

Initial assessment report

Old Main Street, Bingley

November 2016

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1 Initial Assessment Report

Scheme or project location name	Yorkshire Area Initial Assessments: Old Main Street, Bingley
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River Aire at Ireland Bridge

Date	November 2016
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1.1 Introduction and background

1.1.1 Background

In May 2016 CH2M were commissioned by the Environment Agency, on behalf of Bradford Metropolitan District Council (MDC), to undertake Yorkshire Area Initial Assessments providing guidance on measures to reduce flood risk and potential funding availability. This report covers Old Main Street in Bingley.

1.1.2 Description of Location

Old Main Street is a road in the town of Bingley within the Bradford Metropolitan District. This road is close to the left bank of the River Aire and immediately upstream of Ireland Bridge. The study area incorporates Old Main Street and the surrounding area close to the River Aire including both banks upstream of Ireland Bridge. This area experienced severe flooding during December 2015. The site area is shown in Figure 1.

According to the Index of Multiple Deprivation (IMD), the area is amongst the 40 to 50% least deprived neighbourhoods in the country.

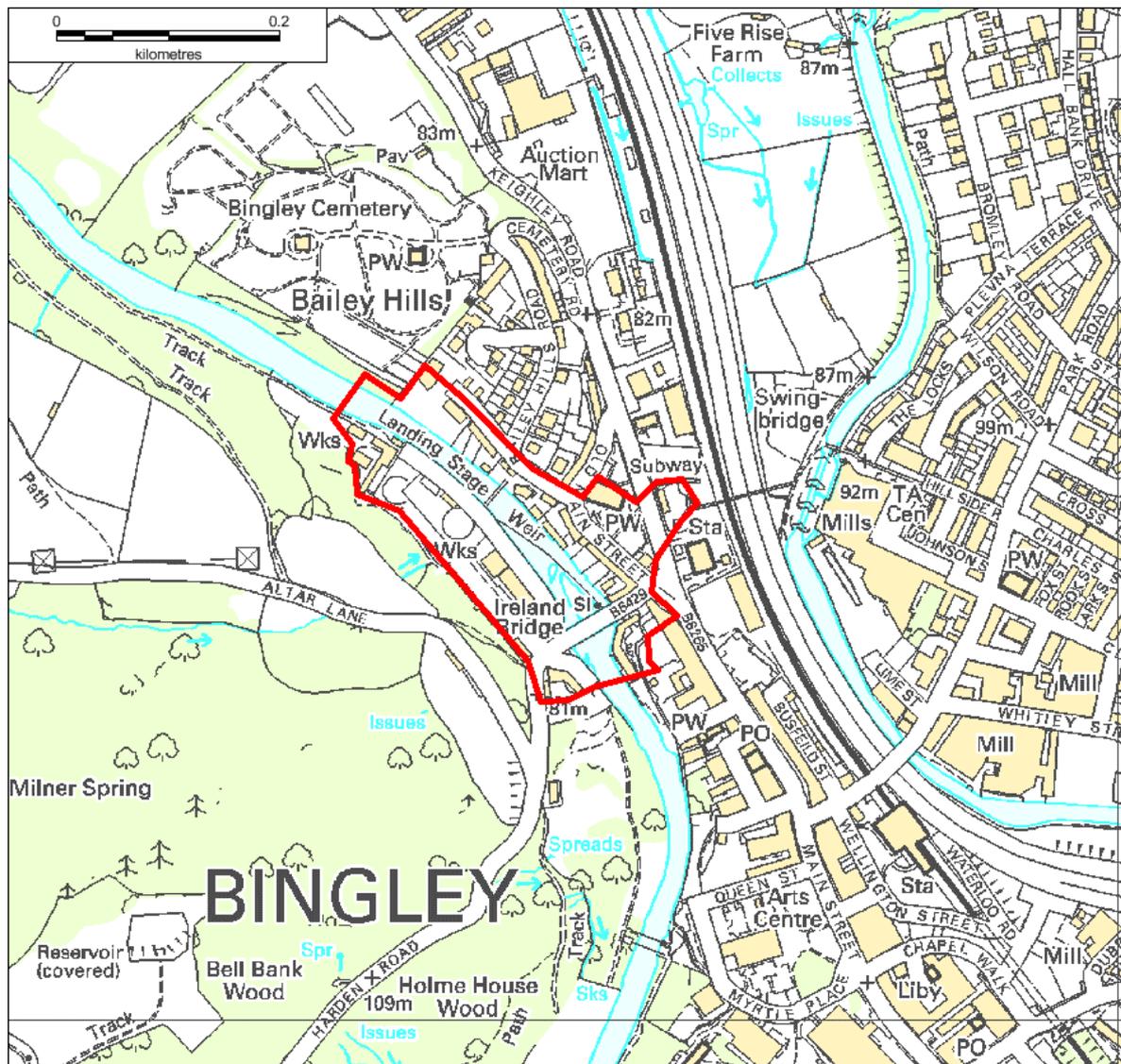


Figure 1: Old Main Street site location

1.1.3 Description of Watercourses and Geology

The River Aire is a major river in Yorkshire flowing from Malham in the Yorkshire Dales, through the urban areas of Bradford and Leeds, before joining the River Ouse at Airmyn. The Aire is approximately 71 miles in length from its source to its confluence.

The Upper Aire around Bradford is heavily urbanised and the floodplain is constrained by development. There are a number of tributaries within this area that respond rapidly to rainfall. There is also a large number of structures such as bridges in this area.

1.1.4 History of Flooding

The properties within the study area have been flooded several times in recent years. During the 2015 Boxing Day event properties were flooded when high river levels in the River Aire caused the river to overtop its banks. This area was also flooded from the river in 2000 and 2012 during large events on the River Aire.

The Boxing Day 2015 flood incident was the largest flood event recorded across the Upper Aire. The return period of this event was estimated to be between 80 and 100 years (1.25%-1% AEP) at Kildwick in the Upper Aire and was greater further downstream with a return period of 200 years at Armley.

1.1.5 Summary of Modelling Analysis

In 2008 hydraulic and hydrological modelling of the Upper River Aire was completed by JBA to support the development of the Flood Risk Management Strategy. For this study the River Aire was modelled from High Hill Weir upstream of Gargrave to Fleet Weir downstream of Leeds and included Ireland Bridge. The Upper River Aire model is a 1D hydrodynamic ISIS model containing 1922 nodes.

