

## Project Appraisal Report

Authority Scheme Reference	IMAN 000628
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Defra / WAG LDW Number	
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Promoting Authority	Environment Agency – Anglian Region
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Scheme Name	Bin Brook Flood Alleviation Scheme
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Date	August 2007
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Version	1
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<b>EA APPROVAL HISTORY SHEET</b>			
Project Title:	Bin Brook Flood Alleviation	Agency Project Code:	LMB 13244
Agency Project Manager:	Steve Peck	Date of PAR:	Aug - 07
Consultant Project Manager:	Graham Boakes	Consultant:	Halcrow
<b>AGENCY STAFF INVOLVEMENT</b>			
Position	Name	Signature	Date
"I have reviewed this document and confirm the project meets EA and Defra/WAG investment appraisal criteria and recommend that the existing system is maintained with no improvement in standard of protection."			
Originator (PM)			
Reviewer (Project Executive)			
"I confirm I am content that the existing system is maintained with no improvement in standard of protection."			
Client Representative			
NEAS Unit Manager			
"I have reviewed this document and confirm that it complies with the current PAR guidelines"			
PAR Reviewer			
"I confirm the project is ready for submission to PAB/NRG"			
Operations Manager			
<b>NRG – National Review Group (Schemes greater than £2 million)</b>			
Date of Meeting:	Chairman:	PAR Amendment No:	
<b>Project Presenter(s):</b>			
Detailed record of any comments/actions required/additional information provided, to be appended to the PAR for onward transmission			
<b>Recommended for approval:</b> In the sum of £0		<b>Date:</b>	
<b>PROJECT APPROVAL</b>			
<b>AGENCY</b>	Officers in accordance with the Agency's SoD: Specified Officer; Regional Director; Director of Operations; Chief Executive or Director of Finance: Agency Board		
PAR Submitted	<b>Date:</b>		
PAR Approved	<b>By:</b> In the sum of £	<b>Date:</b>	
<b>Defra or WAG APPROVAL (delete as appropriate)</b>			
Submitted to Defra / WAG or Not Applicable (as appropriate)		<b>Date:</b>	
PAR Amendment No. (if different):			
Defra/ WAG Approval: or Not applicable (as appropriate)		<b>Date:</b>	
Comments:			

### Notes

- Signatures required for "Agency Staff Involvement" boxes.
- Agency Project Manager to complete (or delete as appropriate), the subsequent boxes as the project is progressed, to provide a complete record of the approvals history.



## FINANCIAL SCHEME OF DELEGATION (FSoD) COVERSHEET

1. <b>Project name</b>	Bin Brook Flood Alleviation			<b>Start date</b>	2004/05
				<b>End date</b>	2007/08
<b>Business unit</b>	Central Area	<b>Programme</b>	Stand alone		
<b>Project ref.</b>	IMAN 000628	<b>Regional FSoD ref.</b>	LMB 13244	<b>Head Office FSoD ref.</b>	-

2. <b>Role</b>	<b>Name</b>	<b>Post Title</b>
<b>Project Sponsor</b>	Dave Gillett	Area Flood Risk Manager
<b>Project Executive</b>	Chris Allwork	Project Team Manager
<b>Project Manager</b>	Steve Peck	Project Manager

3. <b>Outline Risk Assessment (ORA) Category</b>	<b>Low</b>	<input checked="" type="checkbox"/>	<b>Medium</b>	<input type="checkbox"/>	<b>High</b>	<input type="checkbox"/>
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4. <b>FSoD schedule</b>	<input type="checkbox"/>	<b>Description</b>	<b>Delegation</b>	
			<b>Regional – up to</b>	<b>Environment Agency – up to</b>
<b>A1</b>	<input type="checkbox"/>	Non FRM project	£5m	£5m
<b>A2</b>	<input type="checkbox"/>	FRM project within approved strategy	£5m capital	£50m WLC Defra/£5m capital NAW
<b>A3</b>	<input checked="" type="checkbox"/>	FRM project outside of approved strategy	£5m capital	£50m WLC Defra/£5m capital NAW
<b>A5</b>	<input type="checkbox"/>	Consultancy project	£300k	£500k
<b>A9</b>	<input type="checkbox"/>	FRM Strategy	£500k	£50m WLC Defra/£5m capital NAW
<b>O1</b>	<input type="checkbox"/>	IS/IT project	--	£5m
<b>T2</b>	<input type="checkbox"/>	Purchase or lease of land and buildings	£40k purchase/£10k pa lease	£5m

5. <b>FSoD value</b>	<b>£k</b>
<b>Preparation costs for Form A/Business Case/PAR/FRM Strategy</b>	200
<b>Project costs</b>	
<b>Whole Life Costs (WLC) of FRM Project or Strategy</b>	200

6. <b>Required level of Environmental Impact Assessment (EIA)</b>	<b>N/A</b>	<b>Low</b>	<b>Medium</b>	<b>High</b>
	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>

7. <b>FSoD approver name</b>	<b>Post title</b>	<b>Signature</b>	<b>Date</b>
<b>FSoD consultee name</b>	<b>Post title</b>	<b>Signature</b>	<b>Date</b>
	PAB/NRG Chair		
	<input type="checkbox"/> <b>RED</b> <input type="checkbox"/> <b>AMBER</b> <input type="checkbox"/> <b>GREEN</b>		

8. <b>Form G</b>	<b>Form G value (£k)</b>	<b>Regional FSoD ref.</b>	<b>Head Office FSoD ref.</b>	<b>Latest FSoD authorised cost (£k)</b>
1			-	
2				
3				



## 1 EXECUTIVE SUMMARY

### TO CONTINUE TO MAINTAIN THE EXISTING SYSTEM WITH NO IMPROVEMENT IN STANDARD OF PROTECTION.

#### Anglian Region:- Bin Brook Flood Alleviation Scheme

#### Sponsoring Director:- Paul Leinster – Director of Operations

Section A3 of the Financial Scheme of Delegation states that, for a Flood Risk Management project outside of an agreed strategy Regional Director approval is required for project expenditure less than £5,000,000

<b>Route:</b>	National Capital Programme Manager	Miles Jordan
	National Review Group	Ken Allison
	Regional Director	Paul Woodcock
	Director of Operations	Not applicable
	Director of Finance	Not applicable
	Chief Executive	Not applicable
	Defra /WAG	Not applicable
	Treasury	Not applicable

### 1.1 Introduction and Background

This Project Appraisal Report presents the business case and project plan for the continued maintenance of the existing Bin Brook without improvement of standard of protection. Bin Brook is located in the western part of the City of Cambridge. The key objective is to confirm that it is viable to continue maintenance and that it is not justifiable to alleviate flooding problems in the Gough Way housing estate and two Cambridge University halls of residence. Bin Brook is currently main river from its confluence with the River Cam to the Cambridge City boundary (immediately upstream of Gough Way) and non-main river upstream of the boundary. If a flood alleviation scheme were to be implemented the brook would be en-mained over a length of 1.5km up to and including the flood storage area examined as one of the options in this report. The Environment Agency has the powers to undertake the project under the Water Resources Act 1991.

### 1.2 Problem

When the Gough Way estate was built in the early 1970's, Bin Brook was culverted under part of the estate; this culvert has insufficient capacity to pass flood flows. Flooding occurred in Gough Way in 1978 and following this event a relief channel was constructed around the estate to increase flow capacity. Despite construction of this channel, flooding occurred again in October 2001.

The flood risk area falls into Land Use Band A – an intensely developed urban area. 55 houses and 2 university halls of residence are at risk of flooding. The lowest properties are at risk of flooding during a flood with a 1 in 10 (10%) chance of occurrence each year although most houses are first affected by a 1 in 25 (4%) to 1

in 50 (2%) flood. This is lower than the minimum Defra indicative standard of a 1 in 50 (2%) chance of flooding each year for Land Use Band A. 38 properties were flooded during the 2001 event.

The receiving watercourse, the River Cam, has insufficient capacity for any increased flow and would accordingly benefit from a reduction in flow from Bin Brook.

The residents in the area have formed a flood action group, The Gough Way Residents Association, which has been very active in promoting the implementation of a flood alleviation scheme.

### **1.3 Options**

From a longer list of options considered the following were taken forward for further consideration:-

- Option 1 - Do Nothing, maintenance of the existing channel and culverts would stop reducing the existing standard of protection.
- Option 2 – Maintain the existing system and to continue to provide a standard of protection less than the indicative standard.
- Option 3 – Flood storage with fixed control in combination with flood walls at Gough Way with an annual standard of protection of 1 in 75 (1.3%) chance of flooding each year.
- Option 4 – Flood storage with fixed control in combination with flood walls at Gough Way with an annual standard of protection of 1 in 100 (1%) chance of flooding each year.
- Option 5a – Flood storage with automatic control with an annual standard of protection of 1 in 50 (2%) chance of flooding each year.
- Option 5 – Flood storage with automatic control with an annual standard of protection of 1 in 75 (1.3%) chance of flooding each year.
- Option 6 – Flood storage with automatic control with an annual standard of protection of 1 in 100 (1%) chance of flooding each year.

Other options involving increasing flow capacity around Gough Way were considered in outline but were rejected because they increased flood risk downstream and were not sustainable.

Providing a higher standard of protection than 1 in 100 (1%) was also considered in outline but was found not to be feasible due to the limitation of flood storage volume within the existing topography of the flood storage area.

### **1.4 Preferred Option**

The preferred option resulting from the FCDPAG3 decision process is Option 2 to maintain the existing system and to continue to provide a standard of protection less than the indicative standard.

The improve option with the highest benefit cost ratio is Option 6, flood storage with automatic control, increasing the standard of protection to 1 in 100 (1%) chance of flooding each year. The flood storage area would be created by constructing a 700m long dam with a maximum height of 3.6m across the Bin Brook valley. Also, because

it avoids the need for flood walls in private gardens, it is the preference of local residents and the Agency's Operations Delivery and Environmental Assessment representatives. Unfortunately this option cannot be justified by the Defra Decision Rules because the incremental benefit cost ratio above the maintain option is less than unity.

The Health and Safety aspects of the flood storage area have been considered in conjunction with the Operations Delivery representatives and are considered to be satisfactory.

## 1.5 Economic Case and Priority Score

The economic case is summarised in Table 1.

**Table 1 Benefit-cost ratios and priority scores for the Preferred Option 2**

Present Value benefits (100 year period)	£13,894k
Present Value costs (100 year period)	£385k
Net present value	£13,509k
Benefit cost ratio	36.1
Cost per residential property (Number 55)	£7k
Defra priority score	
Not applicable to the maintain option	

## 1.6 Environmental Considerations

1.6.1 A flood storage scheme would be subject to formal Environmental Impact Assessment (EIA) under Schedule 2 of the Town and Country Planning (Environmental Impact Assessment) (England and Wales) Regulations, 1999 (SI 293).

1.6.2 A Scoping Report has been produced, and if the scheme moves forward in the future, an Environmental Statement (ES) will be produced in line with the regulations.

1.6.3 A flood storage scheme would require planning permission from the competent authority, South Cambridgeshire District Council (SCDC). A letter of support has been obtained from Natural England.

1.6.4 An Indicative Landscape Plan is included in Appendix D.

1.6.5 Assessment work carried out at the scoping stage has found that the potential for significant environmental risk is low. Further investigative work would be required in connection with ecology, archaeology and contaminated land but the level of risk is low and could be managed during the design and construction stages.

1.6.6 The flood storage area would be located in a rural agricultural landscape, the ecological value of the potential flood storage area is limited to arable field margins. Environmental impacts are small and can be managed. There are significant environmental benefits. The flood storage area would be within the Coton Countyside Reserve that is currently being developed by the Cambridge Preservation Society (CPS). The dam would form a noise barrier between the M11 motorway and the

Reserve and the borrow area would be developed into a wetland creating, 1.5ha of BAP habitat, that would form an integral part of the reserve.

1.6.7 No significant environmental mitigation actions would be required.

1.6.8 An improvement scheme would reduce the flood risk to 55 houses. The wetland within the Countryside Reserve would provide significant recreational, amenity and environmental enhancements accessible by footpath from the City of Cambridge.

