Initial assessment report
Bradford IA Hirst Mill Saltaire
November 2016

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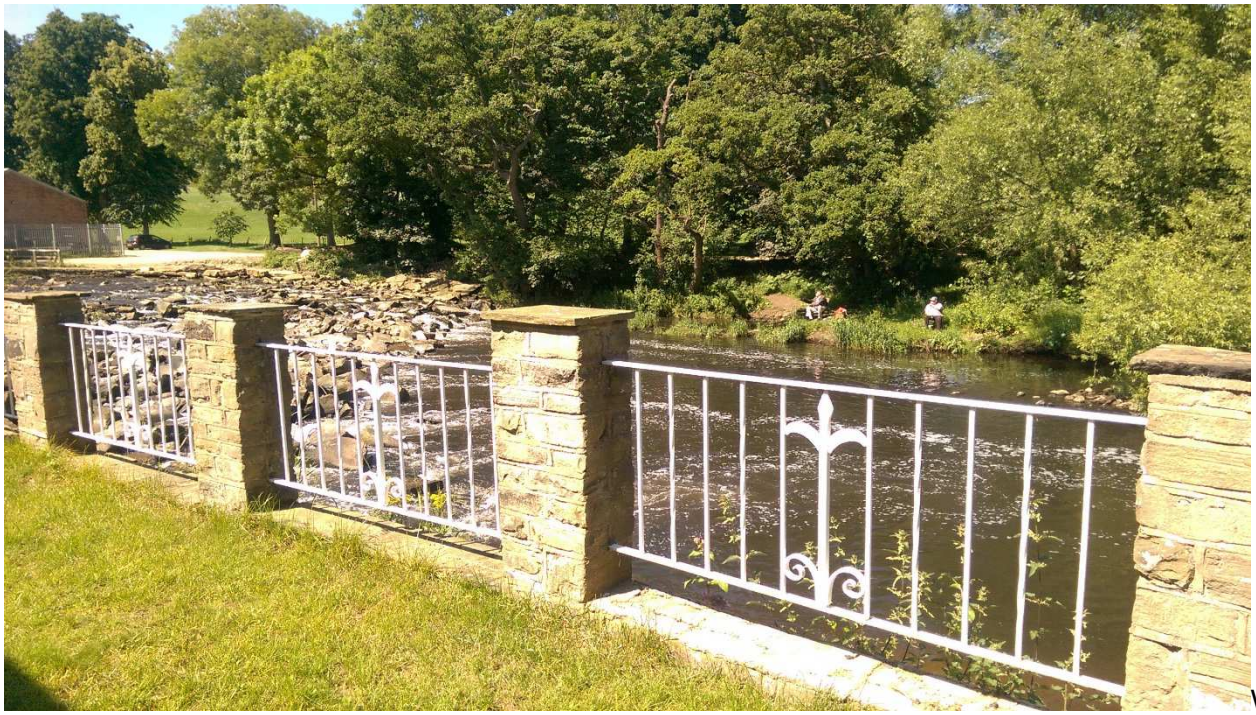
1 Initial Assessment Report

Scheme or project location name	Yorkshire Area Initial Assessments: Bradford IA Hirst Mill Saltaire



Wall facing the river Aire at property boundary (19/07/16)

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Project Executive Approval:	Name:	Title: Project Team Leader	Signature:	Date:
Senior User Approval:	Name:	Title:	Signature:	Date:
Project Sponsor Approval:				

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1.1 Introduction and background

Working in partnership with the City of Bradford Metropolitan District Council, 15 locations within Bradford were identified to have been significantly affected by the 2015 Christmas Floods. These locations were subsequently grouped into five main catchment areas to be put forward for initial assessments through engaging with the engineering consultant CH2M Hill on an existing contract:

- Keighley & Stockbridge
- Bingley & Airedale
- Baildon & Shipley
- Esholt & Apperley Bridge
- Silsden Beck

The inputs for the FCRM Partnership Funding Calculator were obtained through consultation with Bradford Metropolitan District Council and highlighting the properties likely to benefit from a potential scheme at each site location within the catchment - through assessing the EA Flood Zone 3 and draft 2015 Christmas Flood Outline extents (April 2016) on GIS.

