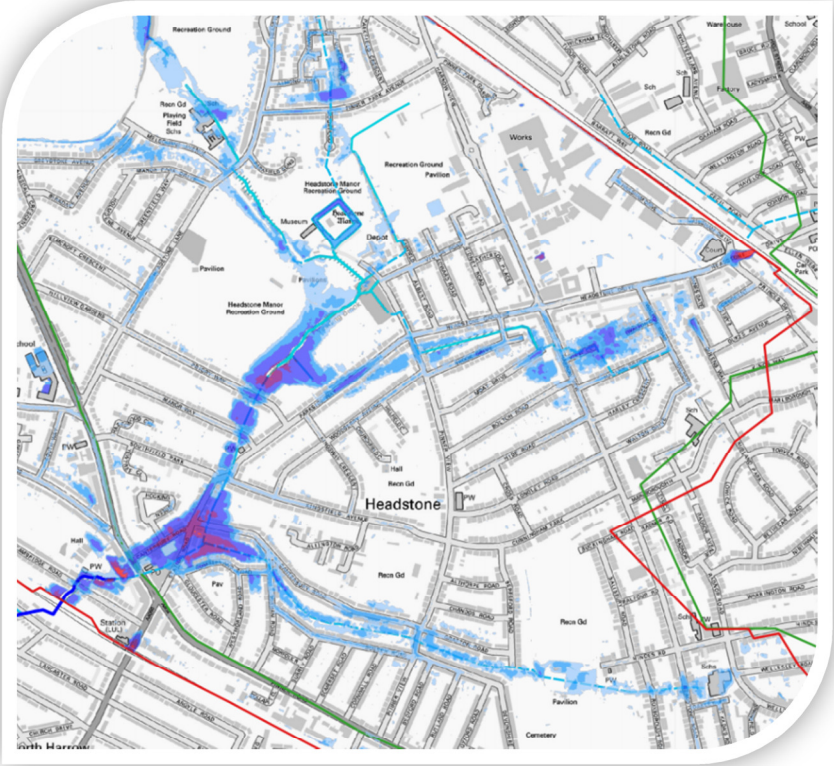
Harrow Council

Headstone Manor Flood Alleviation Scheme

Short Form Business Case

Version No: 1.2 (Updated following NPAS/NPAB comments)

Date: 17/05/2019



METIS

Harrow Council

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Approval Requested

The London Borough of Harrow is located in the north-west of London and is bordered by four London boroughs and two Hertfordshire districts (Figures S.1 and S.2). It includes 21 Wards covering an area of 55km² and lies within 3 main river catchments; the Brent, Pinn and Crane Rivers. The population of the borough is 214,600 (Office of National Statistics, 2004) and this is predicted to rise to 223,000 by 2025 (Harrow Council, 2008). Development within the borough is largely constrained by the greenbelt in the north and the current level of urbanisation.

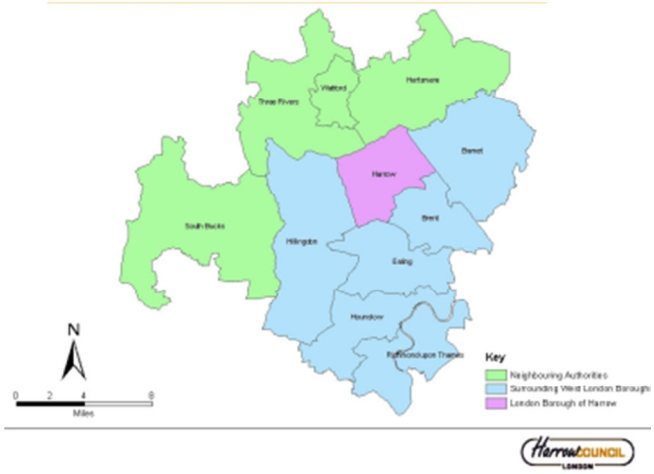

Figure S.1: Map of the London Borough of Harrow and neighbouring authorities

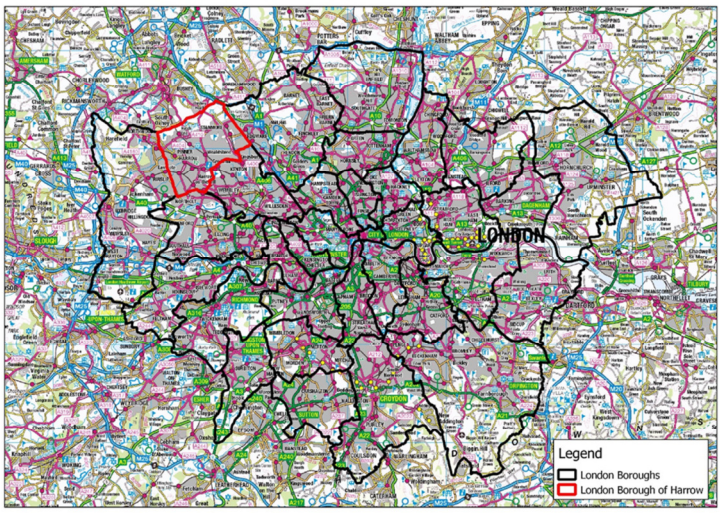

Figure S.2: Map of the London Borough of Harrow within Greater London

The Headstone Manor Flood Mitigation project seeks to address the existing surface water flood risk in the Headstone Critical Drainage Area. There have been a number of flooding incidents detailed within this business case and there is a significant risk of further flooding. There is therefore a very real drive from a flood risk point of view to implement a scheme which addresses these issues. As well as flood risk issues, the moat at Headstone Manor, which is a scheduled monument and part of a Site of Importance for Nature Conservation (SINC, Figure S.3), suffers

from very poor water quality. This negatively impacts upon local wildlife and is a significant concern of Harrow Council.

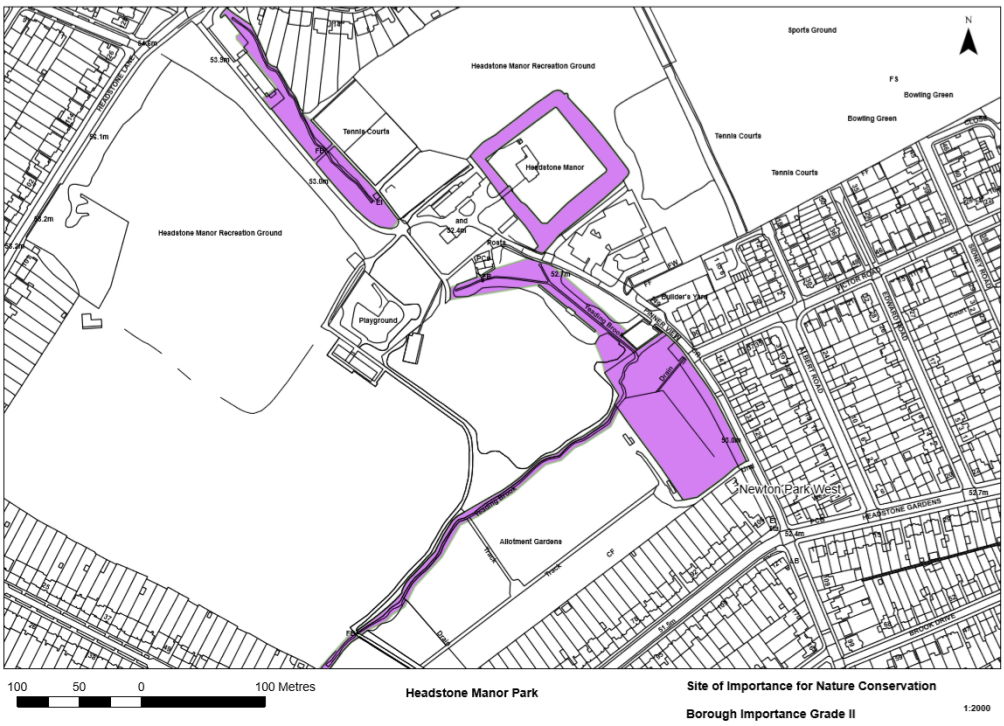

Figure S.3: Extent of the SINC within Headstone Manor Recreation Ground

To better understand the existing flood mechanism and subsequently to explore suitable mitigation options, a series of studies and investigations have been completed. These are briefly listed below:

- 2016 – Environment Agency – Headstone Flood Alleviation Scheme study. This investigation led to the production of a Strategic Outline Case. Harrow Council also had funding for the Headstone Manor Sedimentation Pond and Reed Beds project. Due to the associated fluvial and surface water flood risks, Harrow Council subsequently began leading on a combined project.
- 2017 – Harrow Council – Integrated Urban Drainage Model and Flood Mitigation Options Economic Appraisal Report by Metis Consultants. The model created is the best representation of flood mechanisms in the area to date, and was used to estimate flood damages, and benefits which a scheme would produce.
- 2018 – Harrow Council – Option development by Metis Consultants. Based on the preferred option from the 2017 work, a series of schemes were developed which had the potential to alleviate flooding. The option development phase sought to develop potential solutions which provide environmental and amenity benefits and are future-proofed against the effects of climate change. Options were discussed with Harrow Council and key local stakeholders and subsequently refined, before being assessed by a contractor for costing and buildability improvements. This Outline Business Case summarises the concept design refinements and the subsequent improved benefits, costs and funding amendments.

The proposed scheme comprises a combination of works in the Headstone Manor Recreation Ground playing fields and immediately upstream of the existing Headstone Manor Moat. The works in the playing fields comprise the construction of a 20,000 m^3 storage basin, to reduce flow leaving

site and the pressure on the existing sewer network. The works upstream of the moat comprise a sedimentation pond and reed bed, to attenuate some of the 1 in 40-year storm event and provide environmental enhancement. The preferred option, A4, has a Raw Partnership Funding score of 13% and a benefit / cost ratio of 2.2.

To achieve an Adjusted Partnership Funding score of 100%, a number of funding opportunities have been explored, and proposed contributions are listed below:

- Heritage Lottery Fund - £629.2k *(secured)*
- Harrow Council Community Infrastructure Levy - £300k *(secured)*
- Harrow Council Section 106 - £401.8k *(secured)*
- Harrow Council (other contributions from additional Community Infrastructure Levy and/or Thames Water AMP7 Local Authority funding pots, to be confirmed) - £444k
- GLA Green Capital - £300k *(secured)*
- Local Levy - £50k *(secured)*

The flood alleviation works in the playing fields are detailed more thoroughly in this Outline Business Case, the work upstream of Headstone Manor moat are in conjunction with a wider 'Parks for People' and Green Capital project. The latter is predominantly funded through Heritage Lottery and GLA Funds. Given the flood risk and environmental benefits of the sedimentation pond and reed bed area the associated costs and funding have also been included as part of this Headstone Manor Flood Alleviation Scheme.

In order for the scheme to progress through to detailed design (including value engineering activities) and construction, it is recommended that approval is given for funding to be released for value engineering activities and subsequent construction works. The preferred option's Partnership Funding Calculator (see Appendix A) states that £328,455 of FCRM Grant in Aid (GiA) is available for the scheme, albeit £110,700 has already been claimed as part of the scheme's development to date. Therefore, this requires £217,755 of FCRM GiA funding to be approved for claiming before the end of 2019/20 as allocated in the Environment Agency's six-year Flood and Coastal Erosion Risk Management Investment Programme.

1 Strategic case

1.1 Strategic Context

In 2016 the Environment Agency (EA) carried out the Headstone Flood Alleviation Scheme (FAS) study to identify potential options to alleviate flooding in the catchment. The study (project reference number THC023E/000A/012A) produced a Strategic Outline Case (SOC) [MM1]and used results from a 2015 Initial Assessment exercise and the 2008 River Crane fluvial flood model. The mapping suggested that 225 properties were at risk of fluvial flooding and 61 were at "very significant" risk within the SOC's study area. The SOC's study area is believed to be different to this Outline Business Case (OBC)'s study area (see below reference to fluvial flood risks).

Harrow Council also had a pipeline scheme focused on the surface water element of Headstone Manor Recreation Ground ('the Recreation Ground'). This was to potentially to install a sedimentation basin and reed bed system to improve flood risk and water quality to and from the Headstone Manor moat and from the Recreation Ground.

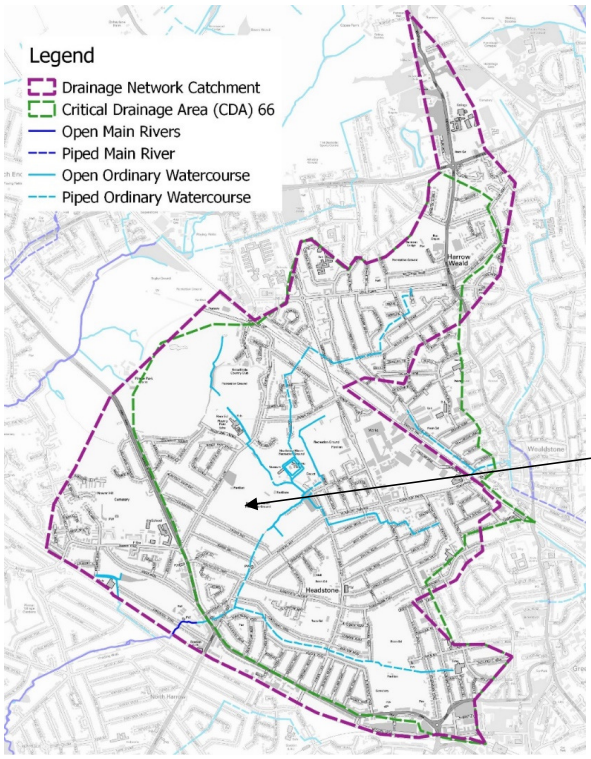

Figure 1.1: Study area

The predominant watercourse within the study area is the Yeading Brook West ('the Brook'), shown in Figure 1.1: Study area. The Brook, mainly surface water sewer-fed upstream of the Recreation Ground, is an ordinary watercourse. There are two significant open watercourse channels within the Recreation Ground: a western arm from Broadfields Recreation Ground and one that flows through Headstone Manor's moat. A third significant flow route into the Recreation Ground comes from the east, draining (via the surface water sewer network) the former Kodak sports ground site and local residential streets (including Victor Road and Brook Drive).

The Recreation Ground sits in the middle of Harrow Council's Critical Drainage Area (CDA) 66 and is scheduled to undergo significant site-wide regeneration work between 2019 and 2020. This work, a 'Parks for People' project, has been awarded £1.126m of Heritage Lottery Funds (HLF). It

includes improvement works around the Manor buildings and associated landscaping work throughout the site. The includes the creation of a reed bed and sedimentation pond to improve the water quality of Headstone Manor's moat, the partial de-culverting of the Broadfields arm of the Brook within the Recreation Ground and addition of a small amenity pond. The size of the reed bed and sediment pond potentially provides attenuation of the runoff volumes for lower return period storm events (up to 1 in 40-year return periods) coming from the north of the CDA but does not alleviate any of the risks from the eastern and western parts of the catchment.