1.6.9 A consultation process has been undertaken including a public exhibition and questionnaires issued to all residents in the area and other interested parties. There was considerable response supporting a flood storage scheme and no serious objections. All consultees who responded rejected the preferred Option 2 to maintain the existing system with no improvement to standard of protection.

## 1.7 Risks

The main project risks to a flood storage scheme are listed in Table 2.

**Table 2 Risks and mitigation**

<b>Risk</b>	<b>Key Mitigation</b>
Change in CPS policy requiring payment for land	Incurring land purchase costs at commercial rates would require the project to be re-appraised. However agreement with CPS has been reached in principle. (Appendix P)
Clay quality or quantity in borrow area is less than expected	Risk analysis includes an allowance for importing clay for the dam core
Works cost increase due to design changes	An allowance is included in the risk analysis.
Archaeological find causes delay	An allowance is included in the risk analysis.
Scheme is delayed due to unavailability of funding or other reason	An allowance is included in the risk analysis.

## 1.8 Implementation

There is no proposal to implement an improvement scheme.

Had a scheme been approved the Key Dates shown in Table 2 were envisaged.

**Table 3 Key Dates**

Activity	Planned Date
FSOD A3 approval received	September 2007
Planning Approval and Mineral Extraction Licence application and approval	September 2007 – January 2008
Instruct Cambridge Water to divert water main	January 2008
Cambridge Water divert water main	July 2008 – September 2008
Detailed design of flood alleviation scheme	April 2008 – August 2008
Contractor target setting and award contract	August 2008 – November 2008
Construction of flood alleviation scheme	April 2009 – September 2009

The preferred option is Option 2 – Maintain the Existing System, there are therefore no costs except for sunk costs and future maintenance. Table 4 is included for information giving costs for a flood storage area with a 100 year standard of protection (Option 6), including the risk allowance, over the 100 year appraisal period.

**Table 4 Project Costs for Option 6 (Note table completed for information only, the preferred option is Option 2 to maintain the existing system)**

Item	Economic appraisal	Whole Life Cash Cost	SoD Approval
Costs pre PAR (outline design)	sunk costs	200,000	
<b>Costs post PAR</b>			
Agency costs	60,000	60,000	60,000
Consultant Fees	217,000	217,000	217,000
Cost consultant fees	6,000	6,000	6,000
Investigations	70,000	70,000	70,000
Construction	1,476,000	1,476,000	1,476,000
Environmental enhancement costs	20,000	20,000	20,000
Compensation	99,000	99,000	99,000
Contingency			
95%ile (represents 14% of project SoD approval)	345,000		345,000
50%ile (represents 5% of project SOD approval)		125,000	
Inflation 5%			268,000
Future costs (maintenance etc)	788,000	2,715,000	
Other (specify)			
<b>TOTAL</b>	<b>3,081,000</b>	<b>4,988,000</b>	<b>2,561,000</b>

For a full breakdown of costs see Section 2.4 and the Cost Appendix, Price Base December 2006

## 1.9 Contributions and Funding

There are no contributions from outside sources other than Cambridge Preservation Society's offer to provide the land for construction of the flood storage area free of charge, though compensation for periodic flooding would be paid. The Cambridge Preservation Society has also undertaken to carry out and maintain landscaping.

## **1.10 Status**

The project is stand alone and does not form part of a wider strategy.

The preferred option is to maintain the existing system and it therefore does not contribute to the national housing target.

As an improvement scheme cannot be justified, 55 houses and parts of two university halls of residence will continue to remain at risk of flooding and will inevitably be flooded again at some time in the future. The decision not to improve flood protection may cause significant adverse public relations.

The scheme would have been developed in partnership with the Cambridge Preservation Society (CPS) and would have assisted in the development of a proposed new Countryside Reserve. In addition to reducing flood risk to properties, the improvement scheme would have presented significant opportunities, in collaboration with CPS, for the creation of new wetland habitats contributing to BAP Targets, and landscape enhancements and improvements to public access in line with the Environment Agency's wider objectives.

## **1.11 Recommendations**

A scheme to improve the standard of protection to the properties at risk of flooding cannot be justified. This decision arises because in the Do Minimum (maintain) scenario most of the houses at risk of flooding have a standard of protection between 1 in 25 and 1 in 50 years (2% – 4%) and there is therefore only a small incremental benefit in raising the standard of protection to 1 in 50 years (2%). This is a logical decision to ensure a fair allocation of limited funds between schemes. It avoids expenditure when the existing standard of protection is near to the bottom end of the indicative range, even though an improvement scheme to a higher standard would have a robust benefit cost ratio.

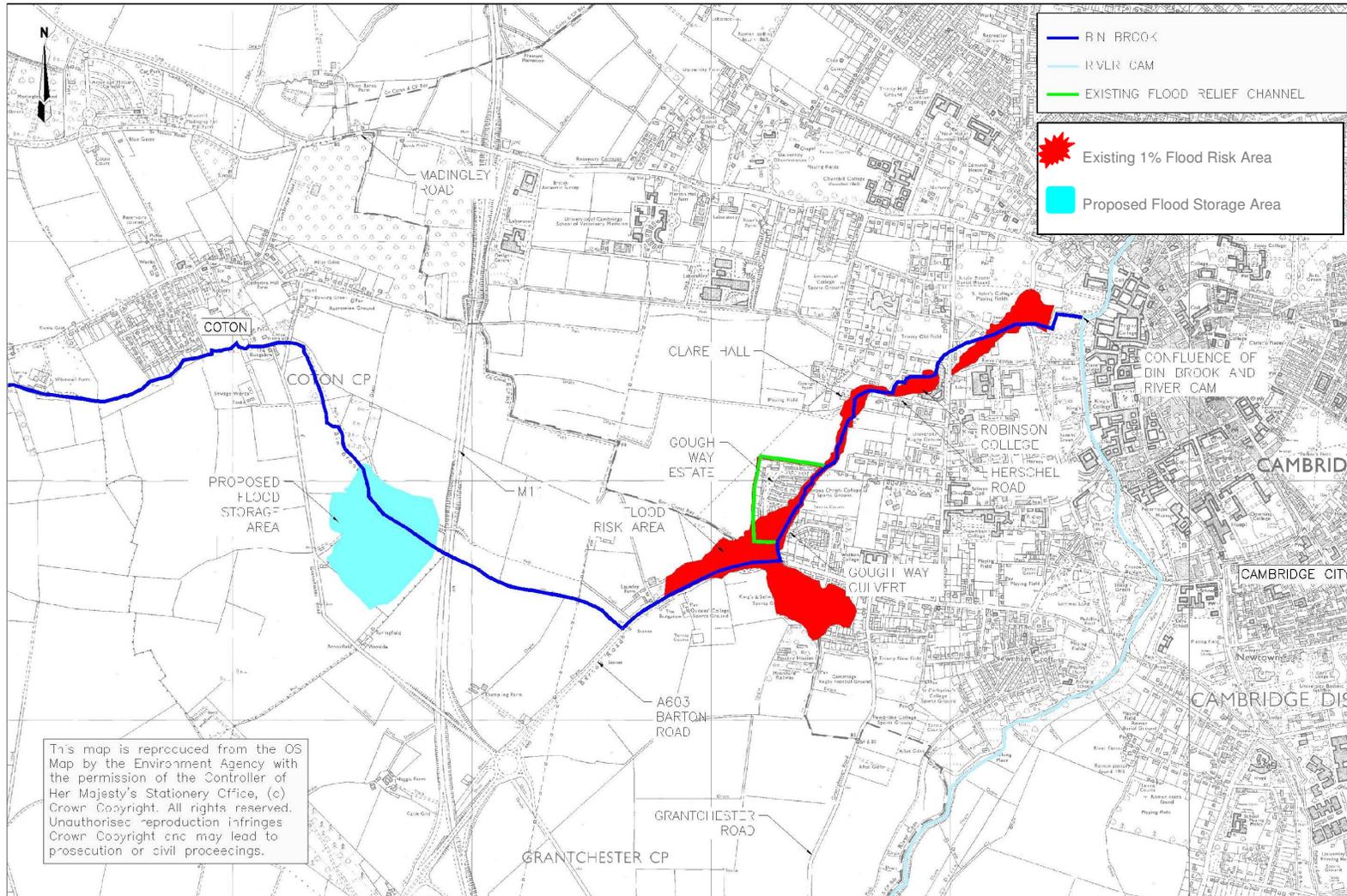
The NRG economist, Bill Watts, has been consulted and he has confirmed that this is the correct decision and that NRG would be unlikely to approve an improvement scheme in the current financial climate.

It is therefore recommended that Option 2 - Maintain is adopted. The existing Bin Brook channel and culverts should continue to be kept clear of debris in order to maintain the existing standard of protection. It is recommended that the project viability is reviewed if the current funding rules change.

## 1.12 Director's Briefing Paper

<b>Region:</b>	Anglian	<b>Project Executive:</b>	Chris Allwork		
<b>Function:</b>	Flood Defences	<b>Project Manager:</b>	Steve Peck		
<b>Project Title:</b>	Bin Brook Flood Alleviation		<b>Code:</b>	LMB 13244	
<b>NEECA Consultant:</b>	Halcrow	<b>NCF Contractor:</b>	Breheny	<b>Cost Consultant:</b>	N/A
<b>The Problem:</b>	When the Gough Way Estate was built in the early 1970's Bin Brook was culverted under part of the estate, this culvert has insufficient capacity to pass flood flows. Flooding occurred in Gough Way in 1978 and following this event a relief channel was constructed around the estate to relieve the culvert. Despite construction of this channel, flooding occurred again in October 2001 flooding 38 houses.				
<b>Assets at risk from flooding:</b>	55 houses and 2 university halls of residence				
<b>Existing standard of flood protection:</b>	1 in 10 (10%) to 1 in 50 (2%)	<b>Proposed standard of flood protection:</b>	No change		
<b>Description of proposed scheme:</b>	Continue to maintain the existing system with no improvement in standard of protection				
<b>Costs (PVC): (100 year life inc. maintenance)</b>	£385k	<b>Benefits: (PVb)</b>	£13,894k	<b>Ave. B: C ratio: (PVb/PVc)</b>	36.1
<b>NPV:</b>	£ 13,509k	<b>Incremental B: C ratio:</b>	N/A	<b>Whole life cost (cash value):</b>	£1,565
<b>Choice of Preferred Option:</b>	The choice of preferred option has been made following the PAG 3 Decision Rules. It is preferred economically but not operationally or environmentally.				
<b>Total cost for which approval is sought:</b>	£ N/A				
<b>Delivery programme:</b>	N/A				
<b>Are funds available for the delivery of this project?</b>	N/A				
<b>External approvals:</b>	N/A.				
<b>Defra approval:</b>	N/A				

## 1.13 Key Plan



## **2 BUSINESS CASE**

### **2.1 Introduction and Background**

#### *2.1.1 Purpose of Report and Methodology*

This Project Appraisal Report presents the business case and project plan for the continued maintenance of the existing Bin Brook without improvement of standard of protection. Bin Brook is located in the western part of the City of Cambridge. The key objective is to confirm that it is viable to continue maintenance and that is not viable to alleviate flooding problems in the Gough Way housing estate and two Cambridge University halls of residence. The study has been carried out in accordance with the FCDPAG Series of documents.

#### *2.1.2 Location*

The study area is shown on Figure 1 and is centred on National Grid Reference TL 433 578. Bin Brook is a tributary of the River Cam, flowing west to east and joining the River Cam in the centre of Cambridge. The brook flows underneath the Gough Way estate in a 1.55m diameter culvert which was constructed when the houses were built. There is also a flood relief channel around Gough Way, by-passing the culvert, which was constructed following flooding in 1978. Bin Brook is currently main river from its confluence with the River Cam to the Cambridge City boundary (immediately upstream of Gough Way) and non-main river upstream of the boundary.

All of the works options considered in detail include the construction of a flood storage area to the west of the M11 motorway. The potential flood storage area is owned by the Cambridge Preservation Society and is currently being developed into a country park known as the Coton Countryside Reserve. Material for the dam creating the flood storage area would be obtained from a borrow area adjacent to the dam and would be developed into a wetland area forming an integral part of the country park. The dam would also form a noise and visual barrier between the M11 and the country park. There is the potential to create 1.5 ha of BAP habitat within the wetland area.