The objectives of the project are to assess the potential for a scheme and associated proposals to aid in the alleviation of flooding within the identified sites in the Bingley & Airedale area, through undertaking initial assessments on an existing contract with the engineering consultant CH2M Hill. The proposals will look to be further progressed to a detailed appraisal, detailed design and construction, following the assessment and selection of an appropriate scheme.

1.1.1 Description of Location

Saltaire is a village located in Shipley, part of the City of Bradford Metropolitan District, in West Yorkshire. Saltaire is located by the River Aire and the Leeds and Liverpool Canal, and is also a designated UNESCO World Heritage Site.

The property at risk is an old mill converted for residential use. The building contains three different properties within its ground floor and is situated immediately downstream of a weir which contains energy dissipating boulders placed along its downstream face.

1.1.2 Description of Watercourses and Geology

The River Aire rises in the Pennine hills near Malham in the Yorkshire Dales, flowing in a south easterly direction until Castleford, where the river is joined by the Calder and turns eastward toward Airmyn. Here, the River Aire meets the River Ouse approximately 148 kilometres from its source.

The River Aire catchment has been considerably modified for flood defence purposes. Flood embankments have been built up along much of the channel and there are several controlled washland (floodplain) areas in the upper reaches as well as downstream of Leeds. These act as both controlled and uncontrolled washlands and significantly attenuate peak flows along the river.

The study area is low lying with little to no gradient. The Lower River Aire follows a gentle meandering course through a broad floodplain.

The geology of the study area is characterised by clay, sand and silts.

Even if there are no detailed information about the watercourse, at the site aim of the study, is judged that at this stage, the information about the generic features of the river, reach a sufficient level of detail.

1.1.3 History of Flooding

Major historic flooding in the Aire catchment occurred in 1775, 1866 and 1946. Minor events include 1967, 1980, June 2000, October/November 2000, February 2002 and August 2002, July 2007 and December 2015. Flood protection throughout the Lower Aire catchment is provided by flood walls, embankments and washlands.

The gradient of the river Aire is low (approx. 1 in 35,000) and the floodplain extensive.

1.1.4 Summary of Modelling Analysis

In 2001, the Upper and Lower Aire Preliminary Strategic Reviews concluded that a combined hydrological-hydraulic model was required to better understand the flooding mechanisms in the catchment and to support the development of a comprehensive strategy to manage flood risk to communities in the floodplain.

In 2001 Atkins were commissioned to deliver Phase 1 of the River Aire Modelling Study. Phase 1 involved the collection of new topographic survey and hydrometric data, estimation of flows using the methods detailed in the Flood Estimation Handbook (FEH) and construction and calibration of a hydrodynamic model of the River Aire and associated floodplains. This further lead onto the development of a robust calibrated model, which was then used to undertake a series of design runs.

The River Aire model reach was defined from Gargrave at its upstream extent, down to its confluence with the River Ouse downstream of Airmyn. In order to accommodate this long stretch, the River Aire was subdivided into the following three reaches and modelled accordingly:

- “Upper Aire” - from upstream of Gargrave Bridge to Leeds Station Weir (FDMS reaches 16-29)
- “Lower Aire” - from Leeds Station Weir to Fairburn Ings (FDMS reaches 12-15) and the Lower Calder from Stanley Ferry to its confluence with the Aire (FDMS reaches 1-3)
- “Tidal Aire” - from Fairburn Ings to the River Ouse at Airmyn (FDMS reaches 1- 11)

The final three models combined to form a catchment wide one-dimensional hydrodynamic (ISIS) model which was deemed to effectively capture the flow attenuation within the catchment. The 1 in 100 year fluvial and 1 in 200 year tidal design flood levels were key deliverables from this study, which was completed in Autumn 2004. This work formed the basis for the Upper Aire Flood Risk Management Strategy which aimed to define flood risk within this area and identify potential flood risk management options.