In 2017, to better understand the existing flood mechanism at Headstone Manor, Metis Consultants was engaged by Harrow Council to build an integrated urban drainage model of CDA 66. This model, covering a study area slightly larger than the original CDA 66 extent (see Figure 1.1), provides the best current representation of the flood mechanisms within the catchment. This model has been used to estimate potential flood damages in the study area and the predicted benefits that a possible FAS will generate. A Flood Mitigation Options Economic Appraisal Report was created and Section 2 of this OBC summarises the options assessed. The associated Model Build Report is in Appendix B. The baseline model results suggest that 460 properties are at significant risk of surface water flooding within the study area, and 588 at 'very significant' risk. The Brook only becomes a main river near Cambridge Road, where it exits the study area boundary. Because of this, no properties are at very significant fluvial flood risk and only one property is at significant risk within the study area, superseding what was stated in the Headstone FAS SOC.

This project assesses the potential impact of a FAS in CDA 66 within the London Borough of Harrow. The main objective is to provide a cost effective, viable option that reduces surface water flood risks to people and properties, maximises environmental outcomes and is adaptable to the potential effects of climate change. Given the significant local risk of surface water flooding downstream from the site, and Harrow Council's desire to provide flood risk benefits alongside the HLF works, this FAS project has largely focused on the Recreation Ground site. One of the main flood alleviation options identified is the provision of storage in the Recreation Ground to restrict the flow of the Brook leaving the site and reduce the flooding downstream. The flood alleviation works in the playing fields are detailed more thoroughly in this Outline Business Case, with the work upstream of Headstone Manor moat being in conjunction with a wider 'Parks for People' project. The latter is predominantly funded through HLF. Given the flood risk and environmental benefits of the sedimentation pond and reed bed area the associated costs and funding have also been included as part of this Headstone Manor Flood Alleviation Scheme. The detention basin work in the playing fields is therefore a continuation of the 'Parks for People' project to maximise benefits and efficiencies.

The 2011 Harrow Council's Surface Water Management Plan identified that the area most susceptible to overland flow are river valleys or topographical valleys which represent routes of lost rivers, including parts of the Yeading Brook. The main issue is that the borough is mostly urbanised and the runoff volumes generated by impermeable areas have to be contained in either watercourses or the sewer network. The latter has reduced levels of service due to the increase in urbanisation, historic misconnections and cross-connections between foul and surface water pipework. Historically, watercourses have been largely culverted to make space for new development, decreasing the storage capacity and increasing the vulnerability of low topographical areas and former floodplains. These systems have limited potential to accommodate additional flows and future flood risks are predicted to increase due to climate change. The area at higher risk of surface water flooding caused by the Brook is the intersection between Station Road and Canterbury Road, where the Brook's culvert is closest to the surface and the topography is at the lowest point of the roads' flow path. Figure 1.2 depicts this area which is where the greatest amount of flood risk benefits (residential properties better protected) are predicted. A further breakdown of OM2 benefits with and without the preferred option in place can be seen in Appendix

A. Aside from the flow paths converging in the Recreation Ground, there is a further main flow route which drains the south-east area of the CDA 66 extent. This is completely made up of surface water sewers and joins the main Brook near the junction of Station Road and Cumberland Road in North Harrow, approximately 0.5 km downstream of the Recreation Ground. This confluence increases the flood risk at the Canterbury Road intersection. The Brook becomes a main river immediately upstream of Cambridge Road near the London Underground railway line (Metropolitan Line) by North Harrow Station.

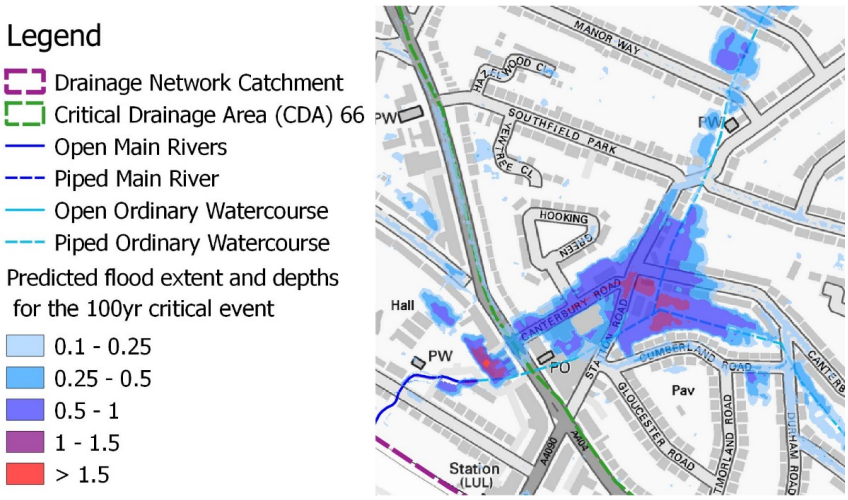

Figure 1.2: Anticipated area of benefitted OM2s from works in Headstone Manor Recreation Ground

Historically, the Headstone Manor moat has suffered from very poor water quality (pollution and silt build-up), and flooding within the Harrow Museum part of the site has been witnessed as recently as July 2018 (surface water, see Figure 1.3) and December 2018. The former event occurred outside the new visitor centre opposite the moat. The latter event was thought to have been caused by a blockage within the foul sewer network, but it is believed to be part of a wider pollution problem across the borough caused by older dual manholes. The Council and Thames Water are committed to improving the dual manhole issue through the wider Brent Catchment Plan, but work done to alleviate siltation and water quality issues in the moat through this FAS will lead to significant local benefits.[MM2]

Figure 1.3: Flood event in July 2018 in Harrow Museum

Table 1.1 lists the numerous strategic documents whose key policies or objectives align to those of the Headstone Manor FAS and the 'Parks for People' project.

Table 1.1: Key strategic documentation objectives aligned to the Headstone Manor FAS and regeneration projects