#### *2.1.3 Legislative Framework*

Any works would be carried out under the powers of Section 165 of the Water Resources Act 1991.

#### *2.1.4 Designations*

There are no environmental designations, scheduled ancient monuments or listed buildings in the project area.

An Environmental Scoping Report has been prepared (Appendix J) this has shown that there are no major environmental constraints and that all environmental issues can be managed.

## 2.2 Problem

### 2.2.1 History of Flooding

Flooding of property occurred in Gough Way in 1978 and following this event a relief channel was constructed around the estate to provide additional capacity to the culvert which passes underneath the estate. Despite construction of this channel, flooding occurred again in October 2001 when 38 properties were flooded.

The area at risk of flooding is shown on Figure 2. The number of properties at risk of flooding is shown in Table 5.

**Table 5 Properties at Risk of Flooding**

	1 in X Year Event						
	5	10	25	50	75	100	200
Do Nothing*	32	49	50	57	57	57	64
Maintain*	0	1	8	51	51	52	52
Property Description							Number
Number of buildings "written off" in the Do-Nothing Scenario							3 no
Number of buildings with 1 in 100 (1%) chance of flooding each year							57 no
Number of residential properties with 1 in 100 (1%) chance of flooding each year							55 no
Total number of commercial properties with 1 in 100 (1%) chance of flooding each year							2 no

\* In the Do-Nothing Scenario no further work would be carried out on Bin Brook. The channel and culverts would gradually become partially blocked. In the Maintain Scenario the channels and culverts are assumed to be completely unobstructed.

All but two of the properties at risk of flooding are houses. The two other properties at risk are the lower ground floor of Robinson College containing the refectory, kitchens and meeting rooms and Clare Hall, a Cambridge University residence for mature students.

### 2.2.2 Existing Defences

There are no existing raised flood defences. All options considered require the continued maintenance of the flood relief channel around, and culvert under, Gough Way.

### 2.2.3 Probability of Flooding

The current standard of protection (maintain option) for the first house effected by flooding is 1 in 10 (10%) chance of flooding each year, although most houses are first affected by a 1 in 25(4%) to 1 in 50(2%) flood. This is lower than the minimum Defra indicative standard of 1 in 50 years (2%) chance of flooding each year for an

intensely developed urban area at risk from fluvial flooding.

#### *2.2.4 Scope of Problem*

There are two discrete areas at risk of flooding:-

- The Gough Way Estate and surrounding residential areas of Barton Road and Fulbrook Road.
- Herschell Road which is about 600m downstream of Gough Way and where Clare Hall, Robinson College and 3 houses are at risk.

These areas are on the flood plain of Bin Brook and would have always have been subject to flooding even before they were developed. Increased run off through development, improved land drainage and climate change will have exacerbated the problem.

When Gough Way was constructed in the early 1970's a 200m length of Bin Brook was piped with a 1.55m diameter culvert. This culvert now passes under roads and footpaths within the estate. The culvert has insufficient capacity to pass the flow in Bin Brook and this resulted in flooding in 1978. Following the 1978 flood event, a by-pass channel was constructed around Gough Way so that the capacity of the by-pass channel and culvert together are similar to the capacity of Bin Brook before it was culverted. Despite construction of the by-pass channel, flooding occurred again on 21<sup>st</sup> October 2001 causing damage to houses in the Gough Way Estate, Barton Road, Fulbrook Road and Clare Hall. 38 houses were flooded internally up to a maximum depth of 900mm.

It should be noted that the Clare Hall buildings that are at risk of flooding pre-date the Gough Way Estate and that one of these buildings, 9 Herschell Road is particularly low lying. Robinson College is a newer building constructed in the 1980's in a flood risk area.

The receiving watercourse, the River Cam, has insufficient capacity for any increased flow and would accordingly benefit from a reduction in flow from Bin Brook.

#### *2.2.5 Strategic Issues (Justification for Approach)*

The problems associated with Bin Brook are confined to the brook itself. The project therefore does not fall within an overall strategy and strategy report.

We are currently developing a Great Ouse Catchment Flood Management Plan (CFMP) which will assess how flood risk may change and could be managed within the catchment over the next 50-100 years. The options link in with the flood risk management policies proposed by the CFMP. In particular it supports Policy 6 to take action to increase the frequency of flooding in one location to achieve benefits locally or elsewhere.

#### *2.2.6 Climate Change*

In the maintain scenario properties are first at risk of flooding during a flood event with a 1 in 10 (10%) to 1 in 50 (2%) chance of occurrence each year. Climate change may reduce this standard of protection further. The effect of climate change on the

preferred option is discussed in Section 2.7.5

### *2.2.7 Project Implementation Constraints*

A 600mm diameter water main belonging to Cambridge Water Company passes through the area proposed for flood storage and under the footprint of the potential dam. This water main supplies water to a large area to the west of Cambridge. Cambridge Water requires unobstructed access to the main at all times and will not accept construction of a dam over it or occasional flooding over it. Flood storage options therefore include for diversion of the water main in advance of the other works at a cost of £402,000. The flood storage area cannot be re-sited to avoid the water main as the main runs parallel to the brook over most of its length where the topography is suitable for flood storage. Diversion of the water main would be carried out by Cambridge Water.

Land for construction of the flood storage area is being offered free of charge by the Cambridge Preservation Society (CPS) as a means to construct a wetland area and noise and visual barrier in the Coton Countryside Reserve which is currently under development (Ref Section 2.1.4). This is equivalent to a cost saving of at least £130,000. If the scheme is delayed until after the reserve is developed, CPS may be reluctant to accept the disturbance caused by construction of the flood alleviation scheme and this cost saving and the opportunity to create a wetland may be lost.

### *2.2.8 Objectives to Be Achieved*

The objectives of the Bin Brook Flood Alleviation Scheme are to:-

- Reduce the risk of flooding from Bin Brook to the people, property and the natural environment surrounding the brook.
- Provide an optimum economic level of flood protection.
- To accommodate climate change.
- Promote sustainability principles in the scheme's design and construction.
- Take account of all social, environmental and economic issues.
- Comply with all legal requirements.
- Provide added benefit to the local community and the environment.
- Minimise environmental impacts on activities within and outside of the study area.
- Minimise health and safety risks during construction and the life of the scheme.

## **2.3 Options Considered**

### *2.3.1 Introduction*

A preliminary stage identified potentially viable options and estimated the level of the do nothing damages. Only options identified as viable at this stage were taken forward to full project appraisal.

### *2.3.2 Alternatives Considered*

Options taken forward are discussed in Section 2.3.3. However it was evident that the following options were not viable.

- Enlarging the existing diversion channel.
- Enlarging Gough Way Culvert.
- Providing flood walls in the Gough Way area.
- Providing a standard of protection of greater than 1 in 100 (1%) chance of flooding each year.
- Providing flood storage in the Fulbrook catchment or at an alternative site in the Bin Brook catchment.
- Providing a new relief channel from the flood risk area to the River Cam

Modelling showed that enlarging the existing diversion channel would be ineffective because of the limited capacity of the channel downstream.

Enlarging Gough Way culvert would also be ineffective due to the limited capacity of the channel downstream. It would also be extremely disruptive because it passes under roads and pavements and is adjacent to other buried services.

Providing flood walls around Gough Way would increase the flood risk downstream and compensatory works downstream are not a realistic possibility, this option was therefore not carried to full appraisal. It would also have not been practically possible to protect all at risk properties from flooding solely with flood walls.

To mitigate against increased flood risk downstream of Gough Way caused by the introduction of flood walls, upstream flood storage was considered. Flood storage in combination with flood walls (Options 3 & 4, Section 2.3.3) and flood storage alone (Options 5a, 5 & 6 in Section 2.3.3) were carried forward to full appraisal. The potential for flood storage is limited by the volume of water that can be stored within the existing topography at the proposed site. To increase the standard of protection above 1 in 100 (1%) chance of flooding each year, by increasing the volume of flood storage, would require excavation and disposal of material from within the site. This would increase the cost of the flood storage area from around £1 million to over £4 million which would be uneconomic.

Alternative flood storage locations in the Bin Brook or Fulbrook catchment were not considered in detail because:-

- no suitable storage sites were apparent in either catchment.
- the proposals for flood storage on Bin Brook were developed in collaboration with the land owner, the Cambridge Preservation Society, as an integral part of the Coton Countryside Reserve. The land is available free of charge, the scheme provides significant environmental benefits in the reserve and the proposed scheme fulfils the project objectives.

A new relief channel from the flood risk area to the River Cam would have to pass 1.5km through developed areas in Cambridge and is not a practical proposition.

### *2.3.3 Options Taken Forward*

The following seven options have been identified to be taken forward for appraisal, and are briefly described below. Their location is shown of Figure 3 (Appendix B) and details on drawings WNBINP 001 to 006 (Appendix C). A detailed description of the options is given in Appendix O.

- Option 1 – Do nothing
- Option 2 – Maintain the existing system and continue to provide a standard of protection less than the indicative standard. (Do Minimum)
- Option 3 – Flood storage with fixed control in combination with flood walls at Gough Way with a standard of protection of 1 in 75 (1.3%) chance of flooding each year.
- Option 4 – Flood storage with fixed control in combination with flood walls at Gough Way with a standard of protection of 1 in 100 (1%) chance of flooding each year.
- Option 5a - Flood storage with automatic control with a standard of protection of 1 in 50 (2%) chance of flooding each year.
- Option 5 – Flood storage with automatic control with a standard of protection of 1 in 75 (1.3%) chance of flooding each year.
- Option 6 – Flood storage with automatic control with a standard of protection of 1 in 100 (1%) chance of flooding each year.

#### *2.3.4 Climate Change and Over Design Events*

In accordance with FCDPAG4, a sensitivity analysis has been undertaken by increasing design flows by 20% to allow for the potential impact of climate change on the preferred option over its 100 year design life. This is discussed in Section 2.7.5 - Sensitivity to Climate Change.

All improvement options taken forward for appraisal involve flood storage and would be affected in the same way by climate change and over design events. Climate change will result in over design events occurring at a lower return period than the original design standard. During over design events, the dam in the flood storage area will overtop via a spillway designed to discharge the probable maximum flood without damage. Water overtopping the dam would be stopped by the M11 embankment to be channelled through the existing culvert under the M11 from where it would flow down Bin Brook. Depending on the severity of the event, water would eventually overtop Bin Brook to flood property, albeit to a lesser extent than it does now for any given inflow.

## **2.4 Cost of Options**

### *2.4.1 Price Base*

The price base for the economic appraisal is December 2006.

### *2.4.2 Cost Estimates*

Option costs are summarised in Table 6, additional information is given in Appendix F. The cost estimates are based on land for the flood storage area being provided free of charge by Cambridge Preservation Society.

**Table 6 Summary of Costs of Options**

<b>Element</b>	<b>Option 2 Do Minimum</b>	<b>Option 3 Flood Storage and Walls 1 in 75 (1.3%)</b>	<b>Option 4 Flood Storage and Walls 1 in 100 (1%)</b>	<b>Option 5a Flood Storage Only 1 in 50 (2%)</b>	<b>Option 5 Flood Storage Only 1 in 75 (1.3%)</b>	<b>Option 6 Flood Storage Only 1 in 100 (1%)</b>
	<b>(£k)</b>	<b>(£k)</b>	<b>(£k)</b>	<b>(£k)</b>	<b>(£k)</b>	<b>(£k)</b>
Divert Water Main		402	402	402	402	402
Construction		1233	1258	1004	1020	1074
GI & Survey		88	88	70	70	70
Agency staff		30	30	30	30	30
Fees (design & supervision)		211	211	207	207	207
Fees (cost consultant)		6	6	6	6	6
Fees (contractor)		Included in construction	Included in construction	Included in construction	Included in construction	Included in construction
Compensation		130	130	99	99	99
Environmental enhancement		20	20	20	20	20
Other *		21	21	40	40	40
Contingency (95%)		345	345	345	345	345
<b>Total</b>	<b>0</b>	<b>2,486</b>	<b>2,511</b>	<b>2,223</b>	<b>2,239</b>	<b>2,293</b>

\* Other costs are planning application, PPS 25 submission, mineral extraction licence, en-maining costs, public exhibition/consultation at start of construction and archaeological and ecological monitoring during construction.

