

# Barnstaple Flood Defence Phase 2

Final Report August 2016

in in T

North District Devon Council Brynsworthy Environment Centre Roundswell Barnstaple, EX31 3NP

northdevon

# JBA Project Manager

Phil Emonson Bradley House Park Five Business Centre Harrier Way EXETER EX2 7HU

# **Revision History**

<b>Revision Ref / Date Issued</b>	Amendments	Issued to
Draft v1.0 31/05/2016		Sally Nelson (NDDC) Andrew Austen (NDDC) John Galt (DCC) Simon Dart (EA)
Final v1.0 22 July 2016		Sally Nelson (NDDC) Andrew Austen (NDDC) John Galt (DCC) Simon Dart (EA)
Final v2.0 12 August 2016	Further amendments as per client comments	Sally Nelson (NDDC) Andrew Austen (NDDC) John Galt (DCC) Simon Dart (EA)

# Contract

This report describes work commissioned by Sally Nelson, on behalf of North Devon District Council, by an email dated 24th November 2015. North Devon District Council's representative for the contract were Sally Nelson and Andrew Austen. Phil Emonson, Oliver Francis, Jessie Kennedy, Nicola Darwin and Matthew Hemsworth of JBA Consulting carried out this work.

Prepared by	Oliver Francis MEng MSc
	Senior Engineer
	Philip Emonson BSc MSc FRGS MCIWEM C.WEM
	Principal Analyst
Reviewed by	Graham Kenn BSc MSc CEng MICE CEnv MCIWEM C.WEM
	Technical Director

# Purpose

This document has been prepared as a Draft Report for North Devon District Council. JBA Consulting accepts no responsibility or liability for any use that is made of this document other than by the Client for the purposes for which it was originally commissioned and prepared.

JBA Consulting has no liability regarding the use of this report except to North Devon District Council.



# Acknowledgements

JBA wish to thank Sally Nelson, Andrew Austen (both North Devon District Council), John Galt (Devon County Council) and Simon Dart (EA) for their assistance and timely supply of data for this project.

# Copyright

© Jeremy Benn Associates Limited 2016

# Carbon Footprint

A printed copy of the main text in this document will result in a carbon footprint of 82g if 100% postconsumer recycled paper is used and 105g if primary-source paper is used. These figures assume the report is printed in black and white on A4 paper and in duplex.

JBA is aiming to reduce its per capita carbon emissions.



# Contents

1	Introduction	1
1.1 1.2 1.3 1.4	Project background Purpose of this study Study area Report structure	1 1 2 2
2	Engineering design concepts	3
2.1 2.2 2.3 2.4 2.5	Overview Design process Design concepts Pricing of defence concepts Next steps	3 3 3 5 6
3	Landscape appraisal	7
3.1 3.2 3.3	Baseline Appraisal Conclusions	7 7 8
4	Preliminary Ecology Appraisal	9
5	Hydromorphology assessment	10
5.1 5.2 5.3	Overview Assessment findings Conclusions and recommendations	10 10 10
6	Conclusions	11
6.1 6.2 6.3 6.4	Engineering design Landscape assessment Ecology Hydromorphology	11 11 11 12
7	Next Steps and Communications	13
7.1	Next Steps	13
Append	lices	I
А	Appendix	L

# List of Figures

# 1 Introduction

### 1.1 Project background

### 1.1.1 Overview of the Barnstaple Flood Defence Options Study

Current and future flood risks in Barnstaple are cause for concern for Devon County and North Devon District Councils. Resultantly, in 2014 JBA Consulting were commissioned by Devon County Council to investigate potential solutions to address future flood risk in Barnstaple. The purpose of the Barnstaple Flood Defence Options Study was to provide a strategy for flood defence improvement for the next 60 to 100 years to enable future redevelopment of housing and employment sites, many of which are brownfield sites that cannot gain planning approvals due to projected flood risks. It was also intended to promote economic development and raise employment opportunities, helping to promote investment (especially in areas such as Pottington), unlocking land potential and raising land values.

#### 1.1.2 Methodology

The current and future (2075 and 2115) flood risks from both fluvial and tidal sources were modelled, using an existing hydraulic model provided by the Environment Agency. From these results the numbers of properties at risk was extracted for a range of flood events and the resultant economic damages were calculated within each of 6 defined flood cells within the town. Results were determined for 2015, 2075 and 2115 through modelling and where required an indication of 2045 results through interpolation of the 2015 and 2075 results.

A suite of flood defence options were considered for each flood cell, and these were modelled to assess how future levels of flood risk could be managed. An outline appraisal of the technical feasibility of each option was undertaken, together with an assessment of cost, environmental impact, and priority.