Document	Key Policies or Objectives
Harrow Ambition Plan	• Build a better Harrow
Harrow Council's Local Flood Risk Management Strategy	• To develop and to improve the understanding of flood risk across the borough • To better inform residents and profile flood risk including flood prevention, preparedness, resilience and resistance • To encourage residents, businesses and local landowners to take action and contribute to the management and reduction of flood risk
Harrow Council's Surface Water Management Plan	• Headstone Manor and the upstream catchment are defined as Critical Drainage Area (Group2_066) • Recommendations made for all Critical Drainage Areas include further investigation and implementation of mitigation schemes
National Flood and Coastal Erosion Risk Management Strategy for England	• Working together to put in place long-term plans to manage the risks of flooding • Building, maintaining and improving flood management infrastructure and systems to reduce the likelihood of harm to people and damage to the economy, environment and society • Increasing public awareness of the risk that remains and engaging with people at risk to encourage them to take action to manage the risks that they face and to make their property more resilient
Harrow Council's Core Strategy	Objectives: • Preserving the quality and function of the natural environment • Maintaining open space to provide a multi-functional and interconnected resource • Enhancing community access to and better use of open space, sport and recreation facilities • Manage the Borough's contribution to climate change and increase resilience to flooding by, amongst others, increasing natural and sustainable drainage Core Policies: • CS 1U to 1W: Sustainable flood risk management • CS 4F: Opportunities will be sought to open-up culverted sections of the Roxbourne River and Yeading Brook where this achieves sustainable flood risk management, habitat creation and, where appropriate, public access
Harrow Council's Development Management Policies	• DM 9: Managing Flood Risk • DM 10: On Site Water Management and Surface Water Attenuation • DM 11: Protection and Enhancement of River Corridors and Watercourses • DM 18: Protection of Open Space • DM 20: Protection of Biodiversity and Access to Nature • DM 21: Enhancement of Biodiversity and Access to Nature • DM 22: Trees and Landscaping • DM 27: Amenity Space • DM 47: Retention of Existing Community, Sport and Education Facilities
Harrow Council's Open Space Strategy	• Key Principle 2 – Parks and Open Space Infrastructure • Key Principle 6 – Adapting to Climate Change • Key Principle 7 – Increasing Biodiversity • Key Principle 11 – Park User Groups
West London Strategic Flood Risk Assessment	• To provide a strategic overview of all forms of flood risk throughout the study area, now and in the future • Determine the variations in risk from all sources of flooding across their areas. • Inform the Sustainability Appraisal so that flood risk is fully taken into account in assessment of Local Plans • Provide the evidence needed to inform the undertaking of the Sequential Test in determining the land use allocations in accordance with the National Planning Policy Framework, and how to apply the Sequential Test for windfall sites within the boroughs • Develop policies to manage the effects of climate change and flood risk from all sources

1.2 Objectives

The objectives of this project are ranked in Table 1.2:

Table 1.2: The project's key objectives

No	Critical Success Factor	Measurement Criteria	Importance (1-5)
1	Reduce the risk of flooding within the study area and the associated flood damages.	Number of properties predicted to be at risk of flooding following the completion of the scheme, compared to the number of properties predicted to be at the same level of risk in the baseline modelling; increased standard of protection to local properties previously at risk of flooding	1
2	Improved water quality and reduction of silt levels in Headstone Manor's moat	Increased dissolved oxygen through improved BOD level	2
3	Maximise biodiversity and amenity benefits wherever possible.	Increased variety of biodiversity following the completion of the scheme	3

2 Economic Case

2.1 Options considered

Table 2.1 lists the option combinations assessed in the 2017/18 flood mitigation option appraisal study and their potential benefits. This shortlist was developed in alignment with the Surface Water Management Plan (SWMP) Technical Guidance (Defra, 2010).

The appraisal process identified a range of measures for flood mitigation, based on the study's objectives (Table 1.2) and on the key areas identified by the modelling study. Less favourable options were screened out and a long list of desirable options was taken forward (see Appendix C). A secondary phase option refinement and systematic processing formed the short list of options shown in Table 2.1, and these were taken forward for cost-benefit evaluation.

Table 2.1: Shortlisted options from the flood mitigation option appraisal study

Options		Description	Technical, Environmental & Social matters
1	Do nothing	Do nothing	This option is not sustainable in an urban environment because it excludes any type of maintenance of the existing assets.
2	Do minimum	Regular maintenance of the culvert in Headstone Manor Recreation ground, the moat structures and outlet and cleaning of gullies in the study area.	Maintenance is a minimum requirement and has no new environmental or social benefits. The technical benefit of maintenance is avoiding the blockage of assets that negatively affects their efficiency.
3	Option A	Flow volumes out of Headstone Manor Recreation Ground are attenuated with a dry storage area (detention basin) adjacent to the watercourse and protected by a raised earth bund. Upstream of the moat, a reed bed and a sedimentation pond reduce the amount of sediment and pollution in the moat while storing a small amount of the attenuation volume for a 1 in 40-year storm event. The partly culverted channel within the Recreation Ground coming from Broadfields Recreation Ground is converted into an open channel with the addition of a small pond.	The scheme considerably reduces the amount of flooding downstream of the Recreation Ground and improves the water quality of Headstone Manor's moat. The scheme provides environmental benefits such as improved biodiversity, air and water quality as well as social, health and amenity benefits for the residents.
4	Option B	Option A plus lowered playing field and flood defence wall to act as a dry basin in Pinner Park School and retrofit of sustainable drainage system (SuDS) features in four other schools within the study area.	In addition to the benefits of Option A, this option would seek to provide delayed discharge (or total disconnection if infiltration was possible) from five schools from the system in lower return period storm events. This reduces capacity pressures on the sewer network and reduces the flood damages to the schools as well as across the catchment. This option has additional

Options		Description	Technical, Environmental & Social matters
			environmental and social (educational) benefits that come from the retrofit of SuDS in schools.
5	Option C	Option A plus de-culverting of sewer pipes in Harrow Recreation Ground with the addition of a pond. Lowered playing field and flood defence wall to act as a dry basin in Pinner Park School.	In addition to the benefits of Option A, the addition of two storage areas in the study area will increase the flood protection benefits by disconnecting various parts of the catchment for lower return period storm events. The de-culverting of the surface water sewer and creation of a pond in Harrow Recreation Ground will provide environmental, air quality and biodiversity benefits to the area as well as health, amenity and recreational benefits to the residents.
6	Option D	Option A plus features within Options B and C.	This option combines the flood protection, social and environmental benefits of Options A, B and C.
7	Option E	Option A plus the installation of raingardens on Victor Road, Headstone Gardens, Brook Drive and Pinner View (highway SuDS retrofitting option).	This option has the benefits of Option A plus the air quality and environmental benefits of retrofitting raingardens in the residential area upstream of Headstone Manor Recreational Ground. The raingardens will also relieve pressure on the surface water sewer network in the lower return period events.
8	Option F	Option D plus highway SuDS retrofitting features within Option E: All option features modelled.	This option combines the flood protection, social and environmental benefits of Options D and E.

2.2 Climate Change

In line with current guidance, the impact of climate change has been considered in this business case. The below bullet points provide an overview of the steps, with further detail in Section 2.9.

- Baseline scenarios (1 in 20-year event, 1 in 40-year event and 1 in 100-year event) were run with and without a climate change allowance of 30%
- Option scenarios (1 in 20-year event, 1 in 40-year event and 1 in 100-year event) were run with and without a climate change allowance of 30%
- The results of these runs were then analysed to ascertain the impact of Climate Change

2.3 Cost Estimation

Each option has been built into the model and tested for a range of high and low return period storm events. The damage assessments for the options and the baseline case ('Do minimum') [MM3]have been calculated following the procedure outlined in the Multi-Coloured Manual (2014). The present value (PV) damage avoided benefits are calculated as the difference between the baseline's and each option's PV flood damages. The total PV benefits are the sum of the damage

avoided benefits and the non-flood risk benefits of each option, estimated with CIRIA's Benefits of SuDS Tool (BeST).

2.4 Optimism Bias

Optimism bias on both construction and future maintenance costs has been calculated using the root mean square method set out in the EA's appraisal guidance. This analysis quantified the below risks, based on an assumed "most likely cost" and "maximum likely cost" associated with each risk. These risks have been selected based on input from the contractor Jackson Civil Engineering, an EA Programme Delivery Unit supplier.

The conclusion of the risk analysis was that a value of approximately 30% was necessary for the optimism bias, in line with guidance. The breakdown of the square root method calculation is contained within Appendix E (for the preferred Option A only).