### 2.4.3 Preferred Option

For discussion on the selection of the preferred option refer to Section 2.7. The preferred option is Option 2 to maintain the existing system. There are therefore no project costs except for sunk costs and future maintenance. Table 7 is included for information giving costs for a flood storage area with a 100 year (1%) standard of protection.

**Table 7 Project Costs for Option 6 (£k) (Note Table completed for information only the preferred option is to maintain the existing system)**

	Cost for economic appraisal PV	Whole life cash cost	Agency SoD approval cost Cash
<b>Costs to PAR:</b>			
Agency Staff	Sunk Costs	29	
Topo & SI Costs	Sunk Costs	11	
Consultant	Sunk Costs	148	
Contractor	Sunk Costs	6	
Cost Consultant	Sunk Costs	0	
Land Agent	Sunk Costs	3	
Other	Sunk Costs	3	
<b>Sub-total to PAR</b>		<b>200</b>	<b>200</b>
<b>PAR to Construction:</b>			
Agency Staff	14	14	14
Topo & SI Costs	70	70	70
Consultant	136	136	136
Water Main Diversion	402	402	402
Contractor	0	0	0
Cost Consultant	6	6	6
Other Costs*	28	28	28
<b>Sub-total PAR to Construction</b>	<b>656</b>	<b>656</b>	<b>656</b>
<b>Construction:</b>			
Construction costs	1,074	1,074	1,074
Inflation Allowance for 36 months			268
Environmental Enhancement	20	20	20
Agency staff	16	16	16
Site Supervision (inc env monitoring)	81	81	81
Cost Consultant	0	0	0
Compensation	99	99	99
Other Costs*	2	2	2
<b>Future Costs:</b>			
100 years Maintenance	788	2,715	
Future construction			
<b>Risk Contingency:</b>			
Monte Carlo 95% or similar	345		345
Monte Carlo 50% or similar		125	
<b>Contributions</b>			<b>0</b>
<b>TOTAL</b>	<b>3,081</b>	<b>4,988</b>	<b>2,561</b>

\* Other costs are - planning application, PPS 25 submission, mineral extraction licence, en-maining costs and public exhibition/consultation at start of construction.

#### 2.4.4 Optimism Bias and Risk Contingency

The Optimism Bias has been included in accordance with Defra's Guidance note "Revisions to Economic Appraisal Procedures Arising from the new HM Treasury "Green Book"". A full "Monte Carlo" analysis has been undertaken for all the residual risks quantified using @Risk software and the 50% and 95% confidence limit for risk contingency has been defined (see Appendix H).

**Table 8 Risk Contingency Values for Option**

Probability	Confidence Limit	Risk Contingency (£k)
0.50	50%	125
0.05	95%	345

#### 2.4.5 Cost Sensitivity

Costs for the flood storage options have been estimated by Breheny and the cost of diverting the water main by Cambridge Water Company, both have been reviewed by Halcrow. Breheny as a framework contractor recently constructed two similar flood storage areas in the Thames Region. Cambridge Water Company has extensive experience of costs for similar work. The estimated base costs are therefore considered to be reliable.

All framework parties have agreed with the Project Appraisal Report estimate.

The main item affecting cost is the earthworks involved in constructing the dam. Clay would be obtained from an adjacent borrow area free of charge. Trial pits have been excavated to confirm that suitable clay is available. Machine outputs for carrying out the work have been based on Breheny's past experience. The risk of the cost of construction of the dam varying is therefore low.

Compensation costs have been agreed with Cambridge Preservation Society, who have an interest in the project being completed, and are therefore unlikely to vary significantly. Draft Heads of Terms are included in Appendix P.

#### 2.4.6 Contributions

There are no cash contributions to the scheme. However the Cambridge Preservation Society would allow use of the land for the flood storage area free of charge other than legal costs. This is as a means to construct a wetland area in the borrow area for the dam. This would form a feature in the Coton Countryside Reserve which is currently under development by the Cambridge Preservation Society. Compensation would however be payable for periodic flooding of the agricultural land within the Reserve.

## **2.5 Benefits of Options**

### *2.5.1 Methodology*

Flood damages have been calculated using the Multi Coloured Manual (MCM) (Middlesex Flood Hazard Research Centre (FHRC) 2005) and the Green Book (HM Treasury, 2003). These documents have been used in combination with the Defra FCDPAG series and Supplementary Guidance Notes (Defra, March 2003 and July 2004). The analysis has been based on that required for a 'full scale project appraisal' as defined in the MCM.

Figures in the Multi Coloured Manual have been updated to December 2006 using retail price indices. Property values and other costs have been obtained from an examination of recent sale prices.

### *2.5.2 Do Nothing Damages*

Do Nothing damages have been calculated using MCM methodology using the Do Nothing Scenario described in Appendix O.

### *2.5.3 Do Something Option Damages and Benefits*

Do Something damages (including Do Minimum) have been calculated using MCM methodology on the basis of flood damage that will still occur when a flood event occurs that is greater than the standard of protection provided by the particular option.

In addition the benefit calculation, for all improvement options, includes Health Related Benefits. These were introduced in 2004 and reflect the reduction in stress resulting from a flood alleviation scheme. The amount is related to the reduction in exposure to flood risk with and without a flood alleviation scheme. For example moving from an annual 1 in 20 year (5%) to a 1 in 100 year (1%) chance of flooding each year provides an annual average benefit of £188 per household.

### *2.5.4 Defra Social Class Weighting*

Scheme benefits have been adjusted by the Defra Social Class Weighting (sometimes referred to as the Social Equity Multiplier). This factor adjusts benefits to account for the fact that flood damage has more of a financial impact on someone with a low income than it does on someone with a high income.

All of the properties at risk of flooding fall into Social Classes A & B. This is confirmed by the Government Rank of Deprivation Index of 7956 for the Ward of Newnham which ranks the area as being in an area of high affluence. This has the effect of reducing the benefits by a factor of 0.74.

This weighting is not used for Priority Score calculation because this is already accounted for in the priority score calculation methodology.

The value of damages, with and without the Social Class Weighting are shown in Table 10.

### *2.5.5 Flood Frequency*

The extent and frequency of flooding was based on hydrology using Flood Estimation Handbook methodology and ISIS computer modelling including out of bank modelling in the Gough Way area. The assumptions for the Do-Nothing option are stated in Appendix O and are based on the channel deteriorating over a period of five years. Topographical information was based on a combination of Lidar and conventional surveying of the channel cross section and in the flood risk areas. The threshold levels of all properties in the flood risk area were surveyed by conventional surveying.

### *2.5.6 Gains Not Quantified*

The borrow area for the dam would be developed into a wetland area with BAP habitat. English Nature places a total present value of between £5,000 and £32,000/ha on new areas created depending on the importance of the ecology and potential for recreational use. However the area of the borrow area is only 1.5 ha and the maximum value of £48,000 is insignificant in comparison to the other benefits.

Barton Road (the A603) passes by Gough Way and is a main commuter route into Cambridge. The road is at risk of flooding but only during events exceeding 1 in 75 years, there are also a number of alternative routes available nearby. The cost of traffic disruption was calculated but is too small to have any significant effect on the economic appraisal.

### *2.5.7 Price Base for Benefits*

Both benefits and costs have been discounted to the same price date of December 2006.

## **2.6 Environmental Issues**

### *2.6.1 EIA requirements*

The proposals do not form part of any over-arching flood risk management strategy or plan and therefore a strategic environmental assessment has not been undertaken.

There are no EIA requirements for the preferred option to maintain the existing system.

Should a scheme involving flood storage go ahead in the future, the works would fall under Schedule 2 of the Town and Country Planning Environmental Impact Assessment (EIA) Regulations SI 99/293. An internal screening and scoping exercise determined that as the works could potentially give rise to significant environmental effects, a statutory EIA will be required. This screening decision would be confirmed with the local planning authority, South Cambridgeshire District Council, should the project go ahead in the future. An Environmental Statement would then be prepared to document the EIA process.

The proposed works would not affect any sites protected under the Habitats Regulations 1994 or the Countryside and Rights of Way Act, 2000. A letter of support for the proposed scheme from Natural England is provided in Appendix N.

### *2.6.2 Environmental Issues, Constraints and Risks*

The potential flood storage area is located in a rural agricultural landscape to the west of Cambridge and the M11 motorway. It is surrounded by only five residential properties and is approximately one kilometre from the nearest village, Coton. Public access is limited to a number of footpaths around its perimeter and limited vehicular access is gained from a minor road. The ecological value of the proposed flood storage area is limited to the arable field margins and the Bin Brook.

Although the potential flood storage area itself attracts no formal designations; there are several significant environmental issues that would require further consideration during the future development of the scheme. These include: impacts on legally protected species; the presence of invasive species; changes in landscape character; potential presence of archaeological features; unknown risk of excavating or flooding contaminated land; and potential changes to water levels in the Bin Brook. Other, but less significant, issues to be considered include the potential disturbance to nearby residents, users of local roads and footpaths, risks to water quality in Bin Brook and the loss of agricultural land.

Whilst an EIA of the potentially significant issues would be required, it is anticipated that following detailed assessment, these issues could be avoided or satisfactorily mitigated. Where appropriate, these issues are shown on the Indicative Landscape Plan (Appendix D) as potential constraints to the development of a scheme, and further details are provided in the Scoping Document.

The survey and assessment work undertaken during the scoping stage of the project has considerably reduced the uncertainties in terms of potential environmental impacts and risks to the delivery of an improvement scheme. The potential for significant environmental impacts and residual risks relating to the design, construction and operation stages of the project is relatively low. However, further investigative and survey works in connection with protected species, archaeology and contaminated land would be required if the project progresses in the future to address current known gaps in the baseline information.

### *2.6.3 Environmental Enhancements*

The development of a flood storage scheme in collaboration with Cambridge Preservation Society's (CPS) proposals for the Coton Countryside Reserve presents opportunities to provide multiple benefits in terms of biodiversity and public amenity. A flood storage scheme presents opportunities to:

- Create 1.5ha of wetland BAP habitat and permanent standing water where material is excavated to construct the new embankment; increasing the biodiversity of this predominantly agricultural ecosystem. The landscaping and future landscape management of this area will be undertaken by CPS at no cost to the Environment Agency.
- Potential to provide additional habitat for protected species such as water voles along the banks of the new pond.
- Improve public access to the countryside by providing new and improved footpath access, in partnership with CPS, within the proposed flood storage

area.

- Improve community access to and awareness of the countryside through the provision of interpretation boards and seating around the flood storage area, in partnership with CPS.
- Strengthen the rationale for protecting this part of the Green Belt against development in the context of the urban growth agenda for Cambridge as part of the Sustainable Communities Programme.

#### *2.6.4 Consultation*

The flood storage option was identified following a detailed option appraisal process and consultation with local residents, organisations and statutory bodies. This has ensured that the choice of a flood storage option would be acceptable to the majority of local people, fulfils our legal requirements; and maximises opportunities to deliver environmental improvements of value to local people. Consultation has been undertaken through general correspondence, meetings, the issue of reports and consultation documents, and the holding of a public exhibition. Throughout the project, regular meetings have also been held with representatives from Gough Way (the Gough Way Residents Association) and CPS.

The extensive and largely supportive comments relating to the flood storage area received in response to this consultation are detailed in Appendices B & C of the Scoping Report.

As is to be expected the preferred option to maintain the existing system and standard of protection does not have the support of those affected by flooding.

#### *2.6.5 Alternative options*

The principal environmental impacts of the works options, as described in Table 9, relate to the location of the proposed works

- All works options appraised require the creation of a flood storage area and present an opportunity to create a 1.5ha area of new wetland habitat, contributing to Biodiversity Action Plan targets and increasing public access to the countryside; working in partnership with the Cambridge Preservation Society; and
- Options 3 & 4 require construction works in private gardens in Gough Way and would have adverse impacts on local residents.

Options which enabled the creation of new BAP habitat and avoided works at Gough Way were environmentally preferred.