The existing hydraulic model has allowed for climate change up to the year 2105 with a 30% increase to the hydrological inflow. However the guidance for climate change analysis has been updated since the Upper Aire Modelling Study and therefore these results are now outdated. Climate change modelled flood outlines were not considered in this initial assessment with analysis using present day outlines to assign flood risk bands. The model has not been calibrated since the work undertaken in 2002-2004 and should be updated including recent events, if the scheme progresses to OBC stage.

Downstream of the study area there are three weirs that can influence the level of the water at the site. Detailed modelling work on the three weirs is currently being undertaken by the EA National Flood Modelling team. An initial review indicates there may be limited benefit from removing or lowering the weirs

1.1.5 Drivers, Constraints, Opportunities

Saltaire falls under the River Aire Catchment Flood Management Plan[1] (CFMP), and is covered by sub-area 3 Worth and Aire. The designated policy for residential areas at risk is Policy Option 5: *areas of moderate to high flood risk where we can generally take further action to reduce flood risk.* This policy will tend to be applied to those areas where the case for further action to reduce flood risk is most compelling. The CFMP vision is to improve the co-ordination between the multiple organizations that manage the various sources of risk.

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

Political Drivers	**Exist?**	**Summary Description**
Catchment Flood Management Plan	Yes	River Aire CFMP 2010
Catchment Flood Management Policy	Yes	Policy 5: Areas of moderate to high flood risk where we can generally take further action to reduce flood risk
Economic Drivers	**Exist?**	**Summary Description**
Enable Development	Yes	There is potential development at this site but is dependent on flood risk and the outcome of this options analysis.
Technological Drivers	**Exist?**	**Summary Description**
Improved Public Safety	Yes	Via reduced flood risk.
Environmental Constraints	**Exist?**	**Summary Description**
World Heritage Site	Yes	World Heritage Site lies approximately 500m east of the Benefits area. A full impact assessment should be conducted once an option has been selected.

1.2 Problem and objectives

1.2.1 Problem

The event of the 25th to 29th December was the result of a weather front which travelled in a north easterly direction immediately following behind storm Eva. The front first passed over West Yorkshire before heading across through North Yorkshire.

The more significant rainfall totals and rainfall return periods occurred for the peak 24 hour and 36 hour period over the 25th and 26th December. During this time, the average monthly rainfall for December fell over the Pennine edge of West Yorkshire and through central North Yorkshire.

[1] https://www.gov.uk/government/publications/river-aire-catchment-flood-management-plan

Rainfall return periods of more than 1 in 50 years were recorded in parts of the upper Calder, upper Aire, and middle Wharfe catchments for the 24 hour peak totals.

The only data available, regarding the flow in the river Aire at Branksome Drive, is from a gauge station located roughly 10 Km upstream of the site. At the Gauge station of Kildwick, was recorded a flow 163 m3/s corresponding to an 80- 100 years return period. It is possible to note that the return period of rainfall and flow is quite different, this is because the rainfall fell on already saturated ground and into rivers that were already high.

There are three properties at risk of fluvial flooding due both to the elevation and proximity to the River Aire. During the Boxing Day event, all the ground floors of the properties at Hirst Mill were flooded from the river.

The gardens adjacent to the property are raised above the river and are retained by a concrete wall. The properties themselves back on to the garden. During the Boxing Day flooding, residents observed water overtopping this wall by approximately 0.5m, inundating the garden and flooding the properties. The threshold levels of the properties are set a few centimetres above the level of the garden and top of wall.

1.2.2 Objectives

The objectives of this initial assessment are to assess the current condition of the site and evaluate the possible options for reducing flood risk at the property.

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.

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

In line with guidance, 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.