This study aimed to define flood risk within this area and identify potential flood risk management options. This informed the Flood Risk Management Strategy for the Upper Aire. The Flood Risk Management strategy recommended local flood risk management schemes, where there was justification, and identified a number of sites that should be progressed. Bingley/Ireland Bridge was not identified as a priority site in this report.

1.1.6 Drivers, Constraints, Opportunities

The study area falls under the Aire Catchment Flood Management Plane (CFMP)¹, and is covered by sub-area 3 Worth and Aire. The designated policy for the area at risk is Policy Option 5: *Areas of moderate to high flood risk where we can generally take further action to reduce flood risk.*

The following drivers, constraints and opportunities have been identified within the study area.

Political Drivers	Summary Description
Catchment Flood Management Plan	Aire Catchment Flood Management Plan 2010
Catchment Flood Management Policy	Policy 5 – Areas of moderate to high flood risk where we can generally take further action to reduce flood risk.
Economic Drivers	Summary Description
Funding Time Constraints	Must be obtained within 6 year programme of capital investment
Technological Drivers	Summary Description
Improved Public Safety	Via reduced flood risk
Environmental Constraints	Summary Description
Special Area of Conservation (SAC)	South Pennine Moors 1.7km northeast of study area
Sites of Specific Scientific Interest (SSSI)	South Pennine Moors 1.7km northeast of study area
Ancient Woodland	Blakey Wood 0.1 kilometre to the south west from the site
Conservation Area	The entire study area is within the Bingley Conservation Area
Tree Preservation Order	There are some TPOs within the study area along the watercourse. All trees within the conservation area are also protected. Any work affecting these trees will require permission from the council prior to work taking place.
Listed Buildings	There are 12 listed buildings within the study area including Ireland Bridge
Historical Park & Gardens	Registered Parks 0.5km to the southwest of the site
World Heritage Site	The Saltaire World Heritage site is approximately 4km East from the study area.

Refer to Appendix B for the full list of constraints that were considered.

¹ Aire Catchment Flood Management Plan (2010) <https://www.gov.uk/government/publications/river-aire-catchment-flood-management-plan>

1.2 Problem and objectives

1.2.1 Problem

The site is at risk of fluvial flooding due to its proximity to the River Aire. 16 residential properties and 4 commercial properties are thought to be at risk from a 1-in-25 (4%) AEP flood incident.