**Table 9 Environmental Impacts**

<b>Option</b>	<b>Key Positive Impacts</b>	<b>Key Negative impacts</b>
<b>Option 1</b> – Do Nothing	None	Flood risk would increase over time
<b>Option 2</b> – Do Minimum (maintain/sustain)		Flood risk would increase over time (maintain) or stay at current levels (sustain)
<b>Option 3</b> - Flood storage with <i>fixed control</i> , in combination with flood walls at Gough Way. Standard of protection of 1 in 75 (1.3%) chance of flooding each year.	A fixed structure is mechanically reliable  Will reduce flood risk (from a 2% - 10% annual chance of flooding to 1.3% or 1%)  Offers potential for creation of new wetland habitat and footpaths	New flood walls required around Gough Way resulting in impacts on local residents during construction and presence of a new intrusive feature
<b>Option 4</b> - Flood storage with <i>fixed control</i> , in combination with flood walls at Gough Way. Standard of protection of 1 in 100 (1%) chance of flooding each year.		
<b>Option 5a</b> - Flood storage with <i>automatic control</i> . Standard of protection of 1 in 50 (2%) chance of flooding each year.	Will reduce flood risk (from a 2% - 10% annual chance of flooding to between 2% and 1%)  Offers potential for creation of new wetland habitat and footpaths	An automated structure requires significant maintenance to ensure its reliability.
<b>Option 5</b> - Flood storage with <i>automatic control</i> . Standard of protection of 1 in 75 (1.3%) chance of flooding each year.	No need for new flood walls at Gough Way	
<b>Option 6</b> – Flood storage with <i>automatic control</i> . Standard of protection of 1 in 100 (1%) chance of flooding each year.		

## 2.7 Choice of Preferred Option

### 2.7.1 Technical and Health and Safety Assessment

The assessment has been carried out with Environment Agency Operations Delivery staff who are responsible for operation and maintenance. The works options fall into two categories Options 3 and 4, a flood storage area with fixed control with flood walls at Gough Way and Options 5a, 5 & 6, a flood storage area with automatic control with no works at Gough Way.

There is no difference in the performance of these two options though there are reliability and maintenance issues:-

- Options with automatic control may be less reliable because of the risk of a failure of the control system.
- Fixed control requires that flow is restricted through a small orifice at all times whereas with automatic control flow would only be restricted through a small orifice during flood conditions. The fixed orifice would be more prone to blockage by debris than with automatic control.
- Flood walls in the Gough Way area will require inspection and maintenance in private gardens.

Operations Delivery has more concern over the problems associated with the orifice becoming blocked and inspection and maintenance of flood walls in private gardens than they do with maintaining the automatic system in a reliable condition. The reliability issues associated with automatic control will be reduced by:-

- Carrying out periodic tests.
- Installing a telemetry system to monitor the status of the system and to sound an alarm if there is a problem.
- Providing a fail safe system whereby the control penstock closes in the event of a loss of signal between the water level monitor at Gough Way and the control penstock.
- Providing manual control so that the control penstock can be operated manually, including when the reservoir is full.

The option that is preferred technically is therefore Option 5a, 5 or 6 which concentrates all of the maintenance activities in one location and avoids flood defences located in private gardens.

Options 5a, 5 & 6 also overcome the lands and public relations issues associated with construction in private gardens and are the options preferred by the Gough Way Residents Association.

Health and safety aspects have also been reviewed with Operations Delivery staff. The difference in health and safety issues associated with the two options are:-

- Options 5a, 5 & 6 avoid flood defences in private gardens and the problems that can occur with construction and maintenance works in private gardens;- children playing on flood walls or residents interfering with the integrity of the defence.
- Options 5 & 6 introduce mechanical and electrical plant to the scheme, the risks associated with these need to be considered. However the public can be isolated from these risks and the risk to Environment Agency staff is no greater than on other similar plant operated by the Agency. These risks are therefore considered to be manageable.

## 2.7.2 Economic Assessment and Decision Rule

The benefit cost ratios with and without the Defra Social Class Weighting for the various options are given in the tables below. Table 10 does not include benefit cost ratios for Options 3 & 4 because they are more expensive than Options 5a, 5 & 6 (Ref Table 6) and are therefore not preferred economically. They are also not the residents or Operations Delivery's preferred option. The benefit cost ratios for Options 3 & 4 are included in Appendix E for information.

**Table 10 Benefit-Cost Assessment**

### Without Social Class Weighting

	Option 1 Do nothing	Option 2 Maintain (Do Minimum)	Option 5a Flood Storage  1 in 50 (2%)	Option 5 Flood Storage  1 in 75 (1.3%)	Option 6 Flood Storage  1 in 100 (1%)
Construction Costs PVc (£K)			1,688	1,703	1,754
Other Costs PVc (£K)			352	352	352
Maintenance Cost PVc (£K)		385	788	788	788
Total Costs PVc (£K)		385	2,828	2,843	2,894
Flood Damage PVd (£K)	17,512	3,618	1,323	594	300
Flood Damage Avoided PVDa (£K)		13,894	16,189	16,918	17,212
Health Related Benefit (£K)			80	97	153
Total Benefits PVb (£K)		13,894	16,269	17,015	17,365
NPV (£K)		13,509	13,441	14,172	14,472
Average Benefit/Cost Ratio		<b>36.06</b>	<b>5.75</b>	<b>5.98</b>	<b>6.00</b>
Incremental Benefit/Cost Ratio			<b>0.97</b>	<b>49.94</b>	<b>6.94</b>

### With Social Class Weighting

	Option 1 Do nothing	Option 2 Maintain (Do Minimum)	Option 5a Flood Storage  1 in 50 (2%)	Option 5 Flood Storage  1 in 75 (1.3%)	Option 6 Flood Storage  1 in 100 (1%)
Construction Costs PVc (£K)			1,688	1,703	1,754
Other Costs PVc (£K)			352	352	352
Maintenance Cost PVc (£K)		385	788	788	788
Total Costs PVc (£K)		385	2,828	2,843	2,894
Flood Damage PVd (£K)	13,843	3,081	1,132	453	228
Flood Damage Avoided PVDa (£K)		10,762	12,711	13,390	13,615
Health Related Benefit (£K)			80	97	153
Total Benefits PVb (£K)		10,762	12,791	13,487	13,768
NPV (£K)		10,377	9,963	10,644	10,875
Average Benefit/Cost Ratio		<b>27.64</b>	<b>4.52</b>	<b>4.74</b>	<b>4.76</b>
Incremental Benefit/Cost Ratio			<b>0.83</b>	<b>46.64</b>	<b>5.58</b>

Option choice is based on the Benefit Cost Assessment including the Defra Social Class Weighting.

The steps of the FCDPAG3 decision process are detailed below.

1. The least cost option, Option 2 Maintain (Do Minimum) has the highest benefit/cost ratio of 27.64, but the standard of protection is not within the indicative annual flood probability range of 1 in 50 to 1 in 200 years (2% to 0.5%).
2. The next ranked cost option, Option 5a, flood storage with automatic control with an annual standard of protection of 1 in 50 (2%), has a benefit cost ratio of 4.52 and an incremental benefit/cost ratio of 0.83. This is below 1.00 rather than robustly above 1 as required by the decision rules to move above the option with the highest benefit cost ratio.
3. The preferred Option is therefore Option 2 Maintain (Do Minimum).

This decision arises because in the Maintain (Do Minimum) scenario most of the houses at risk of flooding have a standard of protection between 1 in 25 and 1 in 50 years (2% – 4%) and there is therefore only a small incremental benefit in raising the standard of protection to 1 in 50 years (2%). This is a logical decision to ensure a fair allocation of limited funds between schemes. It avoids expenditure when the existing standard of protection is near to the bottom end of the indicative range, even though an improvement scheme to a higher standard would have a robust benefit cost ratio.

The NRG economist, Bill Watts, has been consulted and he has confirmed that this is the correct decision and that NRG would be unlikely to approve an improvement scheme in the current financial climate.

The preferred option is therefore confirmed as Option 2 Maintain (Do Minimum).

### *2.7.3 Economic Sensitivity*

All works options appraised involve flood storage and therefore would be affected equally by changes in the cost of the flood storage area. Options 3 and 4 involve construction in private gardens where there is a risk that compensation and reinstatement costs will increase which strengthens the economic case for the Options 5a - 6.

All options also involve the same benefits and therefore any changes in flood damage costs affect all options equally.

### *2.7.4 Environmental Assessment*

There is no significant difference in environmental terms between the flood storage areas for any of the options and therefore environmental issues at the storage areas do not affect the choice between Options 3 and 4 or 5a, 5 and 6.

Flood walls at Gough Way would impact on local residents and introduce a new intrusive feature, they are not the preferred choice of the residents and Operations Delivery. Options 5a, 5 & 6 avoid flood walls at Gough Way and are therefore preferred environmentally.

### 2.7.5 Sensitivity to Climate Change

The preferred option is to maintain the existing system which provides a standard of protection of between 1 in 10 (10%) and 1 in 50 (2%) years. If an improvement scheme is justified then it could be enhanced to cater for possible climate. However climate change cannot be used to justify an improvement scheme if it is not justifiable without climate change.

A sensitivity analysis has been undertaken by increasing design flows by 20% to allow for the impact of climate change on the maintain option over the next 100 years. The difference in water levels at key locations is shown in Table 11.

**Table 11 The Effect of Climate Change on Option 2 (Maintain) Water Levels (mAOD)**

Location	Event with 1 in 10 (4%) Chance of Occurrence Each Year		Event with 1 in 25 (2%) Chance of Occurrence Each Year		Event with 1 in 50 (1%) Chance of Occurrence Each Year	
	Now	+20% Flow	Now	+20% Flow	Now	+20% Flow
Upstream of M11	13.77	13.89	13.96	14.10	14.11	14.27
Laundry Farm	11.15	11.25	11.28	11.34	11.34	11.42
Entrance to Gough Way Culvert	9.92	10.04	10.08	10.12	10.13	10.16
SW Corner of Diversion Channel	9.86	10.04	10.07	10.12	10.12	10.17
Exit Gough Way Culvert	8.96	9.11	9.26	9.46	9.48	9.65
End of Diversion Channel	8.83	9.00	9.14	9.33	9.36	9.50
Fulbrook Road	9.98	10.10	10.14	10.21	10.22	10.29
Claire Hall	8.69	8.91	9.07	9.28	9.31	9.45
Robinson College	8.51	8.70	8.84	9.11	9.13	9.31

The figures in the above table show that:-

- the water levels that would occur during a flood with a 1 in 25 year (4%) chance of occurrence each year, without climate change, would be reached during approximately a 1 in 10 (10%) chance flood with climate change.
- the water levels that would occur during a flood with a 1 in 50 year (2%) chance of occurrence each year, without climate change, would be reached during approximately a 1 in 25 (4%) chance flood with climate change.

The standard of protection to most of the houses would thus fall from between 1 in 25 (4%) - 1 in 50 (2%) to 1 in 10 (10%) - 1 in 25 (4%) if climate change occurs. The standard of protection of Kings College Pavilion would fall to below 1 in 10 years (10%).

### 2.7.6 Recommended Overall Preferred Option and Priority Score

A summary of the key issues affecting option choice are given in the following table.

**Table 12 Option Choice**

Topic	Preferred Option	Reason
Technical/Operational	Option 5a, 5 or 6	Concentrates all maintenance activities in one location. Avoids inspection and maintenance work in private gardens.
Health and Safety	Option 3 or 4 But Option 5a, 5 or 6 would be acceptable	Options 3 & 4 would avoid mechanical and electrical plant. However risks associated with Options 5 & 6 can be managed and advantages outweigh small health and safety differences.
Environmental	Option 5a, 5 or 6	Reduces area of disturbance. Avoids impacts in private gardens
Public Relations	Option 6	Option 2 does not remove the existing unacceptable risk of flooding. Avoids work in private gardens. Provides higher standard of protection than Option 5.
Economic	Option 2	Preferred option determined by the Defra decision rules.

Option 2 Do Minimum is selected as the preferred option because the Defra decision rules demonstrate that it is not economically viable to improve the standard of protection above the existing standard.

If an improvement option could be justified then Option 6 providing a 100 year standard of protection, without flood walls around Gough Way would be preferred.

Consideration of priority score is irrelevant to the preferred option. However the priority score for Option 6 is calculated in Section 4.2 to demonstrate that the score is well below the current threshold for projects to be funded by Defra. The score is based on the economic data in Table 10. The Defra Social Class Weighting is not used because this is accounted for in the People Score part of the priority score.