Table 1.1 Number of Properties at Risk (based on Dec 2015 flood)

Property Type	Flood Risk	Number of Properties
Residential	≥1 in 25 year (4% AEP) (Very Significant Risk)	3
	<1 in 25 year (4% AEP) ≥1 in 75 year (1.33% AEP) (Significant Risk)	0
	<1 in 75 year (1.33% AEP) ≥1 in 200 year (0.5% AEP) (Moderate Risk)	0
Non-Residential	≥1 in 25 year (4% AEP) (Very Significant Risk)	0
	<1 in 25 year (4% AEP) ≥1 in 75 year (1.33% AEP) (Significant Risk)	0
	<1 in 75 year (1.33% AEP) ≥1 in 200 year (0.5% AEP) (Moderate Risk)	0

Detail of the methodology used for assessing the benefits of each option is detailed in Appendix C.

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	Water Course / Areas Affected	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. Maintenance work are needed for channel and existing wall.	Yes	Represents current approach to asset maintenance and repair. Minor works to retain necessary performance.
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 the River Aire at Hirst Mill. Improving the current system would require further modelling which is beyond the scope of this study.
Non-structural (by EA)	Flood action plans		Improved direction of reactionary flood defence measure (fire crews, temporary pumps, etc.)	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 via air brick covers and door guards.	Yes	PLP is assumed to be viable for all ground floor residential properties in the very significant risk band. However, the depth of flooding at these properties would have to be analysed at the next stage, as PLP is only suitable where the flood depth is less than 500mm and

Category	Long List Option	Water Course / Areas Affected	Description	Take Forward for assessment?	Reasoning / Notes / Past Study Reference
					duration less than 3 days.
Structural	Earth bunds		Flood bund	No	This option is not being taken forward in the assessment. The land take in the back garden will be significant and make the construction difficult.
Structural	Flood walls		Flood walls	Yes	Construct a flood defence wall along the property boundary facing the river. If possible this would build on the existing wall and replace the railings in the current wall. It may however be necessary to replace the entire wall.
Structural	Temporary defences		Demountable flood walls, flood gates etc.	Yes	The wall can remain unchanged, but by necessity due to high level in the river protection can be added.
Structural	Conveyance		Channel deepening or widening	No	River is quite wide at this location. Any adjustments to channel profile would affect weir hydraulics.
Structural	Conveyance		River restoration and/or pinch point improvements (bridges, culverts and weirs)	No	The weir is in good condition with recent work undertaken to add energy dissipating boulders. The efficiency of the weir is also not judged as a reason of the flooding.
Flood storage area	Online		Use of active structures and re-profiling to store water online.	No	A large scale FSA system was considered in the Upper Aire SFRA and would reduce flood levels at Hirst Mill. However this is a large-scale

Category	Long List Option	Water Course / Areas Affected	Description	Take Forward for assessment?	Reasoning / Notes / Past Study Reference
					scheme that will have significant impacts beyond the Hirst Mill area and is considered to be outside of the scope of this appraisal.

1.4.1 Shortlisted Options Description

The options below were chosen to be taken forward for assessment in the initial assessment

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.

There could be some advantages of this option in the form of habitat creation due to wetting of dry areas and naturalisation of channel, however, this is also likely to increase the risk for the urbanized areas.

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 failure and deterioration of assets and blockages to the channel.

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 maintenance requirements for existing structures and assets, 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.

Initially the Do Minimum option will sustain current standard of protection to properties within the study area and there are no increase in costs associated with this option. However fluvial flood risk will increase over time due to climate change.

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

Option 1: Property Level Protection

This option is to offer property level protection (PLP) to the 3 ground floor properties in the Very Significant risk band. 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 protect against surface water as well as fluvial flooding. Any changes would need to be in keeping with surroundings.

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. Furthermore, 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 bank (based on NaFRA), and where flooding is less than 500mm deep. The effectiveness of PLP reduces with long duration floods due to seepage. Deliverability of this option is reliant on the residents up take of PLP.