The cost of the sedimentation pond and reed bed, the watercourse de-culverting and the small amenity pond, have been developed using cost estimates provided by a third party on behalf of Harrow Council through the 'Parks for People' project. As these designs are already at a more detailed stage, an optimism bias of 30% was applied to these estimates and added to the cost estimated for the other elements of the scheme. These costs are up to date to April 2019's estimated project bill of quantities. It is recommended that, once finalised, this OBC is revised to incorporate any small changes in the 'Parks for People' project upon tender award.

2.5 Non-flood benefits

CIRIA's Benefits of SuDS Tool (BeST) has been used to quantify the benefits over and above those from flood risk protection, and the results are shown in Table 2.2. Please note that the BeST tools for Options B to E within Appendix F contain figures **above** Option A. The figures in the below table therefore take the figures within each BeST tool in addition to the Option A figures.

Table 2.2: Breakdown of non-flood risk benefits of shortlisted option combinations

	Option A	Option B	Option C	Option D	Option E	Option F
Air quality (S02)	£907.00	£959.00	£975.00	£1,027.00	£923.00	£1,043.00
Air quality (N02)	£549.00	£584.00	£587.00	£622.00	£566.00	£639.00
Air quality (PM-10)	£12,463.00	£13,656.00	£13,007.00	£14,200.00	£13,769.00	£15,506.00
Amenity benefits (permanent bodies of water)	£15,639.00	£15,639.00	£50,089.00	£50,089.00	£15,639.00	£50,089.00
Amenity benefits (street improvements)	N/A	N/A	N/A	N/A	£18,802.00	£18,802.00
Biodiversity benefits (habitat creation)	£119,606.00	£119,606.00	£123,105.00	£123,105.00	£119,606.00	£123,105.00
Education (educational trips)	£422,178.00	£455,560.00	£1,068,758.00	£1,102,140.00	£422,178.00	£1,102,140.00
Health benefits (access to permanent water)	£1,092,383.00	£1,092,383.00	£1,092,383.00	£1,092,383.00	£1,092,383.00	£1,092,383.00
Health benefits (access to green space)	£2,812,566.00	£2,812,566.00	£2,812,566.00	£2,812,566.00	£2,812,566.00	£2,812,566.00
Recreation (general recreation activities)	£11,292.00	£11,292.00	£11,292.00	£11,292.00	£11,292.00	£11,292.00
Recreation (constructed wetlands)	£4,941.00	£4,941.00	£4,941.00	£4,941.00	£4,941.00	£4,941.00
Water quality / pollution benefits (of receiving waters)	£680,723.00	£680,723.00	£715,852.00	£715,852.00	£680,723.00	£715,852.00
TOTAL	**£5,173,247.00**	**£5,207,909.00**	**£5,893,555.00**	**£5,928,217.00**	**£5,193,388.00**	**£5,948,358.00**

2.6 Benefit / Cost Ratios

Two benefit / cost ratios (BCRs) have been calculated for each option. One showing only the flood related benefits, and the other including the wider benefits which are integral to the scheme. These are shown in Tables 2.3 and 2.4 respectively. Incremental BCRs have not been included because of the way the shortlisted options were modelled – some are made up of option feature combinations, others are standalone option features (for example Option B includes features A and B, Option C includes features A and C, but Option D includes features A, B and C (this being different than Option B plus Option C) (see Table 2.1 for full option feature combination details).

Table 2.3 Shortlisted options benefit / cost ratios – flood benefits only

Option		Present Value costs	Present Value damages	Total Present Value benefits	Average benefit / cost ratio (BCR)
1	Do minimum	£0	£21,671,000	£0	0
2	Option A	£2,063,000	£20,810,000	£861,000	0.4
3	Option B	£2,842,000	£19,252,000	£2,419,000	0.9
4	Option C	£2,944,000	£20,482,000	£1,190,000	0.4
5	Option D	£3,496,000	£19,103,000	£2,568,000	0.7
6	Option E	£2,159,000	£20,735,000	£937,000	0.4
7	Option F	£3,592,000	£19,073,000	£2,598,000	0.7

Table 2.4: Shortlisted options benefit / cost ratios with non-flood benefits included

Option		Present Value costs	Present Value damages	Total Present Value benefits		Average benefit / cost ratio (BCR)
				Present Value flood related benefits	Present Value non-flood related benefits	
1	Do minimum	£0	£21,671,000	**£0**		0
				£0	£0	
2	Option A	£2,063,000	£20,810,000	**£6,034,000**		2.9
				£861,000	£5,173,000	
3	Option B	£2,842,000	£19,252,000	**£7,627,000**		2.7
				£2,419,000	£5,208,000	
4	Option C	£2,944,000	£20,482,000	**£7,083,000**		2.4
				£1,190,000	£5,894,000	
5	Option D	£3,496,000	£19,103,000	**£8,496,000**		2.4
				£2,568,000	£5,928,000	
6	Option E	£2,159,000	£20,735,000	**£6,130,000**		2.8
				£937,000	£5,193,000	
7	Option F	£3,592,000	£19,073,000	**£8,547,000**		2.4
				£2,598,000	£5,948,000	

2.7 Preferred way forward

Option A was recommended as the preferred way forward because it achieves the highest BCR of the six 'do something' option combinations. It also required the least amount of additional funding contributions to be generated (as shown in the Partnership Funding (PF) calculator scores in Table 2.5). Map 9 in Appendix C (*Shortlisted Options* document) compares the predicted baseline surface water flood risk extents with those following the inclusion of Option A for the area of greatest predicted benefit within the catchment (Station Road and Canterbury Road).

Table 2.5: PF Calculator scores

PF Calculator			Adjusted PF Score: 100%	
Option	**Damage Avoided Benefits**	**Raw PF Score**	**Additional Harrow contribution required***	**FCERM GiA funding eligible**
Option A	£861,000	20.1%	£268,000	£329,000
Option B	£2,419,000	18.8%	£840,000	£433,000
Option C	£1,190,000	17.6%	£874,000	£407,000
Option D	£2,568,000	17.4%	£1,286,000	£489,000
Option E	£937,000	20.2%	£318,000	£344,000
Option F	£2,598,000	17.7%	£1,332,000	£508,000

* These extra contributions required figures are in addition to funding previously allocated to schemes incorporated into all of the options (as listed in Table 4.2)

NB: All numbers are rounded up to the nearest thousand pounds

The results of this analysis are sensitive to the cost estimates and the damage avoided benefits. While the latter have been obtained following hydraulic modelling, the former have higher uncertainties at this stage. Whilst existing Harrow Council rates have been used wherever possible, a further stage of cost estimation refinement was undertaken in 2018, as detailed in the following section.

2.8 Refinement of Option A

To reduce risk and provide greater confidence in the cost estimates produced in the flood mitigation option appraisal stage, a series of potential arrangements of the preferred option, Option A, were developed for discussion with Harrow Council and key stakeholders. These drawings are shown in Appendix D. Note that these refined options all had a revised volume of excavated material, from 8,000 m^3 to 20,000 m^3. This change was due to the reduction of the height of the bund originally modelled during the Economic Appraisal stage.

A summary of each option and, where taken forward, detailed costs is listed in Table 2.6. Through this discussion phase, a number of these initial options were discounted until three options remained. These three options were then costed by Jackson Civil Engineering.