The priority score has been calculated as 12.51 based on the following key inputs:

- Scheme benefits (PVb) = £17,365k
- Scheme costs (Pvc) = £2,894k
- Benefit cost ratio = 6.00
- No of properties protected = 57
- Risk factor = high

- Affluence factor = -1 (ward deprivation ranking for Newnham 7956)

Environmental score = 0.03 (based on creating 1.5Ha of BAP habitat in the borrow area).

### *2.7.7 Residual Risk*

The key residual risks to the improvement options are as follows:

1. Change to Cambridge Preservation Society policy resulting in requirement to purchase land currently being offered free of charge.
2. Clay quality or quantity in borrow area is less than expected.
3. Works cost increase due to design changes.
4. Archaeological find.
5. Project delayed

The proposed mitigation for these risks is:

1. Incurring land purchase costs at commercial rates would adversely affect the project economic viability making it necessary to re-appraise the project. However agreement with CPS has been reached in principle. (Appendix P)
2. The quality and quantity of clay has been assessed by a preliminary site investigation which suggests this risk is low, however the cost implication would be high. The risk budget calculation includes an amount to import clay for the dam core.
3. The design has been reviewed by the Project Team and Operations Delivery staff and is believed to be robust. Nevertheless this possibility remains and an appropriate sum is included in the risk budget calculation.
4. There are no recorded archaeological finds in the immediate area, an allowance is included in the budget for a pre-construction investigation but nevertheless the risk remains that archaeological artefacts may be found during construction. An allowance for delay is included in the risk budget calculation.
5. The risk budget calculation includes for a 1 year delay. (Excluding item 1 above)

## **2.8 Other Considerations**

### *2.8.1 Flood Warning*

A flood warning system was installed in 2006 (but is not yet commissioned), comprising an ultrasonic water level monitor upstream of the Gough Way culvert linked to the Environment Agency's telemetry system. This will improve the situation but the channel is very small and fluctuations in water level occur rapidly and therefore the warning system is of limited benefit.

### *2.8.2 Sustainable Construction*

Options have been carefully assessed with regard to delivery of sustainable construction objectives. The main component is the dam which would be constructed from material excavated from the adjacent borrow area. The majority of material required for construction would thus be obtained from within the site area, minimising transport and associated noise, air pollution and use of fossil fuel. Techniques and

designs would be pursued which achieve low impact solutions, minimise waste, allow wherever possible for use of recycled materials and limit use of non-sustainable construction products. Careful consideration would be given to the design, specification, and detailing of all structures including associated fencing, railings, pavements, and signage. All construction for the preferred option would be away from housing minimising social impact. The dam would form a noise barrier between the M11 and the Coton Countryside Reserve and the borrow area would be landscaped into a wetland area forming an integral part of the Reserve. An improve option would therefore have amenity value in addition to providing flood defence. A preliminary Site Waste Management Plan has been prepared and would be developed should the preferred option alter.

### *2.8.3 Construction, Maintenance and Safety*

The Planning Supervisor and Area Asset Manager (represented by the Operations Delivery representatives) have been involved in the outline design of the do something options and have reviewed the risks to public safety. The design has been carried out in line with the guidance contained within the Agency Public Safety Risk Assessment guide.

Maintenance arrangements have been costed and agreed in discussion with Agency's Operations Delivery representatives. The principal maintenance requirements for the options are:

- Maintenance of the existing Bin Brook channel, including works to improve the section that is currently non main river before it is enmained.
- Maintenance of the grass on the dam.
- Clearance of debris from the trash screen.
- Periodic testing and maintenance of the automatic control system

The outlet structure has been designed to minimise confined spaces.

Allowances for these costs have been included in the benefit cost assessment as shown in Appendix F.

### *2.8.4 Planning Policy and Development Control*

No approvals are required for the preferred option to maintain the existing system.

Construction of a flood storage area would require a statutory Environmental Statement, Planning Approval, a Mineral Extraction Licence and an Impounding Licence. Allowances for these are included in the cost estimates.

The flood storage area would fall under the auspices of the Reservoirs Act requiring the appointment of a Construction Engineer and the issue of an impounding certificate.

### *2.8.5 Technical Aspects*

The technical aspects of the scheme are described in Sections 2.3.3, 2.7.1 and 3.2 of this report. In summary the preferred option is to maintain the existing drainage system by:-

- Maintaining the Bin Brook channel and diversion channel clear of debris by regular bushing, weed clearance and silt clearance.
- Regular clearance of debris from culverts.
- Regular clearance of the trash screen upstream of Gough Way culvert.
- Maintenance of the flood warning system.
- Carrying out any necessary repairs to the concrete lined diversion channel.

## **3 PROJECT PLAN**

### **3.1 Project Objectives**

The objectives of the Bin Brook Flood Alleviation Scheme are to:-

- Reduce the risk of flooding from Bin Brook to the people, property and the natural environment surrounding the brook.
- Provide an optimum economic level of flood protection.
- To accommodate climate change.
- Promote sustainability principles in the scheme's design and construction.
- Take account of all social, environmental and economic issues.
- Comply with all legal requirements.
- Provide added benefit to the local community and the environment.
- Minimise environmental impacts on activities within and outside of the study area.
- Minimise health and safety risks during construction and the life of the scheme.

### **3.2 Scheme Elements and Construction Approach**

The preferred option is to maintain the existing drainage system by:-

- Maintaining the Bin Brook channel and diversion channel clear of debris by regular bushing, weed clearance and silt clearance.
- Regular clearance of debris from culverts.
- Regular clearance of the trash screen upstream of Gough Way culvert.
- Maintenance of the flood warning system.
- Carrying out any necessary repairs to the concrete lined diversion channel.

### **3.3 Defence Standard**

The preferred option results in a standard of protection of between 1 in 10 (10%) and 1 in 50 (2%) chance of flooding each year. This is below the indicative standard of 1 in 50 years (2%) and climate change will reduce this standard.

### **3.4 Programme**

A programme is not required for the preferred option.

### **3.5 Management of Environmental Impacts**

Maintenance works should be carried out in accordance with standard Environment Agency practice which will minimise adverse environmental impacts. An Environmental Scoping Report (Appendix J) has been prepared should an improvement option be implemented in the future.

### 3.6 Planning Consent

Planning consent is not required for the preferred option.

Should an improvement scheme be implemented in the future Planning Consent together with a statutory environmental statement, Mineral Extraction Licence and Impounding Licence will be required for the flood storage area.

A flood storage area would fall under the auspices of the Reservoirs Act requiring the appointment of an Inspecting Engineer and the issue of an impounding certificate.

### 3.7 Procurement

#### 3.7.1 Proposals

A procurement procedure is not required for the preferred option to maintain the existing system.

The project team at the Project Appraisal Stage is shown in the following table.

**Table 13 Procurement Strategy to PAR**

<b>Supplier</b>	<b>Contact</b>	<b>Procurement Strategy</b>	<b>Role</b>
Halcrow Group Ltd	Graham Boakes	NEC PSC2 Option C	Consultant
Breheny Civil Engineering Ltd	Robin Percy	NEC PSC Option E	Construction/Cost advice
Halcrow H & S Ltd	Bruce Langston	NEC PSC Option C	Planning Supervisor

#### 3.7.2 Project Risks

The preferred option is to maintain the existing system. The overriding project risk is that property will again be flooded leading to a difficult public relations situation. This risk can be minimised by ensuring that the channels and culverts are kept clear of debris and particularly by keeping the trash screen upstream of Gough Way Culvert clear.

### 3.7.3 Key Staff

Key staff during the preparation of this Project Appraisal Report were as shown in the following table.

**Table 14 Key Staff**

Agency Staff		Framework Staff	
Client		NEECA Team – Halcrow	
Project Sponsor	Dave Gillett	Project Manager	Graham Boakes
Business User	Keith Hutchinson	M&E Team Leader	Bill Tate
		EIA Team Leader	Sharon Duggan
		Planning Supervisor	Bruce Langston
NCPMS (Appraisal & Delivery)		NCF Team – Breheny	
Project Executive	Chris Allwork	Contracts Manager	Robin Percy
Project Manager	Steve Peck		
Technical Advisors		NCCF Team – Not used	
Ops Framework Manager	Glen Ridgeway		
NEAS	Emma Love		
Estates Officer	George Shelton		

### 3.7.4 Benchmarking

Maintenance costs in this report are based on actual costs in recent years.

### 3.7.5 Other Projects by Same Team

The following projects in the Thames and Anglian Regions have been carried out by the same consultant and contractor:

Wisbech Defences (Appraisal); Heybridge FAS (Appraisal); Houghton Lock (Area Scheme – Delivery); Bedford Ouse Erosion Protection (Area scheme – Delivery); Silk Stream FAS ( Delivery); River Quaggy FAS (Delivery); Radlett FAS (Delivery); Washlands Phases 1 & 2 (Delivery); Cheshunt Reservoir (Delivery); Cobbins Brook (Appraisal).

### 3.7.6 Key Dates

Not applicable to the preferred option.

### **3.8 Spend Profile**

Maintenance costs on the Bin Brook channel have historically been £11,500 per annum. A similar amount should be budgeted for future maintenance plus staff costs to “enmain” Bin Brook upstream of the Cambridge City boundary and costs to improve the channel to bring it up to Environment Agency standards should it be enmainned as part of any future improvement scheme. These costs have been estimated by the Environment Agency to be £2,000 and £12,000 respectively.

### **3.9 Risk Schedule**

The project implementation risk schedule is not applicable to the preferred option.

For improvement options a risk workshop was held on 14<sup>th</sup> September 2006. The resulting Risk Register and details of the risk budget are included in Appendix H should it be required in the future. The key risks are described in Section 2.7.7.

### **3.10 Safety Plan**

Standard Environment Agency health and safety procedures should be adopted when carrying out maintenance work.

## 4 DEFRA/WAG PROJECT APPRAISAL REPORT-DATA SHEET

### 4.1 Project Appraisal Report - Data Sheet

The data sheet is not applicable to the preferred option to maintain the existing system. However the sheet has been completed for information for Option 6 providing a 1 in 100 year standard of protection.

#### GENERAL DETAILS

Authority Project Ref. (as in forward plan):	IMAN 000628	LDW/CPW
Project Name (60 characters max.):	Bin Brook Flood Alleviation Scheme	
Promoting Authority:	Defra ref (if known)	
	Name	Environment Agency
	RE Region:	
Emergency Works:	(Y/N)	N
Strategy Plan Reference:	N/A	LDW/CPW
Shoreline Management Plan:	N/A	LDW/CPW
Project Type:	Stand alone. Fluvial flood defence.	
Shoreline Management Study/ Preliminary Study/ Strategy Plan/Prelim. Works to Strategy/ Project within Strategy/Stand-alone Project Coast Protection/Sea Defence/Tidal Flood Defence/Non-Tidal Flood Defence/Flood Warning - Tidal/Flood Warning - Fluvial/Special		

#### CONTRACT DETAILS

Estimated start date of works/study:	Sep 2007	
Estimated duration in months:	26 months overall*	*2 summer stages
Contract type	Framework	
Direct labour, Framework, Non Framework, Design/Construct		

#### COSTS

	APPLICATION (£)	Defra ADJUSTMENT (£)
Appraisal:	200,000	
Costs for Agency approval:	2,561,000	
Total Whole Life Costs:	4,988,000	

For breakdown of costs see Table in Section 2.4

#### CONTRIBUTIONS:

Windfall Contributions:		
Deductible Contributions:		
ERDF Grant:		
Other Ineligible Items:		

#### Defra use only, below this line on this page

Application submission date:				
Date application received:		Last papers received: <input type="text"/>		
Recommendation:		Action Office:		
Formal Approval/Agreement/Agreement to Strategy/Without Prejudice/Refer Back		(HQ/Region)		
Special Conditions required? (Yes, only if conditions required on approval letter):				
Y/N				
Special Conditions:				
Progress:	Officer (Surname)	Start (date)	Complete (date)	Days
Senior Engineer:		/ /	/ /	
Regional Engineer:		/ /	/ /	

Entries required in clear boxes, as appropriate, shaded boxes are for Defra use.