Option 2: Flood wall

This option consists of replacing the existing wall which consists of stone columns with railings between, with a continuous wall.

Evidence from residents states that the level of the water during the Boxing Day 2015 event was 0.5 m above the base of the railings in the existing wall. A return period of 80-100 years has been estimated for the flow in the River Aire during the Boxing Day event.Therfore for a SOP of 100 years, it is assumed that the height of the wall from the base of the railings would have to increase by 0.5m plus an allowance for freeboard.

. However, following confirmation of the required standard of protection, and subsequent modelling, the exact height may be above this level.

The wall could be constructed from reinforced concrete, brick, stone or timber and cladding may be required in order to match the other elements of the house. There are approximately 10 sections to cover between the columns, each approximately 2m in length.

Option 3: Temporary defences

In order to maintain the current visual appearance of the property, customised temporary defences could be utilised and installed when required. These defences may consist of aluminium or timber stop logs, and would be put in place by sliding them into specific grooves cast into the existing columns. Other options are also available and can be considered during the detailed appraisal.

There are approximately 10 sections to be covered between the columns, each approximately 2m in length, and as for option 2 the temporary defences would need to be 0.5m high plus an allowance for freeboardThe material should be as light as possible to allow the residents to manage it easily and quickly. A flood warning should also be issued giving enough time to the residents to put in place the devices.

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 assets will be required at some point during the appraisal period after the initial construction phase. The timing of these replacements is based on the EA's Asset Deterioration Guidance (2013), an appraisal period of 100 years has been used and the assumptions are outlined in Appendix B. Table 1.2 shows the initial cost and annual maintenance costs of the option and is assumed that a major replacement of the assets will be required at some point during the appraisal period.

Table 1.2 Project costs (£k)

Item	Do Minimum	Option 1	Option 2	Option 3
Construction Costs		26	22*	81
Environment Agency staff		4	3	13
Consultant fees (appraisal)		2*	1*	5*

Item	Do Minimum	Option 1	Option 2	Option 3
Consultant fees (design)		6	5*	17
Consultant fees (construction)		2*	1*	5*
Site investigation & survey		0.1*	0.1*	0.1*
Land purchase		0.1	0.0	0.0
Optimism Bias (44%)		17	14	53
TOTAL		**57**	**47**	**174**
Annual Operation and Maintenance Costs (including optimism bias)	0.5	0.5	0.5	0.5

*Cost seem low for some of the activities but it is expected that these activities would be part of a package of work; eg ground investigation for several sites, so adjustments to the costs have not been made, and also there is an optimism bias of 44%. The above costs are just for Hirst Mill.

1.5 Initial environmental assessment

Table 1.3 Key environmental impacts, mitigation and opportunities

Key positive impacts	Key negative impacts	Mitigation/ enhancement opportunity
Option 1		
-Reduced risk of fluvial flooding, -Low risk of pollution incidents and disruption to area during construction. -Low aesthetic effect	Option only protects properties and not surrounding land.	
Option 2		
Reduced risk of flooding	-Construction work takes place alongside watercourse. Risk of pollution incidents and disruption to area during construction -Aesthetic impact	-Best practice should be followed including referring to EA Pollution Prevention Guidance -Upholstery by stone
Option 3		
-Reduced risk of flooding -Low aesthetic effect	Construction work takes place alongside watercourse. Risk of pollution incidents and disruption to area during construction	Best practice should be followed including referring to EA Pollution Prevention Guidance

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.

If this project is taken forward for further appraisal it is recommended that consultation is focused on, but not limited to, the following:

- Residents in the area at risk
- Riparian landowners, especially owners of riverside walls acting as informal defences.

1.7 Economic summary and preliminary preferred option

Table 1.4 summarises the economic assessment carried out for all options. The calculations for PV benefits area shown in Appendix D. The options are ordered by benefit (lowest benefit first).