Table 2.6: Summary of Jackson Civil Engineering costing

Option	Description	Decision on whether to proceed to costing	Updated cost estimate (including risk)
A-1	This option comprises the filling of an existing section of the Yeading Brook West channel, the construction of two detention basins and installation of two flow controls at the outlets of each detention basin. The first detention basin is at the existing cricket pitch towards the north of the site, and the second in the south east of the Recreation Ground, partially on existing football pitches.	This option was discounted following consultation with the cricket pitch, as following construction of the works the cricket pitch would not be usable for approximately two years, thus rendering the option unworkable.	N/A
A-2	This option comprises the construction of a detention basin on the existing football pitches towards the south of the site, a length of new footpath and a new flow control at the outlet of the detention basin.	This option was progressed to the costing exercise.	£1,446k
A-3	This option comprises the construction of a detention basin at the north west of the Recreation Ground, a number of areas requiring raising towards the north east corner of the Recreation Ground, three significant lengths of below ground pipes, the construction of a further detention basin in the south east of the Recreation Ground on the existing football pitches and installation of three flow control structures at the inlet/outlets of the detention basins.	This option was discounted due to the likely prohibitive construction cost associated with the below ground pipes, as well as the likely maintenance issue which such a solution would pose to the Council.	N/A
A-4	This option comprises the construction of two adjoined detention basins in the south east of the Recreation Ground, a new flow control at the outlet of the basin, and creation of a new ditch and length of footpath.	This option has progressed to the costing exercise.	£1,407k
A-5	This option comprises the construction of a detention basin on the existing football pitches in the south east of the Recreation Ground, the diversion of the existing Yeading Brook West channel ditch and the installation of a flow control at the outlet of the basin.	This option has progressed to the costing exercise.	£1,450k

Table 2.7 shows the updated BCRs of the refined Option As which have been costed. It is important to note that whilst the BCR has reduced from the initial estimates achieved, as all other options (B to F) incorporated Option A, their cost estimates would have also increased. It has therefore not been deemed necessary to re-analyse Options B to F because their BCRs would be still less desirable than Option A.

Table 2.7: Refined Option A Benefit / Cost ratios

Option		Present Value costs	Present Value damages	Total Present Value benefits		Average benefit / cost ratio (BCR)
				Present Value flood related benefits	Present Value non-flood related benefits	
1	Option A2	£2,916,811	£17,930,647	**£5,953,256**		2.0
				£780,008	£5,173,247	
2	Option A4	£2,882,629	£17,930,647	**£5,953,256**		2.1
				£780,008	£5,173,247	
3	Option A5	£2,921,950	£17,930,647	**£5,953,256**		2.1
				£780,008	£5,173,247	

This type of flood defence feature is sustainable and should not greatly increase the necessary maintenance required, as the only hard structure / proprietary feature of the scheme is a flow control.

The size of the detention basin should allow sports pitches to be re-established within the basin, meaning there would be no long-term social negatives associated with the scheme. This is on the assumption that groundwater levels (which can vary significantly from year to year) are low enough that the pitches do not become too boggy. It is recommended that groundwater testing should be undertaken in the Detailed Design phase, as outlined in Appendix E.

Table 2.8: Refined Option A PF Calculator results

PF Calculator			Adjusted PF Score: 100%	
Option	Damage Avoided Benefits	Raw PF Score	Additional Harrow contribution required*	FCERM GiA funding eligible
Option A2	£780,008	13%	£457,000	£331,008
Option A4	£780,008	13%	£414,000	£328,455
Option A5	£780,008	13%	£462,000	£331,040

* These 'additional contributions required' figures are in addition to funding secured or previously allocated to this scheme (£30k Harrow Council contribution) as listed within Table 4.2. Table 4.2 also states how Harrow Council propose to fund this additional contribution.
NB: All numbers are rounded up to the nearest thousand pounds

Table 2.8 shows the refined PF Calculator results for the three costed Option A concepts. The recommended preferred option is A4, as this option is the most economically viable option (requires the least amount of additional funding to move forward).

2.9 Impact of Climate Change on Option A

In line with current guidelines, a number of different model runs have been undertaken to explore the impacts which expected climate change (CC) would have on the proposed options. These runs are shown in Table 2.9.

Table 2.9: Initial climate change model runs

Scenario	Return period	Climate Change allowance
Baseline	1 in 20-year event	0%
Baseline	1 in 40-year event	0%
Baseline	1 in 100-year event	0%
Option A	1 in 20-year event	30%
Option A	1 in 40-year event	30%
Option A	1 in 100-year event	30%

As expected, the flood depths in Option A with 30% CC were higher than the corresponding baseline (without CC) flood depths. In detail:

- 1 in 20-year return period: 130 to 140 mm increased flood depth in the Option A CC run
- 1 in 40-year return period: 60 mm increased flood depth in the Option A CC run
- 1 in 100-year return period: 100 to 110 mm increased flood depth in the Option A CC run

This was not deemed a useful way of analysing the effectiveness of the scheme because the results do not clarify the extent that the CC-induced flood depth increases have been reduced by the proposed FAS. For this reason, additional runs were modelled, as listed in Table 2.10.

Table 2.10: Secondary climate change model runs

Scenario	Return period	CC allowance
Baseline	1 in 20-year event	30%
Baseline	1 in 40-year event	30%
Baseline	1 in 100-year event	30%

The results were as follows:

- 1 in 20-year return period: 300 to 400 mm increased flood depth in the CC run
- 1 in 40-year return period: 300 to 400 mm increased flood depth in the CC run
- 1 in 100-year return period: 200 mm increased flood depth in the CC run

It is evident that the proposed scheme is reducing the effects of CC. A final set of runs were modelled to directly compare the proposed FAS with CC with the baseline with CC. Table 2.11 lists the modelled runs compared.

Table 2.11: Final climate change model runs

Scenario	Return period	CC allowance
Baseline	1 in 20-year event	30%
Baseline	1 in 40-year event	30%
Baseline	1 in 100-year event	30%
Option A	1 in 20-year event	30%
Option A	1 in 40-year event	30%
Option A	1 in 100-year event	30%

The results showed that there are 20 properties which would have become flooded with CC that would be protected by the scheme. Whilst the effectiveness of the scheme is likely to fall as the effects of CC are realised, the scheme will still provide a benefit at the end of its 100 year design life.

2.10 Sensitivity to material reuse

A significant proportion of the construction cost for all variants of Option A is the cost to dispose of excavated material offsite. It is therefore recommended that opportunities to reuse material onsite wherever possible should be explored in future design phases, potentially through bunds, landscaped areas, or by levelling the existing sports pitches.

To understand the potential impact which reducing the disposal quantities would have on the scheme, a scenario where 50% of excavated materials have been reused on site has been explored for the preferred Option A4. It is important to note that no additional construction time has been included in this analysis, only material savings.

In this scenario (which has the same quantifiable benefits), a PF score of 16% is realised, £208,673 of GiA would be claimable (excluding the GiA already claimed), leaving a funding gap of only £16k for Harrow Council to fill (as opposed to the £444k). As this should still be explored during the detailed design stage, Section 4 of this OBC has not taken this potential material reuse into account but should be updated at a later date.