**LOCATION - to be completed for all projects**

EA Region/Area of project site (all projects):	Anglian – Central Area	Ref.
Name of watercourse (fluvial projects only):	Bin Brook	
District Council Area of project (all projects):	Cambridge City and South Cambridgeshire	Ref.
Grid Reference (all projects):	TL 433 578	
(OS Grid reference of typical mid point of project in form ST064055)		
Specific town/district to benefit:	Mainly Gough Way estate, Newnham, Cambridge	

**DESCRIPTION**

Brief project description including essential elements of proposed project/study  
(Maximum 3 lines each of 80 characters)

Flood alleviation scheme providing 1 in 100 (1%) SOP to 55 houses and 2 university halls of residence, comprising an upstream flood storage area formed by a 700m long dam with a maximum height of 3.6m. Material from the dam will be excavated from an adjacent borrow area.

Postcodes zones of protected property wholly or partially within proposed benefit area

CB3 9\*\*

**DETAILS**

Design standard (chance per year):	1%		%
Existing standard of protection (chance per year)	10 %		%
Design life of project:	100yrs		yrs
Fluvial design flow (fluvial projects only):	10.5m <sup>3</sup> /s		m <sup>3</sup> /s
Tidal design level (coastal/tidal projects only):	N/A		m
Length of river bank or shoreline improved:	N/A		m
Number of groynes (coastal projects only):	N/A		
Total length of groynes* (coastal projects only):	N/A		m
Beach Management Project? Y/N	N		
Water Level Management (Env) Project? Y/N	N		
Defence type (embankment, walls, storage etc)	Storage		

\* i.e. total length of all groynes added together, ignore any river training groynes

**ADDITIONAL AGREEMENTS:**

Maintenance Agreement(s):	Not applicable	Not Applicable/Received/Awaited	
EA Region Consent (LA Projects only):	Not applicable	Not Applicable/Received/Awaited	
Non Statutory Objectors: Y/N	N		
Date Objections Cleared:			

Entries required in clear boxes, as appropriate, shaded boxes are for Defra use.

**ENVIRONMENTAL CONSIDERATIONS**

Natural England (or equivalent) letter:	Received	Not Applicable/Received/Awaited	
Date received			

**Sites of International Importance** (Y/N for each)  
 Answer Y if project is within, adjacent to or potentially affects the designated site

Special Protection Area (SPA):	N	
Special Area of Conservation (SAC):	N	
Ramsar Site	N	
Biosphere Reserve	N	
World Heritage Site	N	

**Sites of National Importance** (Y/N for each)  
 Answer Y if project is within, adjacent to or potentially affects the designated site

Environmentally Sensitive Area (ESA):	N	
Site of Special Scientific Interest (SSSI):	N	
National/Regional Landscape Designation	N	
National Park/The Broads	N	
National Nature Reserve	N	
AOND, RSA, RSC, other	N	
Scheduled Ancient Monument	N	
Other designated heritage sites	N	

**Other Environmental Considerations**

Listed structure consent	N/A	Not Applicable/Received/Awaited	
Water Level Management Plan Prepared? Y/N	N/A		
FEPA licence required? NA/R/A	N/A		

**Compatibility with other plans**

Shoreline Management Plan	N/A	Yes/No/Not Applicable	
River Basin Management Plan	N/A	Yes/No/Not Applicable	
Catchment Flood Management Plan	Yes	Yes/No/Not Applicable	
Water Level Management Plan	N/A	Yes/No/Not Applicable	
Local Environment Agency Plan	N/A	Yes/No/Not Applicable	

**SEA/Environmental Impact Assessment**

SEA/Environmental Impact Assessment	Required		
Statutory required/Agency voluntary/not applicable EIA	Statutory		
Yes (schedule 1); Yes (schedule 2); SI1217; not applicable SEA/EIA status	Scoping Prepared		
Scoping report prepared/draft/draft advertised/final			
Other agreements	Detail	Result	(Not Applicable/Received/Awaited for each)
	Final prepared	No objections	

Entries required in clear boxes, as appropriate, shaded boxes are for Defra use.

### COSTS, BENEFITS & SCORING DATA

(Apportion to this phase if part of a strategy)

Local authorities only: for projects done under Coast Protection Act 1949, please separately identify:

FD = Benefits from reduction of asset flooding risk; CE = Benefits from reduction of asset erosion risk

**Benefit type** (DEF: reduces risk (contributes to Defra SDA 27); CM: capital maintenance; FW: improves flood warning; ST: study; OTH: other projects)

DEF

#### LAND AREA

Total area of land to benefit:	25.5ha		ha	
of which present use is:	FD	CE	FD	CE
Agricultural:	9.4ha	ha	ha	ha
Developed:	7.4ha	ha	ha	ha
Environmental/Amenity	8.7ha	ha	ha	ha
Sched. for development:	ha	ha	ha	ha

#### PROPERTY PROTECTED

	Number		Value (£'000s)		Number		Value (£'000s)	
	FD	CE	FD	CE	FD	CE	FD	CE
<sup>1</sup> Resid.	55		26,000					
Comm./ind.								
Other: (description)	2		4,000					
Description: University Hall of residence				Description:				

#### COSTS AND BENEFITS

<sup>1</sup> Present value of total project whole life costs (£'000s):	2,894			
Project to meet statutory requirement? Y/N	Y – planning process			
	£'000s		£'000s	
	FD	CE	FD	CE
Present value of urban benefits:		17,365		
Present value of agricultural benefits:				
Present value of environmental/amenity				
<sup>1</sup> Present value of total benefits (FD & CE)	17,365			
Net present value:	14,472			
Benefit/cost ratio:	6.00:1		:1	
	Category U/UA/AU/EU etc:			
Base date for estimate:	12/06			
Project Appraisal Guidance used: Y/N	Y			
PAG Decision rule stages III and IV applied: Y/N	Y			

#### OTHER PRIORITY SCORING DETAILS<sup>1</sup>

Economics	People	Environmental
Non-works study, eg coastal process (Y/N)?	Risk*:	BAP net gain (Ha):
N	H	1.5
	Vuln**:	SSSI protected (Ha):
	-1	
		Other habitat (Ha):
		Heritage sites***:

\* (VH, H or N/A); \*\* (from ODPM website) \*\*\* ("I or II", "II or other" or "N/A") See back page for score calculation details

#### Exemption Details (if exempt from priority scoring system)

Exempt from Scoring (Y/N):	N
Reason (max 100 chars):	

<sup>1</sup>Highlighted fields all used to generate priority score - see Annex for calculation flowchart

## 4.2 Priority Score Calculation Flowchart (For Option 6 - Flood Storage with a 1 in 100 Year Standard of Protection)

### ECONOMIC SCORE

		Benefits (£'000s)		Costs (£'000s)		Economic Score
	Divide	17,365	by	2,894	multiply by 2 and subtract 1 =	11.00

Economic score = (benefits / costs \* 2) - 1

(Max is 20)

### PEOPLE SCORE

No of residences	Cost (£'000s)	Base People Score	Risk factor very high = 2 high = 1	Affluence factor: 1 to 300 301 to 1500 1501 to 6664 <b>6665 to 8114</b> 8115 to 8414	Add: +2 +1 No adjust' -1 -2	People Score
57	multiplied by 75, divided by 2,894	= 1.48	plus 1	plus	-1	= 1.48

(Max is 8)

(Max. is 12)

People score = (number of residences protected \* 75 / cost) + risk factor + vulnerability factor

### ENVIRONMENTAL SCORE

BAP (Ha)	SSSI (Ha)	Other (Ha)	Cost (£'000s)	Heritage I or II* = 2 II or other = 1	Environment al Score
(1.5)	( )	( )	2,767	( )	0.03
multiplied by 2)	multiplied by 1.5)	plus	multiplied by 25 divided by	plus	=
( ( 3.0 ) )	( )	( )	( )	( )	( )

Environmental score = (((BAP area created \* 2) + (SSSI area protected \* 1.5) + other designated area protected) \* 25 / cost) + heritage factor

(Max is 12)

### TOTAL SCORE

Economic + People + Environmental =	12.51
-------------------------------------	-------

Studies should be scored as for the works to which they relate; studies not related to works (eg coastal process studies for SMPs) score 20. (Max is 44)

Please note there is an Internet Score Calculator at <http://www.defra.gov.uk/enviro/fcd/policy/grantaid.htm>



## **APPENDIX A - LIST OF REPORTS PRODUCED**

## **A LIST OF REPORTS PRODUCED**

The following reports have been prepared for the Bin Brook Flood Alleviation Scheme

- Environmental Scoping Report; Halcrow, February 2007.
- Great Crested Newt Survey; Green Environmental Consultants, July 2006
- Flood Risk Management Review (Consultation Document); Environment Agency, April 2005
- Geotechnical Site Investigation Report; AEG, April 2005.
- Ecological Survey; Landscape Science Consultancy, April 2005.
- Update on Economic Analysis. File Note. Halcrow, September 2003.
- Pre-Feasibility Report, Halcrow, February 2003.

These reports are available from either the Environment Agency or Halcrow for inspection upon request.

## **APPENDIX B - FIGURES**

## **B FIGURES**

The following figures identify the location of the scheme and the composition of the options considered.

Figure 1 – Study Area.

Figure 2 – Flood Risk Area.

Figure 3 – Location of Options.

## **APPENDIX C - DETAILS OF PROPOSED WORKS**

## **C DETAILS OF THE PREFERRED DO SOMETHING OPTION**

The following drawings show outline details of the proposed works for the preferred do something option. (This is not the preferred option overall)

- WNBINP 001, Flood Storage Area, Plan
- WNBINP 002, Flood Storage Reservoir, Cross Sections
- WNBINP 003, Reservoir Outlet Structure, Inlet
- WNBINP 004, Reservoir Outlet Structure, Outlet and Sections
- WNBINP 005, Gough Way Flood Defences, Plan
- WNBINP 006, Gough Way Flood defences, Cross Sections

## **APPENDIX D - LANDSCAPE PLAN**



## **APPENDIX E - ECONOMIC APPRAISAL**

**E ECONOMIC APPRAISAL**

**Benefit Cost Assessment Summary**

## **APPENDIX F - COST BREAKDOWN**

## F COST BREAKDOWN

### Calculation of Option Costs

A breakdown of the costs of the various options used in the benefit/cost assessment are summarised in the following attached spreadsheets :-

### Maintenance Costs

Maintenance costs have been allowed as follows:-

- £11,500 per annum to maintain the Bin Brook channel and culverts from the flood storage area to the confluence with the River Cam. This was the actual expenditure in 2003/2004.
- £11,500 per annum to maintain the flood storage area including periodic clearance of the trash screen
- £215,000, the estimated cost of replacing 25% of the existing concrete lined diversion channel around Gough Way. This cost is assumed to occur in year 50.

### Risk Contingencies

Detailed breakdowns of the 50 and 95 percentile risk contingency values for Option 6 is provided in Appendix G.

By undertaking a full "Monte Carlo" analysis the values calculated for this option using the @Risk software has been defined as follows :-

Option	Total Delivery Cost (£k)	50 Percentile Risk		95 Percentile Risk	
		Value (£k)	%	Value (£k)	%
6	2223	125	6	345	15

The 50 and 95 percentile risk values calculated for Option 6 have been used in the expenditure profile provided in Appendix G.

## **APPENDIX G - EXPENDITURE PROFILE**

## G EXPENDITURE PROFILE

The expenditure profile for the project appraisal and delivery stages of Option 6 – Flood Storage with a 1 in 100 Year Standard of Protection is set out in the attached Scheme Expenditure Profile.

Previous years costs up to the end March 2005 have been obtained from the Agency's IAS and iBiS cost databases.

## **APPENDIX H - RISK REGISTER**

## **H RISK REGISTER**

The risk register developed for the flood storage options is summarised in this appendix.

The key risks identified are as listed below:-

1. Change to Cambridge Preservation Society policy resulting in requirement to purchase land currently being offered free of charge.
2. Clay quality or quantity in borrow area is less than expected.
3. Works cost increase due to design changes.
4. Archaeological find.