The benefit values are estimates based on the methodology detailed in Appendix C. There is significant uncertainty in these estimates, which are based on Weighted Annual Average Data (WAAD) from the Multi-Coloured Manual (MCM, 2015/16). If this project progresses to further appraisal the benefits of these options should be more accurately assessed though hydraulic modelling and use of the more detailed flood depth / damage data from MCM.

Table 1.4 Benefit-cost assessment

	PV costs (£k)	PV benefits (£k)	Av. BCR	Incr' BCR	Option for iBCR calc	Comments
Do Nothing						
Do Minimum	16	5	0.3			
Option 1	87	179	2.1	2.5	Do Minimum	
Option 2	67	179	2.7	3.4	Do Minimum	Highest ABCR
Option 3	236	179	0.8	0.8	Do Minimum	

1.7.1 Funding and contributions

Preliminary estimates for Partnership Funding scores for Options 2 has been calculated as shown in Table 1.5.

Table 1.5 FDGiA Funding Calculator

Contributions to outcome measures	Option 2
OM1 – Economic Benefit:	
Benefit period used for Partnership Funding calcs	*69*
PV Benefits (£k)	*165,306*
PV Costs (£k)	*62,135*
Benefit/Cost ratio	*2.7*
OM2 – No. of households moved out of any flood probability category to a lower category	3
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	0
OM2c – No. of households in the 20% most deprived areas moved from the very significant or significant flood probability	3

category to the moderate or low category	
Partnership Funding (PF) Score	54%
Contributions required for a PF score of 100%	£28,735
Contributions required for a PF score of 120%	£34,301

. Other potential funding sources identified include:

- Community Infrastructure Levy
- Benefitting local businesses
- Council Tax
- Local Enterprise Partnerships

1.7.2 Key delivery risks (economic, social and environmental)

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

Table 1.6 Risks and mitigation

Risk	Key Mitigation
Insufficient 3rd party Funding available to allow scheme to progress.	Assess potential funding options before progressing scheme appraisal further.
Risk of reducing the aesthetics of buildings (PLP)	When considering resistance measures keep in mind their impact on aesthetics of buildings (PLP)
Inaccurate benefits assessment due to limited understanding of flood risk hence unreliable approach to economic damage calculations used for IA's.	A more accurate damages assessment based on hydraulic modelling and flood depth damage data should be considered before progressing to further appraisal.
Accuracy of costs	A more refined and detailed cost estimate should be completed in conjunction with the benefits review.

1.8 Project Scoring

The data used in this assessment has been subjected to a RAG assessment. 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 greens(well defined, not likely to be an issue) respectively. The results are shown below:

- A – Problem Definition: The flooding mechanisms are simple and well defined – **GREEN**
- B – Economic Case: The benefits assessment has been based on moving properties from flood risk bands and weighted average annual damages – **RED**
- C – Funding: The options are likely to require external funding. Work will be needed to obtain founding but there are opportunities – **AMBER**

- D – Engineering case: Solutions taken to outline design are common defence options, no particular issues are expected – **GREEN**

- E – Permissions & Consents: Solutions are unlikely to require unusual permissions or consents, but permission for third party properties is required – **AMBER**

- F – Environmental sensitivities: Initial environmental assessments has been completed based on outline options – **GREEN**

- G – Opportunities: Some potential opportunities for partnership working but minimal environment opportunities – **AMBER**

Model. A	Econ. B	Funding C	Eng. D	Permission E	Env. F	RAG	Opps. G
1	3	2	1	2	1	123	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:

- A more accurate damages assessment based on hydraulic modelling and flood depth damage data should be considered before progressing to further appraisal.

Table 1.7 outlines key dates if these option move forward for further appraisal.

1.10 Conclusions and Recommendation

The main risk of flooding within Hirst Mill is fluvial from the overtopping of river banks, the existing flood risk is moderate to high. There was significant flooding in the area during Boxing Day 2015 from the River Aire. Option 2, raising the existing flood wall provides the highest ABCR. The option is eligible for 54% of the costs being funded by FDGiA funding.

Appendices