3 Commercial case

3.1 Procurement strategy

It is proposed that the Council will use their term contractor to deliver the scheme, using their previously agreed schedule of rates wherever possible to determine the costs. At the time of this OBC, a new term contractor was being procured. It was for this reason that Jackson Civil Engineering were used to provide an independent cost assessment, and comparisons with local supplier quotes supplied by the Council confirmed similarities (of per cubic metre costs). For any work outside of the term contractor's remit, it is expected that the commissioning will be performed in line with the Council's in-house Procurement team's processes which follow National Government legislation and therefore comply with the Official Journal of the European Union. This will include the writing of the specification, liaising with the Council's Legal and Finance teams where required, and sending out the invitation to tender via the London Tenders Portal. This approach has been proposed due to previous successful working relationships with contractors for the Council's Queensbury Recreation Ground (Kenton Brook river restoration and flood storage) and Stanmore Marsh projects and the Newton Park West FAS. This approach is likely to take between 6 and 10 weeks, assuming the use of Harrow's tender contractor.

3.2 Key contractual terms and risk allocation

The works will be project managed by Council officers, aligned to in-house project management systems. The scope of the work is to be clearly defined following final refinement of the designs of the dry detention basin (to maximise ecological and water quality benefits).

All construction works, including ground investigations, will be carefully managed to keep disruption to the Park to a minimum. Key risks associated with the project are outlined in Appendix E.

3.3 Efficiencies and commercial arrangements

Efficiency savings are to be tracked through the use of the EA's Combined Efficiency Reporting Tool (CERT). The target is for RMA-led projects to achieve 10% savings which, combined with all other projects on the EA's six year capital investment programme, will help to offset future inflation costs (for example of construction). Efficiencies are to be reported on quarterly and will be reviewed by central Government. As with the HM Treasury's five case three stage business case model, the data submitted within the CERT is to be proportionate to the size of the project. The CERT will be a live document throughout future phases of the scheme, capturing efficiencies against their baselines. This project aims to meet the 10% target through the following efficiencies as a minimum, listed in the order which Harrow Council anticipate them being realised:

- Time and cost savings – lessons learnt from similar projects delivered by the Council, such as the Newton Park project will be put into practice to maximise savings throughout the project. Such savings should be identified from the procurement and design phases through to construction and completion.
- Funding savings – similarly to above, lessons learnt from the similar projects delivered by the council, including the Newton Park project, will be put into practice to maximise savings throughout the project. Such savings should be identified from the procurement and design phases through to construction and completion.
- Alignment of modelling – the modelling of the option has been done by combining the FAS with the features in the park regeneration scheme. This ensures that any attenuation volumes held by the HLF-funded regeneration scheme features is not accounted for in the design volume for the dry detention basin.
- Alignment of Council FAS meetings – since the commencement of the modelling work, several Harrow Council FAS progress meetings have occurred concurrently. Examples include Temple Pond, Wealdstone and North Harrow. These have been attended by

various parties such as the consultants, the Council, the EA, Thames Water and Thames21 and this is proposed to continue throughout the detailed design and construction phases.

- Combination savings – all the savings above will be further improved by the combination of the wider Headstone Manor 'Parks for People' project with the FAS. Since the two projects are in the same location, the cost of getting personnel and materials to the site will be shared. The same goes for maintenance of the assets. Both projects are also being led and managed by the same Council team, maximising the potential for efficiency savings to be realised.
- Material savings – it is recommended that re-use of excavated material on site is explored. This could be in the form of bunds, landscaped areas or by improving the existing football pitches and associated drainage. The latter example would provide not only a saving in terms of material re-use, but also offer wider social benefits.
- Future maintenance savings – careful design will ensure that maintenance regimes are suitable and prevent unnecessary duplication of tasks, working with nature wherever possible. Access to the channel will be improved through the project, potentially limiting the time and size of plant required to undertake maintenance.

4 Financial case

4.1 Financial Summary

Tables 4.1 and 4.2 have been used to complete the Partnership Funding Calculator submitted alongside this OBC.

Table 4.1: Summary of the project's projected costs

	Cost for economic appraisal (PV)	Whole-life cash cost	Total Project cost (approval)
Costs up to OBC		£122,631	£11,931
Costs after OBC			
Value Engineering & Construction (including future project management)	£1,792,875	£1,823,711	£1,792,875
Risk Contingency*			
Risk or Optimism Bias**	£537,862	£547,113.20	£537,862
Future costs (maintenance & decommissioning)***	£330,200	£1,725,151	
Optimism Bias on future cost**	£99,060	£517,545.26	
Project total cost	£2,759,998	£4,736,151	£2,342,668

* The risk contingency method used is reflective of the scale of the overall project. The sensitivity analysis in the Partnership Funding calculator demonstrates that the whole life cost of the project's construction is the most variable.

** Optimism bias calculated as 30% of the construction cost as this project is at the detailed design stage.

*** Annual maintenance costs based on Environment Agency FCERM Research & Development Programme's SC080039/R3 report (March 2015) and the decommissioning cost assumed to be 40% of the construction cost, with a lifetime of 100 years (scheme operation of 98years from Year 2 to Year 99 – assuming no maintenance occurs in year of construction and year of decommissioning).

4.2 Funding sources

Table 4.2: Sources of funding and Partnership Funding Score for Option A4

	%	Description	Total £k
Raw Partnership Funding score	13		
Funding:			
Heritage Lottery Fund		For the wetlands/sediment basin and watercourse deculverting (incl. small pond reinstatement) element only	629.2
Harrow Council – Community Infrastructure Levy		Made up of a confirmed Borough CIL contribution (for the HLF water work)	300.0
Harrow Council - Section 106		Made up of a confirmed contribution (for the HLF water work)	401.8
Harrow Council – other contributions		To be made up of Harrow Council contributions (£30k previously allocated plus a proportion of an additional CIL business case (TBC% of £500k) and Thames Water AMP7 SuDS money (TBC% of £150k) *(exact split TBC))*[MM4]	444.0
GLA		Confirmed Green Capital funding (towards HLF water work)	300.0
Local Levy			50.0
Non GiA contributions			2,124.9
Adjusted Partnership Funding score	100		
Grant in Aid		Total GiA the project is eligible for	328.5
		Total GiA the project has already claimed during development work to date[MM5] (£100k by Harrow Council for pre-OBC feasibility work plus the £10.7k by EA for SOC)	-110.7
Project total cost (approval)			**217.8**

5 Management case

5.1 Project and contract management

The project is to be managed by the Council and led by their Lead Local Flood Authority team. The Council's Senior Drainage Engineer will be the project manager and they will be the central communication point between all Council staff, contractors, partner organisations, Councillors and interested local residents.

Table 5.1: Anticipated Roles and Responsibilities

Role	Provider	Responsibilities
Project Manager	Harrow Council	The project lead. Sets timeframes and manages milestone delivery, acts as the contact between council and partners and manages the budget. Such partners could be charitable organisations like Friends of Harrow Museum, Thames21 and Green Corridor, as well as organisations associated with the 'Parks for People' project works upstream of the Recreation Ground such as Land Use Consultants and Community First Partnership. Acts as the Council's representative, the link to council activities and alignment with priorities etc. Informs the project team of progress, including future responsibilities / legacy rollout, and the link with councillors, local committees, neighbourhood groups etc. Organises planning matters and contracts.
Project Executive	Harrow Council	Will ensure that the Council's priorities are met and that links to Council activities are maintained.
Project Team	Harrow Council and Partners	Report to the Project Coordinator. Made up of all key partners (including involved authorities, design consultants, construction contractor and trusts) and stakeholders. Responsible for ensuring the final designs promote maximum water quality benefits, and the identification of possible additional funding routes. Raising of good practice and providing supporting advice regarding specific elements of the design (e.g. water quality improvements).
Construction Team	Contractor (TBC)	Value engineering of detailed design development where necessary. Oversees delivery, informs roll out and progress to Project Coordinator, and contributes to management plans. Construction of scheme as agreed with Project Coordinator.