The proposed mitigation for these risks is:

1. Incurring land purchase costs at commercial rates would adversely affect the project economic viability making it necessary to re-appraise the project.
2. The quality and quantity of clay has been assessed by a preliminary site investigation which suggests this risk is low, however the cost implication would be high. The risk budget calculation included an amount to import clay for the dam core.
3. The design has been reviewed by area staff and is believed to be robust. Nevertheless this possibility remains and an appropriate sum was included in the risk budget calculation.
4. There are no recorded archaeological finds in the vicinity but nevertheless the risk remains and if investigations are required this could delay the project. An allowance for delay was included in the risk budget calculation.

## **APPENDIX I - LIST OF CONSULTEES**

## I LIST OF CONSULTEES

A list of the statutory and other consultees consulted during the development of the project appraisal is as follows :-

English Heritage	Cambridgeshire Mammal Society
Natural England	Cambridgeshire Bat Group
South Cambridge District Council	Cambridgeshire Bird Group
Cambridge City Council	Hawk & Owl Trust
Cambridgeshire Preservation Society	British Horse Society
Gough Way Residents Association	Ramblers Association
All residents in the flood risk area	Inland Waterways Association
National Farmers Union	British Waterways
RSPB	Defence Estates
Council for the Protection of Rural England	Biological Records Centre
National Farmers Union	Royal Commission on the Historical Monuments of England
Butterfly Conservation	Faber Maunsell
Woodland Trust	Farming and Wildlife Advisory Group
Cambridgeshire Badger & Otter Group	

## **APPENDIX J - ENVIRONMENTAL REPORTS**

## **J ENVIRONMENTAL REPORTS**

### **Environmental Scoping Report Non-technical Summary**

A non-technical summary of the Environmental Scoping Report is included in this Appendix.

### **Environmental Statement and Environmental Action Plan**

An Environmental Statement and Environmental Action Plan is not required for the preferred option to continue to maintain the existing system.

## **Environmental Scoping Report Non-technical Summary**

Note – this summary was prepared for Option 6 to construct a flood storage area providing a 1 in 100 year standard of protection and is included here for information should it be required in the future. The preferred option to maintain the existing system does not require a Scoping Report.

This Scoping Report presents the findings of the environmental scoping assessment of a flood alleviation scheme on the Bin Brook, a tributary of the River Cam in Cambridgeshire. There is a history of flooding from the Bin Brook; affecting properties in the west of Cambridge.

Option 6 comprises a new flood storage reservoir on agricultural land upstream of the flood risk area to contain floodwaters during periods of high flows in the Bin Brook. This scheme would reduce the flood risk to 55 residential properties and two university halls of residence to a 1% annual probability of flooding.

The scheme was developed in partnership with the Cambridge Preservation Society (CPS) and would have assisted in the development of a proposed new Countryside Reserve. In addition to reducing flood risk to properties, the scheme presented significant opportunities, in partnership with CPS, for the creation of new wetland habitats and landscaping and improvements to public access.

The flood storage area would be located in a rural agricultural landscape to the west of Cambridge and the M11 motorway. It is surrounded by only five residential properties and is approximately one kilometre from the nearest village, Coton. Public access is limited to a number of footpaths around its perimeter and limited vehicular access is gained from a minor road. The ecological value of the area is limited to the arable field margins and the Bin Brook itself.

This assessment identified several potentially significant issues requiring further consideration. These included: impacts on legally protected species; the presence of invasive species; changes in landscape character; potential presence of archaeological features; unknown risk of excavating or flooding contaminated land; and potential changes to water levels in the Bin Brook. Should a flood storage option be progressed these issues will need to be considered further and be reported in an Environmental Statement.

Other issues considered included the potential disturbance to nearby residents, users of local roads and footpaths, risks to water quality in Bin Brook and the loss of agricultural land. Further detailed consideration of these issues is not required although appropriate management will be required during the construction and/or operation of a storage scheme to minimise any potential impacts.

The preferred do something option was identified following a detailed option appraisal process and consultation with local residents, organisations and statutory bodies. Alternative options considered included the provision of different standards of flood protection or the construction of new flood walls or channel enlargements within the flood risk area. Option 6 is the most cost-effective option which successfully reduces flood risk with minimal adverse environmental impacts. Extensive consultation, including a public exhibition, has identified this as the preferred do something option with strong local support.



## **APPENDIX K - SCHEME PHOTOGRAPHS**

## **K SCHEME PHOTOGRAPHS**

### **Scheme Photographs**

The following photographs are included in this appendix to provide a visual understanding of the Bin Brook Flood Alleviation Scheme.



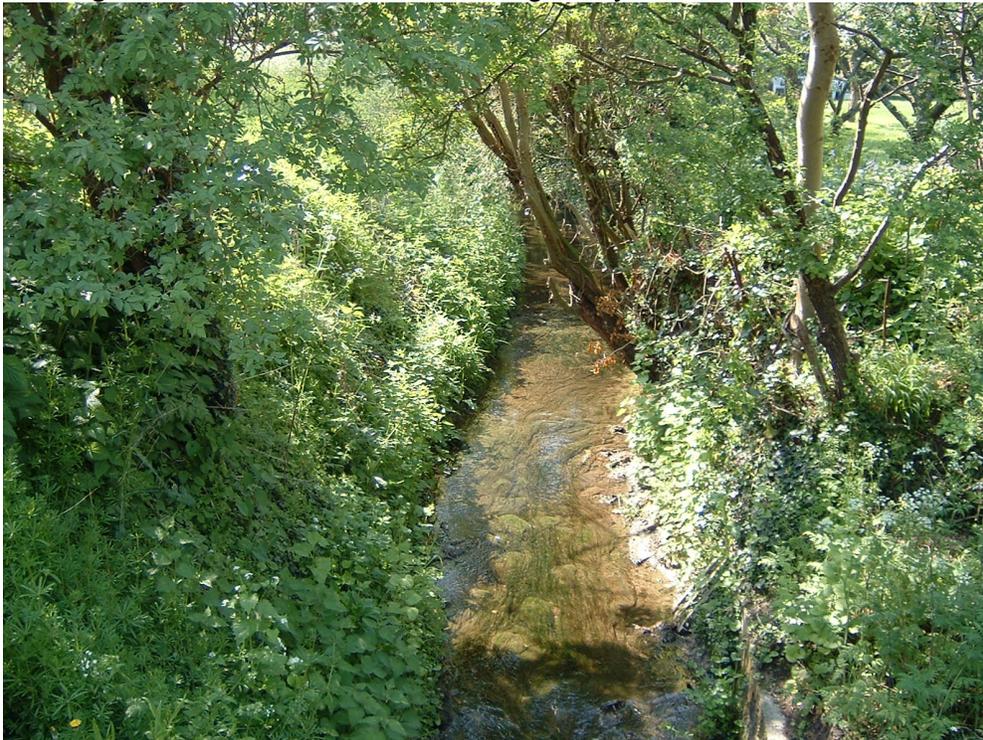
Flooding in Gough Way – 1978. (There are no photographs available of the October 2001 flood because it occurred at night)



Entrance to Gough Way Culvert



Existing Diversion Channel around Gough Way



Typical Channel Upstream Gough Way Culvert



Entrance to Gough Way Culvert and Start of Diversion Channel in Flood Conditions



Bin Brook in Proposed Flood Storage Area



View along Potential Dam Alignment in the Flood Storage Area with the M11 Motorway on the Left



View across Flood Storage Area. Bin Brook is running right to left across the photo next to the row of trees. The dam would be aligned in front of the hedge on the far left of the photo.

## **APPENDIX L - PROJECT PROGRAMME**

## **L PROJECT PROGRAMME**

A copy of the project programme envisaged for the design and construction stages had an improvement scheme been approved is attached.

## **APPENDIX M - VALUE REGISTER**



## **APPENDIX N - NATURAL ENGLAND LETTER OF SUPPORT**



## **APPENDIX O - TECHNICAL REPORT**

### *Option 1 - Do Nothing*

The Do Nothing Option is the option to which all other options are compared. The Option assumes that, after 5 years:-

- the channel becomes partially blocked by weeds and silt (Manning's n is increased from 0.035 – 0.05 to 0.1)
- Laundry Farm entrance culvert is blocked by 50%
- Gough Way Culvert is blocked by 50%
- The culvert at the south west corner of the diversion channel is blocked by 25%
- The two culverts under Barton Road are blocked by 50%
- The culverts near Clare Hall under Herschel Road and Sylvester Road are blocked by 25%.
- The opening of the sluice under Robinson College is blocked by 50%.

### *Option 2 - Do Minimum*

The Do Minimum option assumes that the channel and structures are maintained in their present condition. The cost includes for 100 years maintenance of the drainage system including repairs to the existing Gough Way diversion channel in 50 years time with a cost equivalent to replacing 25% of its length.

*Options 3 & 4 - Flood storage with fixed control in combination with flood walls at Gough Way with a standard of protection of 1 in 75 (1.3%) and 1 in 100 (1%) chance of flooding each year.*

These options comprise a flood storage area immediately upstream of the M11 motorway combined with flood walls around the south west corner of Gough Way where the land is locally low.

In designing the flood storage reservoir it was found to be impossible to completely remove the flood risk at Gough Way with a fixed diameter outlet from the reservoir. This is because the flows entering the system downstream of the reservoir site almost utilise the capacity of the existing channel around Gough Way. This makes it necessary to throttle almost all of the flow from upstream of the flood storage area at the peak of the event. This would require a very small diameter outlet from the flood storage area which would cause the storage area to fill too early during the event and then take several weeks to empty again. The use of a fixed discharge outlet, such as a "hydrobrake", to increase the efficiency of flood storage was tested but there was little advantage over a fixed outlet because the variation in head is not great enough for a "hydrobrake" to be effective.

For these options, the outlet from the flood storage area has been designed as a fixed orifice with an area of 0.6m<sup>2</sup>. This does not completely overcome the flooding problem at Gough Way and flood walls with a maximum height of 1.1m are required around the south west corner as shown on drawings WNBINP 005 & 006. Water would be out of bank in the flood storage area for a period of about 50 hours during a flood event with a 1 in 10 (1%) chance of occurrence each year.

Details of the outlet structure are shown on Drawings WNBINP 003 & 004. The outlet is provided with a manually operated penstock so that the area of the orifice can be

varied if required and so that it can be opened should the orifice become blocked with debris during a flood event.

The only difference between the options with standards of protection of 1 in 75 (1.3%) and 1 in 100 year (1%) chance of flooding each year is the volume of storage and hence the height of the dam at the flood storage area. The flood walls around Gough Way are identical for both options.

*Options 5a, 5 & 6 - Flood storage with automatic control with an annual standard of protection of 1 in 50 (2%), 1 in 75 (1.3%) and 1 in 100 (1%) chance of flooding each year.*

These options comprise a flood storage area immediately upstream of the M11 motorway with the size of the orifice limiting the flow from the flood storage area controlled according to the water level in the brook at Gough Way.

The outlet structure from the flood storage area would be similar to that for Options 3 & 4 except that the penstock would be automatically operated by an electric actuator controlled according to the water level at Gough Way. The water level in Bin Brook at Gough Way would be continually monitored by an ultrasonic gauge located on the headwall of the Gough Way Culvert and the signal transmitted to the reservoir site by a dedicated telephone line. The control unit for the water level gauge would be located in an existing adjacent Anglian Water sewage pump house. A control unit at the reservoir site would control the actuator on the penstock to throttle the flow from the flood storage area. The 1.5m diameter penstock would normally be set to fully open and would progressively close down to provide an orifice with a minimum area of 0.1m<sup>2</sup>. Following the flood event the penstock would progressively open to empty the flood storage area. Water would be out of bank in the flood storage area for a period of about 40 hours during the design event with a 1 in 100 (1%) chance of occurrence in any year. In the event of a system failure the penstock would automatically be closed to its lowest position. The status of the penstock would be relayed to the Environment Agency's control centre via the telemetry system. Power and telephone supply are available near to both the water level gauge and flood storage area sites.

The only difference between the options with standards of protection of 1 in 50 (2%), 1 in 75 (1.3%) and 1 in 100 year (1%) chance of flooding each year is the volume of storage and hence the height of the dam at the flood storage area.



**APPENDIX P - DRAFT HEADS OF TERMS WITH CAMBRIDGE  
PRESERVATION SOCIETY**