Work is currently being undertaken by the Environment Agency to determine the standard of protection provided by the existing river bank.

Properties are also at risk of surface water flooding due to the steep slopes toward the river. Areas on both banks of the river have been identified as at risk of surface water flooding. There was significant flow observed down Altar Lane during Boxing Day 2015 causing flooding to properties to the south of Ireland Bridge.

This report will identify potential solutions to the flooding issues and determine if there is scope for a flood scheme.

1.2.2 Objectives

The primary objective of this initial assessment is to undertake an initial appraisal to identify the flood risk issues and viable solutions for the affected properties and to identify any other potential flood risk management measures which are consistent with the current CFMP policy.

The purpose of this report is to lay the groundwork and, where applicable, provide a business case for future appraisal. The report aims to achieve the following:

- Confirm the need for a project;
- Identify the issues and Political, Environmental, Societal, Technological, Legislative and Economic (PESTLE) drivers and opportunities related to the need;
- Identify the options to address the need and problem;
- Demonstrate that viable options exist based upon the available information;
- Provide sufficient information to allow the packaging and optimisation of packages of future appraisal, design and construction packages;
- Provide sufficient information for the appraisal scope to be prepared;
- Make an assessment on the deliverability of the project;
- Provide a basis/starting point for discussion with communities and partner organisations for use in the development of potential schemes and negotiations regarding funding contributions.

1.3 Benefits

In this area the primary benefit associated with a reduction in flood risk would be the reduction in economic damages to properties. This in turn would reduce disruption to local transport, businesses, schools and other infrastructure.

The properties at risk consist of residential properties with some commercial properties such as shops and public houses. There are no significant public buildings within the study area.

Social benefits relate primarily to a reduction in stress, health effects (including risk to life) and loss of memorabilia for those at risk.

An appraisal period of 100 years is assumed, over which the current Standard of Protection of existing assets is expected to decrease as a result of climate change.

1.4 Options

A long list of options has been compiled for the study area and is summarised in the table on the following page. The table shows the range of options considered and the reasoning for or against them being taken forward to the shortlist of options to be assessed.

Category	Long List Option	Description	Take Forward for assessment?	Reasoning / Notes / Past Study Reference
Do nothing	Do nothing	All operational and maintenance activities cease	Yes	Required to support development of business case and benefit cost ratios.
Do minimum	Do Minimum	Continue with current operational and maintenance activities.	Yes	Required to support development of business case and incremental b/c ratio.
Non-structural (by EA)	Improved flood warning	Enhanced flood warning to allow residents to prepare plus appropriate implementation of flood action plans	No	Not funded via the capital programme. A Flood warning system is already in place for Bingley. During the 2015 Boxing Day event it was reported that these warnings were received after the onset of flooding to some properties. The Flood warnings for the area have been updated following the Boxing Day flooding.
Non-structural (by EA)	Flood action plans	Improved direction of reactionary flood defence measures	No	The study area is already within a Flood Warning and Flood Alert area operated by the Environment Agency.
Property level protection	Property level protection	Protection to individual properties (e.g. via air brick covers, door guards etc).	Yes	This may be viable given the high risk and relatively small number of properties at risk. There may be additional challenges implementing this due to the Bingley Conservation Area and the numerous listed buildings at risk This would not have been effective in flooding of the depths experienced in December 2015. This option may need to be considered in combination with other options.
Operational (by Others)	Improve operation/design	Improve operation/design of assets not owned by the EA	No	No assets contributing to risk have been identified.
Urban drainage	Improve urban drainage.	Improved surface water drainage system.	No	There is some surface water risk in the area particularly on the right bank of the river. This is a less significant risk than that from fluvial flooding and no solution has been identified for this assessment. This should be considered in any future appraisals.

