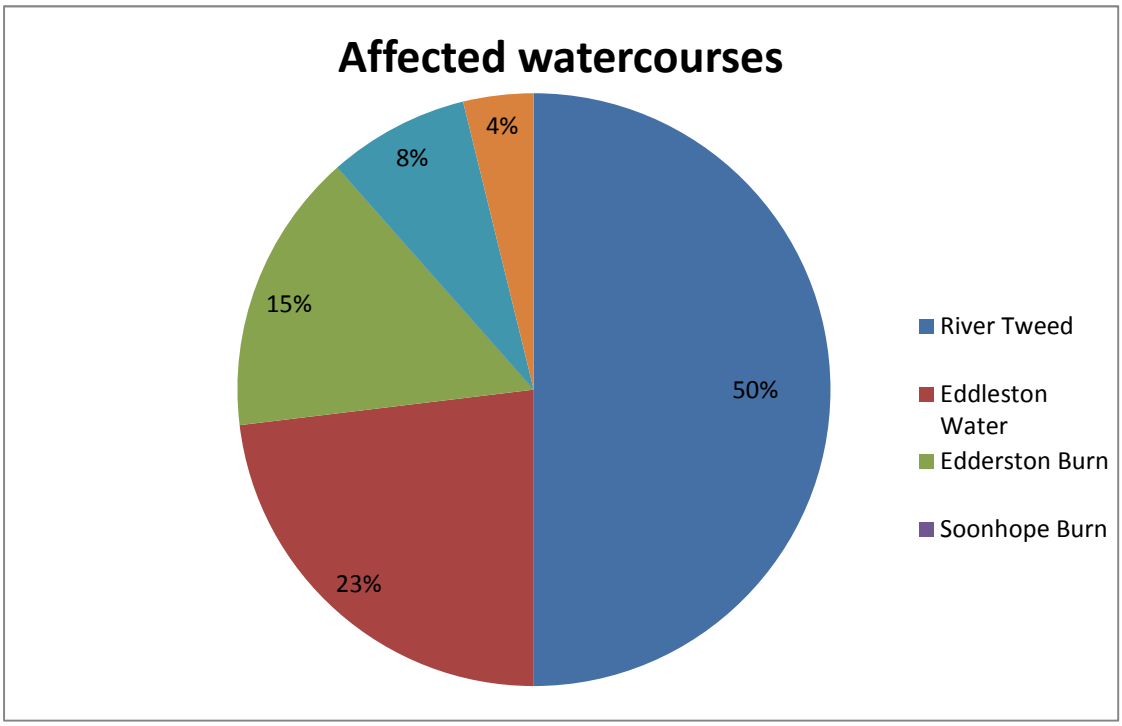
Question 1

Please circle the watercourse/s which impact upon you?

In Peebles there are five main water courses which are of concern and may impact upon different people depending on where they live in the town. The watercourses that were available to circle on the questionnaire were **the River Tweed, Eddleston Water, Edderston Burn, Soonhope Burn and Haystoun Burn**. There was also an 'N/A' option to circle if you were not affected by any of these or would rather not say. Some residents who may have been affected by a few different watercourses circled multiple answers which are reflected in the table below.

Affected watercourse	Number of people affected
River Tweed	13
Eddleston Water	6
Edderston Burn	4
Soonhope Burn	0
Haystoun Burn	2
N/A or unspecified	1

As shown from the data collected, the members of the public who took part in the questionnaire were mostly affected by the River Tweed & Eddleston Water watercourses.



Question 2

Have you previously experienced flooding?

Out of the 17 participants, 11 answered yes to this question and the remaining 6 answered 'No'. Of those who answered 'Yes' there were a variety of comments, mostly explaining what date they experienced the flooding. The majority of comments related to the devastating floods of December 2015, one resident noted "major impact" describing the effect of the flooding in their home in Peebles. A few participants noted that they were evacuated and some had witnessed flooding but not in their homes.

Question 3

Do you want to see a flood protection scheme in the site of interest?

15 people answered yes to this question, indicating that there is a strong desire to have a flood protection scheme in Peebles. 1 person answered no but stated "I realise it is required". The 1 participant who did not circle an answer stated that they were "undecided". Most made comments regarding wanting a protection scheme in order to protect their homes after previously being flooded, examples of which are below;

- *"The exhibition suggested that a proposed scheme was very cost effective. Flooding is devastating for those involved. We all pay a price (e.g. through insurance)".*
- *"To prevent further flooding of our residence."*
- *"Most definitely. Need to reduce risk of this happening again."*
- *"To prevent flooding of properties."*
- *I don't want our house/street to be flooded again - we were affected for 2 years afterward.*

One participant expressed their opinion on what type of scheme they would like making it clear that they would not like a wall to be built and that they would like Natural flood Management (NFM) to be used instead.

- *"It depends, Natural flood management yes, walls etc. no."*

Question 4

Do you approve of the approach that we are taking in developing a Flood Protection Scheme in your community?