5.2 Schedule

Table 5.2: Schedule of main events

Activity	Date (DD/MM/YYY)	Comment
Discussion with partners who could provide FAS financial support	Ongoing	Led by Harrow Council
Public consultation, led by the Community Engagement Team	Ongoing	This has been in progress since the R2 HLF submission in February 2018.
Submission of OBC to the Environment Agency's National Project Advisory Service	01/04/2019	Approval of support from the Environment Agency's Area Flood and Coastal Risk Manager required prior to submission
'Parks for People' Headstone Manor site-wide regeneration project work to start on site	01/07/2019	
Liaison with Harrow Council's Legal, Finance and Procurement teams to ensure all standard Council processes are being performed	01/09/2019	
Refinement of FAS final designs to maximise ecological / water quality benefits and minimise construction & operation costs ('value engineering stage')	01/10/2019	Close working with partners, including Thames21, once initial funding has been confirmed.
Procurement and appointment of FAS construction contractor	01/01/2020	Budget confirmation required following decision on OBC
'Parks for People' Headstone Manor site-wide regeneration project work substantially completed by	31/03/2020	
FAS work to be started on site	01/04/2020	
FAS work substantially completed by	31/03/2021	

5.3 Outcomes

The primary benefit of the FAS is to reduce flood risk. While most of the flood alleviation benefits are given by the dry detention basin, the site-wide Headstone Manor regeneration scheme itself will contribute towards the overall storage volume required by the FAS. The aligned projects provide the flood risk reduction benefits of the FAS with the substantial environmental, water quality and amenity benefits of the park's regeneration scheme.

Table 5.3: Outcome Measures delivered by the project

Contributions to outcome measures	
Outcome 1 – Ratio of whole-life benefits to costs	
Present value benefits (£k)	£5,953,256
Present value costs (£k)	£2,882,629
Benefit: cost ratio	2.1
Outcome 2 – Households at reduced risk	
2a – Households moved to a lower risk category (number – nr)*	36
2b – Households moved from very significant or significant risk to moderate or low risk (nr)	12
2c – Proportion of households in 2b that are in the 20% most deprived areas (nr)	0%
Outcome 3 – Households with reduced risk of erosion	
3a – Households with reduced risk of erosion (nr)	N/A
3b – Proportion of those in 3 protected from loss within 20 years (nr)	N/A
3c – Proportion of households in 3b that are in the 20% most deprived areas (nr)	N/A
Outcome 4 – Water framework directive	
4a – Hectares of water-dependent habitat created or improved (ha)	N/A
4b – Hectares of intertidal habitat created (ha)	N/A
4c – Kilometres of river protected (km)	N/A
4d – Kilometres of WFD water body enhanced through FCRM	0.1
4e – Kilometres of water body opened up to fish and /or eel passage through FCRM	N/A
4f – Kilometres of river habitat enhanced (including SSSI) through FCRM	N/A
4g – Hectares of habitat (including SSSI) enhanced through FCRM	N/A
4h – Hectares of habitat created through FCRM	0.5

* This figure counts all of the residential properties which are moving risk bands between the Do Minimum baseline and the preferred Do Something (Option A4), not the net outcome between very significant, significant and moderate risk.

5.4 Risk, constraint and dependency management

Key project risks, constraints and dependencies are detailed in Appendix E. We would anticipate that the risk register being a live document which is regularly updated throughout the project delivery, to ensure that risks are being identified, mitigated and considered in a pro-active manner.

5.5 Sustainability

The project will be managed with the full engagement from officers responsible for environmental, economic and social sustainability within Harrow Council. There will also be a consultation which

will give the local community an opportunity to provide feedback on the design and input their requests and concerns. Monitoring procedures will be put in place by Harrow to monitor the impacts of the environmental improvements realised from the scheme, including monitoring water and air quality.

The project should seek to deliver the project with local contractors, using locally sourced materials wherever possible.

5.6 Assurance

The project is largely dependent on the provision of external contributions from partner organisations. This is largely the EA (distributors of Defra's FCRM GiA funding) for the finalisation of the detailed designs, plus a number of stakeholders and environmental organisations for its construction. As a result, the project will need to conform to the standards and policies of all of the partners involved. The Project Manager will provide the central liaison role between the Council and each partner to ensure that all requirements are met. This role will also ensure that all necessary documentation is produced to obtain approval for the allocated funding.

It is intended that regular progress meetings are held between the Project Manager and the Project Team, plus the Contractor once confirmed. The progress meetings will allow for peer reviews of the detailed design refinement, whilst ensuring that all funding opportunities are seized. Internal project board meetings are proposed on a bi-monthly basis or as required. Independent review and approval by NPAS/NPAB at the necessary timescales, and it has been agreed that the Council's EA Partnership and Strategic Overview contact (who has been involved throughout the appraisal and design stages to date) will assist with the guidance of the project through this process. It is expected that this contact will also provide technical support when needed so that it achieves Financial Scheme of Delegation approval.

Following the completion of the project, there will be a post-project review by the project team to document the successes and lessons learnt. It is intended that such a review will enable the project to be replicated elsewhere in the borough, incorporating any improvements from this project. It is also anticipated that this project could become a useful case study for similar projects elsewhere within the Thames region, and possibly nation-wide.

5.7 Engagement with Stakeholders and compliance with the Equality Act 2010

During the value engineering stage of the scheme, it is proposed that the Council will engage with various stakeholders and resident groups to ensure the scheme is not undertaken in isolation. Communication with such partners is still in its early phases so will develop over time and updated in future refinements of this business case report. At present the list of possible partners includes, but is not limited to the following:

- Cricket Club
- Football Clubs
- Environment Agency
- Harrow Nature Conservation Forum
- Headstone Manor / Harrow Museum
- Thames Water Utilities Ltd.
- Thames21

It is worth stating that consultation undertaken to date with the Cricket Club and Football Clubs has informed design decisions, in particular the acceptable location of any detention basins. This engagement will continue throughout the detailed design processes.

5.8 Evaluation

Following the completion of the project, there will be a post-project review by the project team to document the successes and lessons learnt. It is intended that such a review will enable the

project to be replicated elsewhere in the borough, incorporating any improvements from this project. It is also anticipated that this project could become a useful case study for similar projects elsewhere within the Thames region, and possibly nation-wide.

References – Other associated study reports[MM6]

Environment Agency – Headstone Flood Alleviation Scheme Initial Assessment (2015)

Environment Agency – Headstone Flood Alleviation Scheme Strategic Outline Case (2016)

Metis Consultants – Integrated Urban Drainage Model and Flood Mitigation Options Economic Appraisal Report (2017)Harrow Council 'Parks for People' – Site-wide regeneration work for Headstone Manor Recreation Ground (scheduled for 2019-2010)

Harrow Council – Queensbury Recreation Ground (Kenton Brook River Restoration and Flood Storage)

Harrow Council – Stanmore Marsh projects

Harrow Council – Newton Park West Flood Alleviation Scheme

Appendix A: Partnership funding calculator

Appendix B: Model Build Report

Appendix C: Appraisal Options

Appendix D: Refined Option A Drawings

Appendix E: Risk Register

Appendix F: Benefits of SuDS Tool Spreadsheets