Category	Long List Option	Description	Take Forward for assessment?	Reasoning / Notes / Past Study Reference
Structural	Earth bunds	Flood bunds	No	There is not sufficient space available for this option.
Structural	Flood walls	Flood walls	Yes	Construction of a flood wall along the river banks would reduce the risk of flooding from the river. This could be constructed on both river banks but would have most benefit on the left bank where the standard of protection is thought to be lower and more properties are at risk. The existing third party walls along the river could be replaced with a flood defence. Walls would be sheet piling with cladding to fit with local surroundings. There is limited space available and the wall would need to be along the riverbank.
Structural	Temporary defences	Demountable flood walls, flood gates etc.	No	There is not thought to be sufficient warning time prior to a flood incident to deploy temporary defences within the study area.
Structural	Conveyance	Channel deepening or widening	No	There is no available route or space for this option. The EA currently undertakes gravel removal from the channel at this location to maintain conveyance.
Structural	Conveyance	Supplementary bypass channel(s), tunnels or floodway	No	No suitable locations for a bypass channel have been identified.
Structural	Conveyance	Pinch point improvements – Ireland Bridge Weir	No	The weir upstream of Ireland Bridge could be removed. This would reduce water levels and reduce the potential for debris to collect here during a flood event and hence reduce risk. This is a high cost option and is not thought to produce a significant reduction in flood risk so has not been taken forward for assessment
Structural	Conveyance	Pinch point improvements – Ireland Bridge	No	Ireland Bridge could be modified to reduce the obstruction posed by this bridge and the potential for the bridge to collect debris.

Category	Long List Option	Description	Take Forward for assessment?	Reasoning / Notes / Past Study Reference
				<p>This bridge is a listed structure and would be challenging to modify. This option is not thought to reduce flood risk to a suitable extent to justify this modification.</p> <p>This option has not been taken forward for assessment.</p>
Flood storage area	Online	Use of active structures and re-profiling to store water online.	Yes	<p>The Upper Aire SFRA considered 2 online storage areas at Keighley Holden Park and Marley Bridge. These are upstream of Old Main Street and would reduce flood levels in the study area.</p> <p>These areas are being investigated for their benefits to Leeds City Centre as part of phase 2 of the Leeds FAS. This storage would also have benefits across the River Aire including the properties at risk at Old Main Street.</p>
Flood storage area	Offline	Gravity or pumping to offline storage area	No	No offline storage sites have been identified.

1.4.1 Shortlisted Options Description

On-line Storage on River Aire

The modelling carried out to support the Upper Aire SFRA tested a number of on-line flood storage areas (FSA). Two of these were found to lead to significant reductions in flood risk. These sites are Keighley Holden Park and Marley Bridge. Holden Park is the larger of these sites. The location of these two sites in relation to the Old Main Street study area is shown in Figure 2.

Both these storage sites are upstream of the Old Main Street study area. As such these sites would reduce flood risk to the properties at Old Main Street.

These two FSAs were tested for a 1-in-100 (1%) AEP flood incident and were estimated to reduce flood levels by 0.99m at Ireland Bridge. There are also benefits across the River Aire downstream with an estimated reduction in flood levels of 0.43m in Leeds City Centre.

These FSAs have been considered primarily for their benefit in reducing risk to Leeds City Centre and are to be investigated as part of work for phase 2 of the Leeds FAS. However these will provide benefits to areas along the River Aire downstream of the FSA.

This initial assessment considers the Old Main Street area. The FSA upstream of here would reduce risk to properties in this area but it will also have significant benefits beyond the study area. As such assessing the benefits and costs of this option are considered to be outside of the scope of this study and the option has not been taken forward for further assessment.