14 out of the 17 Participants answered yes to this question and 3 left it unanswered but provided additional details which support why they chose not to answer. Those who answered yes supported their answers with positive comments welcoming the approach that is being taken towards the development of a flood scheme:

- *"Great consultation information and friendly staff to explain info at the event."*
- *"Tweed Green, Tweed Avenue and Walkershaugh were badly affected by the flood in 2015 and the scheme is very much addressing this."*
- *"To protect my home. Any flood reduction would be appreciated. Older folk find it hard to use normal property protection measures. Not everyone can afford them."*
- *"Seems to be very comprehensive."*

The participants who left the question unanswered were concerned about the visual effect of the proposed flood schemes and some believed the flooding is caused by poor land management:

- *"Too much emphasis on structural 'solutions' in town, the main problem is the catchments are terribly managed by landowners / farmers. Tax payers are basically subsiding poor land management. We are paying to create more floods."*
  - *A long list of solutions was drawn up and non-feasible options were withdrawn from the process, allowing us to create a short list of options, with a preferred option. In this instance, there is no feasible alternative to structural solutions within Peebles but we will look at areas where NFM measures can be incorporated. With regards to land management upstream, policy changes etc. would be required out with the remit of flood risk management.*
- *"Partially. I think the council is listening more than before. I still think [there is] too much emphasis on hard solutions and not enough on soft (NFM)."*
  - *Answer as above.*

Question 5

Are there any flood related issues that you feel we have missed?

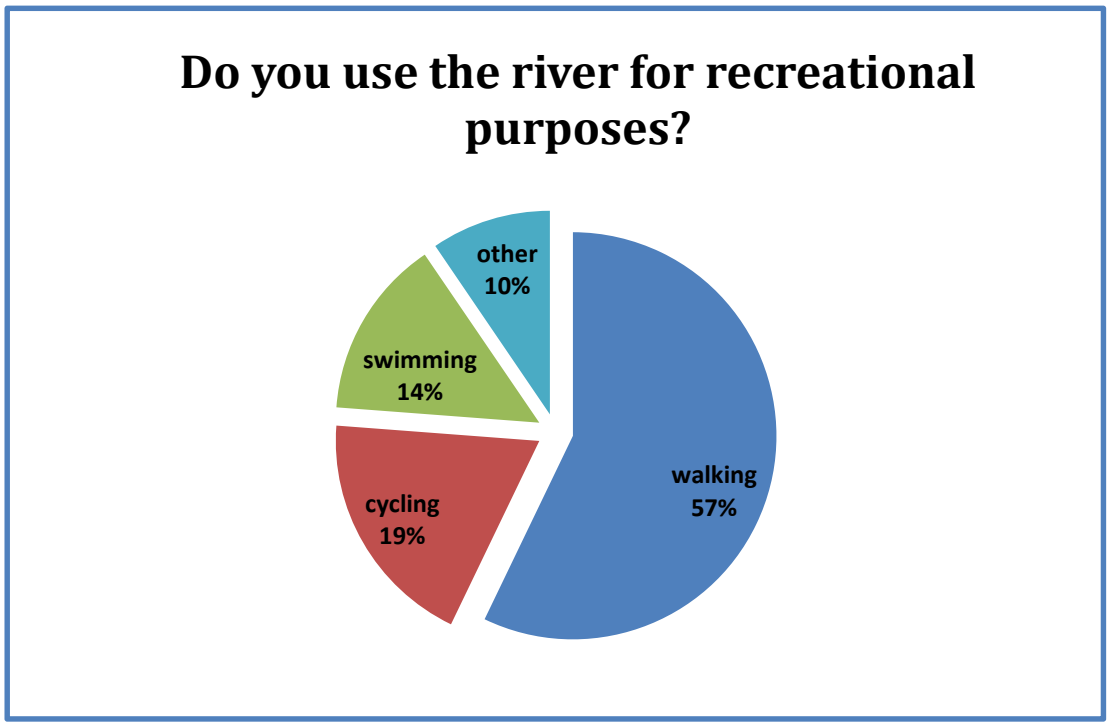
There was a divided response to this question. 8 People answered 'no' showing they are happy that the majority of flood issues in Peebles have been discussed. 3 people answered 'yes' and 6 left it unanswered however included comments regarding some issues that may have been missed. The comments from those that answered yes and where a comment has been left but the question was left unanswered are shown in the table below:

Response no.	Watercourse area	Comments
1	Eddleston Water	*"Timeline of Eddleston water incorrect. Not stating water levels in 2000 (my home was flooded twice)" – Can be incorporated.*
2	Eddleston Water Edderston Burn River Tweed	*"Yes flooding from Eddleston Water at Manor Swore Bridge not included. Advised member of team." – Can be incorporated.*
3	River Tweed Eddleston Water	*"More on NFM. It is more proven than you give credit for. The challenges are also social and political - engaging with and/or regulating land use in the catchment." – NFM potential will be looked at as a long-term strategy?*
4	River Tweed	*"The plan shows how lateral water would be kept out. One of the biggest unknowns is what the water table would do in event of significant flooding." – Protection against groundwater would be incorporated into the design, for example sheet piling for the wall or a waterproof core of an embankment taken down x metres.*
5	River Tweed	*"Natural flood defences upstream of Peebles were mentioned, but largely ignored. Scottish Water and the Forestry Commission could help but do not seem minded too. (They are public bodies in Scotland, and should therefore be accountable to us all, but they don't seem to be in reality)" – Stakeholder engagement with Scottish Water and Forestry will take place / has taken place. NFM potential will be considered.*
6	River Tweed Edderston Burn	*"Despite the poster explaining why sediment removal is not suitable I can see the huge island forming in the Tweed is affecting the river banks (erosion) and will soon impact the Tweed bridge." – Study undertaken on effect on removing the island – very limited effect and will likely re-fill very quickly – we will not be removing (or undertaking any other dredging)*
7	Eddleston Water	*"Yes flooding from Eddleston water at Manor Swore Bridge not included. Advised member of the team." – Can be incorporated.*
8	Eddleston Water	*"The whole grant system which incentivises poor land management, over grazing by sheep etc. is ridiculous. After exiting the CAP, build grants from bottom up to incentivise good land management." – Policy that is out with flood risk management.*

Question 6

Do you use the river for recreational purposes?

Collated data from the questionnaire makes it apparent that walking is the most common recreational activity that people use the riverside for. Other recreational uses include cycling and swimming, as shown in the chart below.



Question 7

Do you have any concerns about how the flood mitigation options proposed may affect recreation activities at the river?

Out of the 17 participants 12 were not concerned about the flood defences affecting any of their recreational activities that they take part in at the river. 1 left the question unanswered and the remaining 4 circled 'yes' indicating that they were concerned. Issues raised by participants who circled 'yes' included concerns about access to the river and the existing walkway and the aesthetics of the proposed flood defence options.

"Too many structures affecting how the river looks and works."

"Yes. It is essential we are not cut off from walking along the river. The "Three Bridges walk" is a very popular and regular walk for many."

"Mitigation for other areas needs to blend in as much as possible, both on the ground & for events."

A mitigation option that blends in suitably with the current area is essential and we will look to reduce the aesthetic losses and mitigate these with alternatives such as raised footpaths. The riverside walkway will exist post-scheme.

Question 8

Currently are there any access issues to the existing river infrastructure including issues which effect individuals with a disability?

9 people responded 'yes' – there were issues accessing the river infrastructure, 3 responded 'no' and 5 left the question unanswered. Below are a couple of comments from participants who responded with 'yes'.

"The hump and the path below riverside house which is not fit for purpose - muddy and eroded."

"Behind Haylodge hospital, pathway not possible in a wheelchair. Both Priorsford & Haylodge footbridge have been successfully dealt with."

The answers to this question are useful as if there are any issues of accessibility, we can work to address these and consider them in the design of flood defences.

Question 9

Are you particularly concerned with any of the proposed options?

11 people respondents were not concerned with the proposed options, representing around 65 percent of the total consultees. Concerns and issues that were raised on the questionnaires by those answering yes are shown in the table below.

Response no.	Watercourse area	Comments
1	River Tweed	*"Somewhat [concerned] about building a wall in Tweed Green"*
2	Eddleston Water	*"Structural protection measures focus on good land management upstream and flood individual houses. Stop grants for land management that increases flood risk."*
3	River Tweed	*"If a wall or embankment is sited at Tweed Green then access to existing footpaths could be an issue."*

Question 10

Do you have any other issues that you would like to raise?

The final question on the questionnaire gave participants the opportunity to voice any issues they had, which may not have applied to the other questions. 3 people raised their concerns, 8 had no issues to raise and 6 left the question unanswered. The concerns highlighted by residents are detailed below;

Response no.	Watercourse area	Comments
1	River Tweed	*"Water level data from the early stages of the Tweed, at Glenbreck and Kingledores, is critical to understanding the potential of flooding in Peebles. The monitoring needs to be well protected."*
2	Eddleston Water	*"Look at link between CAP, land ownership / reform, length / security of tenancy for farmers and floods! Identify and treat the causes not only the symptoms"*
3	Eddleston Water River Tweed	*"Take NFM seriously"*

A participant who raised an issue included a comment displaying their positive thoughts about a flood defence to protect property:

"Fully in support of proposal to protect property affected by the River Tweed with the construction of a flood retaining wall. Seems to be excellent cost/benefit"

Outcome / Conclusion

As shown from the data collected in the questionnaires, there has been a generally positive response to flood defence options presented in Peebles. However, the questionnaire has highlighted issues that will be considered at the next stages of the process, including negative comments about flood walls and the lack of natural flood management.

The mainly positive view is likely to be because many people have unfortunately been affected by flooding in the recent past, understand how devastating flooding can be and appreciate the benefit of having their properties protected by a formal flood protection scheme.

Offices at
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Doncaster
Dublin
Edinburgh
Exeter
Glasgow
Haywards Heath
Isle of Man
Limerick
Newcastle upon Tyne
Newport
Peterborough
Saltaire
Skipton
Tadcaster
Thirsk
Wallingford
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