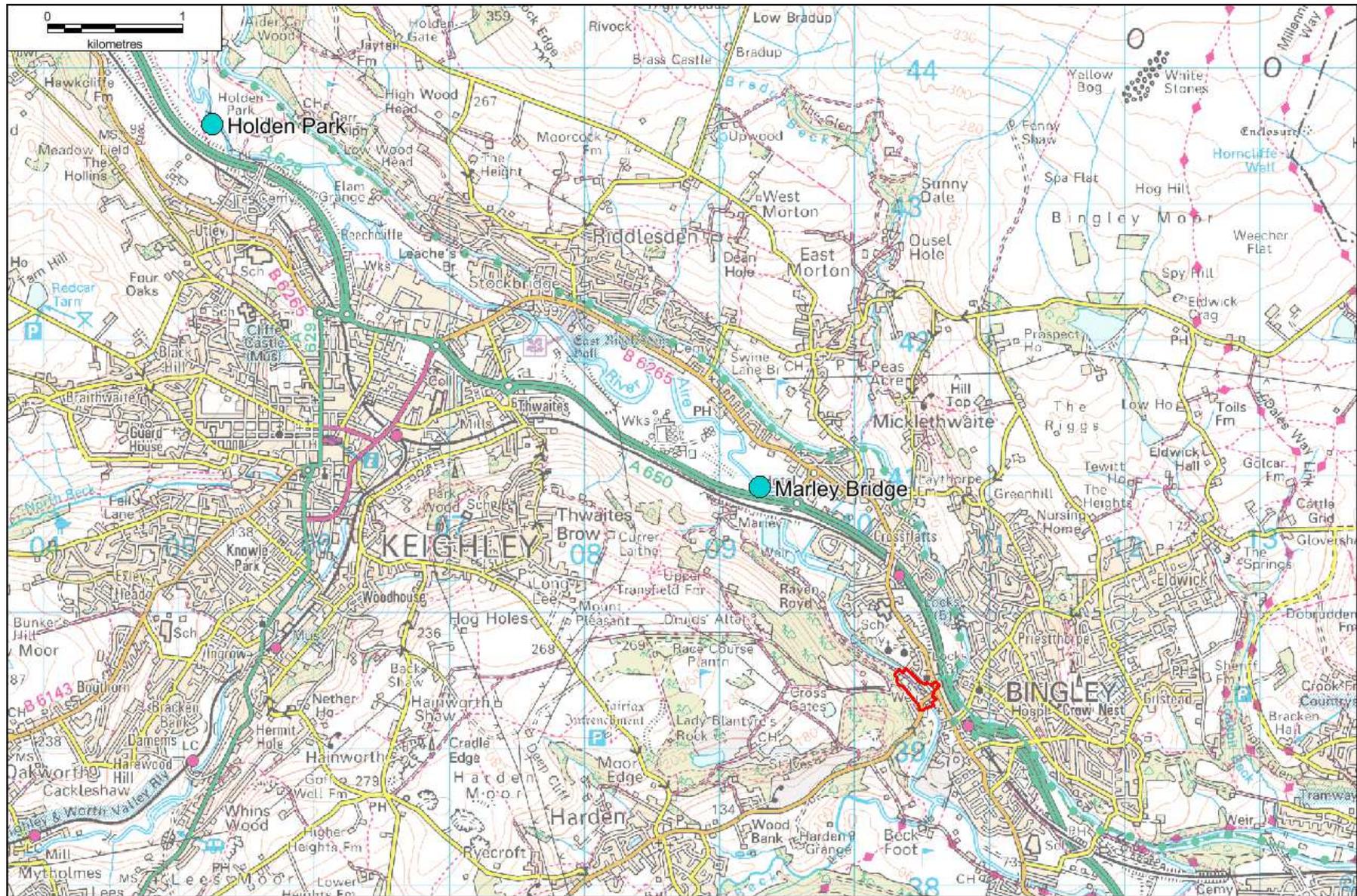


Figure 2: Approximate location of potential storage sites on River Aire

The following options were chosen to be taken forward for assessment in conjunction with the EA and Bradford Metropolitan District Council (MDC).

Do Nothing

The Do Nothing option is defined as taking no action whatsoever; under this option all management activities would cease, including maintenance and repair work to existing assets.

Under this assumption, natural deterioration of the channel would occur, leading to reduced conveyance and increased flooding. There would also be no flood warning service provided.

The Do Nothing option is not to be taken forward as a viable option as it results in an unacceptable increase in flood risk to people and property due to deterioration of the channel and build-up of blockages.

Do Minimum

The Do Minimum option is defined as the minimum level of action or intervention necessary to sustain the standard of service (SOS) presently offered throughout the study area. It will form the appraisal baseline.

This option assumes continuation of the existing maintenance regime. This includes channel maintenance, operation and maintenance of weirs and other in-channel structures and where possible, existing non-structural measures such as flood forecasting and flood warning.

The advantage of Do Minimum is that it sustains current standard of service within the study area and there are no capital costs associated with this option. The Do Minimum scenario does not allow for climate change.

There are no indicators to suggest that this option is non-viable or undeliverable.

Option 1 - Flood Walls

This option constructs flood walls along the left bank of the river to increase the standard of protection. This will reduce the risk of fluvial flooding to the properties protected on this side of the river. There are existing third party owned walls along the river banks upstream of Ireland Bridge. These could be replaced by formal flood defences and raised to provide the required standard of protection.

The alignment of the walls and their dimensions are a rough estimate. If this option is taken forward, they will have to be assessed and optimised at that stage. The design of the flood walls must be made to fit visually into the surrounding area and would need to consider the Bingley Conservation Area. Views of the river, in particular from properties, would be adversely impacted as would access to the river for maintenance purposes.

Two options are considered providing different standards of protection.

- **Option 1A** providing a 1-in-100 (1%) AEP standard of protection (SOP) including climate change. At the start of the appraisal period the standard of protection provided would be expected to be higher due to the allowance for climate change. This will require the construction of a 1.4m high wall based on the results from the Upper Aire modelling report.
- **Option 1B** providing a 1-in-200 (0.5%) AEP standard of protection (SOP) including climate change. This will require the wall to be constructed to a greater height of 1.7m. As the wall height is increased it will provide a greater reduction in risk at higher cost and with a greater impact on the area.

Further modelling would be required in order to assess the impact of removal of flood plain due to the construction of this flood wall on communities further downstream. Compensatory flood plain storage may be required, adding to the costs of the scheme. It must be ensured that the compensatory storage is hydraulically linked to the flood plain lost, otherwise the benefits from it may not be fully realised.

There may be aesthetic challenges to the scheme due to the close proximity of the walls to many properties. Large heights may not be viable, due to the aesthetic impact of the walls. There are also no environmental benefits to the scheme. Construction of the wall has the potential to cause temporary disruption to roads and properties.

Option 2 - Property Level Protection

This option is to offer property level protection (PLP) to the 16 ground floor residential properties identified as being at very significant risk of flooding. PLP can take the form of barriers in doorways, non-return valves fitted to drains, and airbrick/vent covers. Properties can also be made more flood resilient, using waterproof plaster, solid concrete floors or tiled floor coverings in order to reduce the amount of time and money needed to recover from a flood event. PLP is generally used as an option for properties that experience less than 500mm of flooding.

Advantages of this option include the fact that defences have minimal visual and land impact, and do not remove any of the flood plain area. PLP will also protect against surface water as well as fluvial flooding. Any changes would need to be in keeping with surroundings and not impact on the conservation area.

Disadvantages of this option include the requirement for residents to receive sufficient alert and for them to be available and educated in deploying PLP measures. Alternatively passive PLP measures could be installed, removing the need for manual operation at times of flooding.

PLP does not provide any wider environmental benefits and does not prevent the flooding of areas surrounding the property. PLP is also only possible for properties in the Very Significant risk band and where flooding is less than 500mm deep. This option would not prevent flooding during incidents of a magnitude similar to the Boxing Day 2015 flooding due to the depth of flooding.

Deliverability of this option is reliant on the resident's uptake of PLP. Some properties within the area have already implemented a degree of PLP.

1.4.2 Costs of options

The costs for the options were calculated using the Environment Agency's Project Cost Tool and Long Term Costing Workbook. The maintenance and operation costs relate to mechanical maintenance of the assets to Target Condition 3.

It is assumed that a major replacement of flood walls will be required 90 years after the initial construction phase. The timing of this is based on the EA's Asset Deterioration Guidance (2013). PLP measures will require replacement every 20 years to ensure these continue to protect properties.

An appraisal period of 100 years has been used. A detailed breakdown of costs across this period is included in Appendix B.

Table 1.1 shows the build-up of costs for all options.

Table 1.1 Project costs (£k)

Item	Option 1A	Option 1B	Option 2
Construction Costs	*684	*830	118
Environment Agency staff	105	127	18
Consultant fees (appraisal)	38	47	*7
Consultant fees (design)	132	160	23
Consultant fees (construction)	34	42	6
Site investigation & survey	*9	*12	*2
Land Purchase	*3	*4	*0
Optimism Bias (44%)	443	537	76
TOTAL	1,449	1,759	250
Annual Operation and Maintenance Costs	0.638	0.638	0.611

* These costs will need to be calculated more accurately for any future appraisal.

1.5 Initial environmental assessment

The main impacts of each option are summarised in Table 1.2:

Table 1.2 Key environmental impacts, mitigation and opportunities

Key positive impacts	Key negative impacts	Mitigation/ enhancement opportunity
Option 1A/1B Flood Walls		
Reduced risk of flooding	Visual impact of wall Works adjacent to listed structure (Ireland Bridge). Construction work alongside watercourse. Risk of pollution incidents and disruption to area during construction Flood protection measures may impact on listed buildings and conservation area	Best practice should be followed including referring to EA Pollution Prevention Guidance. Design of wall must be sympathetic to character of area.
Option 2 Property Level Protection		
Reduced risk of flooding including surface water flooding	Flood protection measures may impact on listed buildings and conservation area	Design of PLP measures must be sympathetic to character of area

1.6 Consultation

The options in this appraisal were developed in consultation with the Environment Agency and Bradford MDC. No public consultations were held at this stage as the work is a high-level assessment of potential options. Stakeholder engagement will take place at subsequent stages of the project.

1.7 Economic summary and preliminary preferred option

Table 1.3 Benefit-cost assessment

	PV costs (£k)	PV benefits (£k)	Av. BCR	Incr' BCR	Option for iBCR calc	Comments
Do Nothing						
Do Minimum	18	30	1.7			
Option 2 - PLP	523	742	2.8	1.4	Do Minimum	Highest ABCR and IBCR
Option 1A – Flood Wall (1in100 +CC)	1,495	1,064	0.7	0.7	Do Minimum	
Option 1B – Flood Wall (1in200 +CC)	1,811	1,136	0.6	0.6	Do Minimum	

Option 2 is the preferred Do Something option. This has the highest BCR of the options considered. Properties remain at risk with this option implemented as the PLP measures will not be effective during larger flood incidents with higher flood depths (>500mm) or long durations of flooding (>3 days).

The Partnership Funding scores for the 3 options has been calculated as shown in Table 1.4. The benefit period is 90 years for Option 1A/1B and 20 years for Option 2 as after this time the assets require replacement and further investment would be required. The details of this calculation and sensitivity testing are including in Appendix F.

Table 1.4 Benefit-cost ratios and outcome measures

Contributions to outcome measures	Option 1A Flood Wall (1in100 +CC)	Option 1B Flood Wall (1in200 +CC)	Option 2 – PLP
OM1 – Economic Benefit:			
<i>Benefit period used for Partnership Funding calcs</i>	90	90	20
<i>PV Benefits (£)</i>	1,042,875	1,113,369	366,040
<i>PV Costs (£)</i>	1,467,160	1,777,554	258,775
<i>Benefit/Cost ratio</i>	0.71	0.63	1.41
OM2 – No. of households moved out of any flood probability category to a lower category	12	12	16
OM2b – No. of households for which the probability of flooding or coastal erosion is reduced from the very significant or significant category to the moderate or low category	12	12	16
OM2c – No. of households in the 20% most deprived areas moved from the very significant or significant flood probability category to the moderate or low category	0	0	0
OM4a – Hectares of water dependent habitat created or improved to help meet the objectives of the Water Framework Directive	0	0	0
OM4b – Hectares of intertidal habitat created to help meet the objectives of the Water Framework Directive for areas protected under the EU Habitats/Birds Directive	0	0	0
OM4c – Kilometres of rivers protected under the EU Habitats/Birds Directive improved to	0	0	0

Contributions to outcome measures	Option 1A Flood Wall (1in100 +CC	Option 1B Flood Wall (1in200 +CC	Option 2 – PLP
help meet the objectives of the Water Framework Directive			
Partnership Funding (PF) Score	8%	7%	18%
Contributions required for a PF score of 100% (£)	1,354,638	1,653,499	212,071
Contributions required for a PF score of 120% (£)	1,373,000	1,674,000	220,000

1.7.1 Limitations and Uncertainties

This initial assessment has produced a high-level appraisal of options available to manage flood risk in Old Main Street. There are limitations to the methodology applied and more robust appraisal would be required to have greater confidence in the results.

Costs for options are based on the EA Project Costing Tool. These costs will need to be reviewed in more detail for any future appraisal work.

The Weighted Annual Average Damages (WAAD) from the Multi-coloured Manual have been used to assess damages and hence benefits. This assesses damages based on the number of properties affected. This does not take into account the depths of flooding and more accurate damages could be calculated if information on expected flood depths was available.

The WAAD methodology is unsuitable for assessing the impacts of climate change. Defences have been assessed as provided a constant standard of protection throughout the appraisal period. Options accounting for climate change will provide a higher standard of protection early in the appraisal period and will therefore have greater benefits than those assessed.

1.7.2 Funding and contributions

A funding analysis tool was used to identify potential direct and indirect beneficiaries of the scheme. This is included in Appendix E. Based on these beneficiaries potential funding sources identified include:

- Community Infrastructure Levy
- Council Tax
- Local Enterprise Partnerships

1.7.3 Key delivery risks (economic, social and environmental)

Key delivery risk and recommendations for mitigating these risks are shown in the table below.

Table 1.5 Risks and mitigation

Risk	Key Mitigation
Effectiveness of PLP limited by Flood warning time	Flood warnings should continue to be reviewed to ensure suitable lead time is available to deploy PLP. Alternatively passive PLP measures could be specified removing the requirement for flood warning.
Insufficient third party Funding available to allow scheme to progress	Assess potential funding options before progressing scheme appraisal further.

Risk	Key Mitigation
Properties at risk already have PLP measures installed reducing the effectiveness of additional measures	Review level of protection provided by PLP that is currently installed within the area and adjust costs and benefits to reflect this

1.8 Project Scoring

The data used in this assessment has been subjected to a RAG assessment. The RAG score assesses the project against the categories shown below. This gives a three figure score with the first number being the number of reds, where there is significant uncertainty or challenges. The second and third numbers are the numbers of amber(defined as needs development, but is manageable) and green(well defined, not likely to be an issue) scores. The results are shown below:

- A – Problem Definition: The fluvial flooding is well defined with flood outlines but further investigation is required to understand the surface water flooding mechanisms – **AMBER**
- B – Economic: There are limitations to the methodology applied and more robust appraisal would be required to have greater confidence – **RED**:
- C – Funding: The options are likely to require external funding. Potential funding sources have been identified – **AMBER**
- D – Engineering case: Preferred solutions are tried and tested defence options – **AMBER**
- E – Permissions & Consents: Solutions are unlikely to require unusual permissions or consents – **GREEN**
- F – Environmental sensitivities: Initial environmental assessments has been completed based on outline options, some impact from options requiring work close to river – **AMBER**
- G – Opportunities: Some potential opportunities for partnership working – **AMBER**

Model	Economic	Funding	Eng.	Permissions	Env.	RAG	Opps.
A	B	C	D	E	F		G
2	3	2	2	1	2	141	2

1.9 Further work requirements

If the project is taken forward for further appraisal it is recommended that the following work is carried out to improve confidence in this economic assessment:

- Assessment of depths of flooding in Old Main Street should be carried out through hydraulic modelling. This would allow more accurate assessment of damages and the effectiveness of PLP to be carried out. A review of the existing models would allow the results from these to be used to provide a more accurate damages assessment. This review is currently being undertaken.
- The extent of existing PLP measures installed within the area should be assessed to determine if further PLP can be practically implemented.

- Surface water flood risk in the area should also be assessed further and measures to reduce this considered. In particular the overland flow down Altar Lane observed during the Boxing Day flood should be addressed to prevent flooding from this source.
- The potential storage areas identified on the River Aire in the Upper Aire SFRA should be assessed further. This assessment should include the benefits to Bingley and to other sites along the River Aire. Previous assessment investigating flood storage at Holden Park and Marley Bridge estimated this would reduce flood levels at Ireland Bridge by 0.99m. This would significantly reduce the need for a scheme at Old Main Street and may provide a viable solution to provide a higher standard of protection.

1.10 Conclusions and Recommendations

- Properties at Old Main Street are at high risk of flooding from the River Aire. The main risk of flooding is fluvial from the River Aire overtopping its banks. There was significant flooding in the area during Boxing Day 2015.
- Flooding during the Boxing Day 2015 incident was exacerbated by flood warnings arriving after the onset of flooding to several properties. These warnings have since been reviewed and updated. This will reduce the damage of future events and increase the effectiveness of PLP measures including those already installed in the area
- The preferred option for managing this flood risk is Property Level Protection. With PLP measures in place the area will remain at risk from larger flood incidents. It is not seen to be economically viable to construct defences at this location.
- The Preferred option does not remove risk of flooding during large flood incidents and additional work will be required to fully address flooding to this area. This site would remain at risk from severe incidents such as the Boxing Day 2015 flooding.
- There are a number of properties in the study area at high risk of flooding. As such there is a high economic benefit from providing a relatively low standard of protection.

Appendices