#### 1.1.3 Recommendations

The future flood risks from fluvial and tidal sources were shown to be greatest in the area known as Flood Cell B. Flood cell B comprises the Braunton Road and Mill Road area and the southern part of Pilton. It extends along the River Taw from the A361 crossing to the outfall of the River Yeo and along the right bank of the River Yeo from the River Taw through Pilton Park to Pilton Quay.

The options tested for Flood Cell B included either piling around the existing course of the Yeo through Pilton Park (option 1), or re-routing it along the A39 Pilton Causeway (option 2). With either of the proposed flood defence options in place in the future, the fluvial and tidal flood risks will substantially reduce compared to the situation in the future without them (Do Minimum). The cost of each option was estimated, showing the option to re-route the channel was substantially more cost effective.

Due to the increase of flood risk in the future in flood cell B (and adjoining cell C), the investment in flood defence upgrades for this part of Barnstaple was considered the first priority.

The full report from the Flood Defence Options study, together with a shorter summary report and environmental report can be downloaded from:

http://www.northdevon.gov.uk/environment/barnstaple-flood-defence-improvements/

### 1.2 Purpose of this study

The purpose of this phase of study is to further develop the design of the flood defences and realignment proposed for the River Yeo frontage of Flood Cell B comprising the right bank of the Yeo from the Swingbridge up to Pilton Bridge. The design development will result in an outline design to a level suitable for planning consideration. This will include consideration of the proposed alignment and material finishes of the defence, along with a refinement of the form and some initial structural assessment.

As necessary for the channel realignment further consideration of a section of Flood Cell C on the left bank of the River Yeo through Pilton Park will also be included as part of this commission. Improvements to the Rolle Street Bridge will not be included within this commission but for the purposes of the adjacent defences it is expected that the line of defence will be continued either by installing a set of flood gates or by constructing a solid parapet.

2016s3792 Barnstaple Flood Defence - Final Report v2.0

Furthermore, this phase will include a number of additional environmental appraisals to help further refine the plans and designs:

- Preliminary Ecological Appraisal (PEA)
- Initial landscape appraisal
- Water Framework Directive (WFD) impacts screening

### 1.3 Study area

The study area (Figure 1-1) stretches along a section of the River Yeo from Pilton Bridge in the north down to the Swingbridge in the south at the confluence of the River Yeo and River Taw. The River Yeo is a tributary of the River Taw and flows in a southwesterly direction through the Barnstaple urban area, separating Pilton and Pottington from the town centre.



Figure 1-1: Study area

### 1.4 Report structure

This report serves to provide an overview of the various elements of this phase of study and design.

- Chapter 2 Engineering Design Concepts
- Chapter 3 Landscape Appraisal
- Chapter 4 Preliminary Ecology Appraisal
- Chapter 5 Hydromorphology Appraisal
- Chapter 6 Conclusions
- Chapter 7 Next Steps and Recommendations

An appendix containing the full technical appraisal for each chapter is included.

JBA



# 2 Engineering design concepts

### 2.1 Overview

The main aim of the engineering design aspect of this commission was to take forward the concepts developed in the Phase 1 study and develop the design to a level of detail that would be suitable for a future planning submission. This process has included:

- Further consideration of alignment
- Preliminary structural analysis
- Consideration of materials
- Overall feasibility (including services search)
- Scheme drawings
- Cost estimate
- Input into the wider assessment

A non-technical summary of the engineering design is given in this document, with greater detail provided within the appendices.

### 2.2 Design process

Within this commission we have followed the same general design process adopted in the Phase 1 study. At the outset we produced a Design Input Statement (DIS) which set out the assumptions on: the design life of the engineering options; the standard of protection they should afford (given by a design water level); and provided a summary of all of the available information and relevant design standards.

Following on from the production of the DIS the study area was split into a number of frontages in order to consider the different defence solutions required. The frontages identified were:

- 1. Pilton Park
- 2. Mills Way (Port Mill Court)
- 3. Rolle's Quay
- 4. Mill Road Depot & Sea Cadets

After some additional consideration it was also decided to include a fifth frontage along the lower section of Pilton Causeway from Pilton Park to the Rolle Street Bridge.

For each reach, an assessment of the existing flood defences was made. This considered: their height; their form; and their suitability for raising. The development of flood defence concepts for each reach are presented in a series of Design Technical Notes (DTNs) included within the appendices. The DTNs include all assumptions made about the form of the defence along with any relevant supporting calculations.

To ensure compliance with the CDM Regulations 2015 our design team were looking to reduce Health & Safety risk at all stages (Construction, Operation & Maintenance, and Decommissioning) throughout the design process. Evidence of this process is provided within the Designers Risk Assessment (DRA) which records: the risks identified; how they can be eliminated or reduced; and how they can be communicated and controlled. A copy of the DRA can be found in the appendices.

Throughout the design process we have sought to keep North Devon District Council, Devon County Council, and the Environment Agency involved in the decision making process and have held a design workshop and a number of supplementary teleconferences.

### 2.3 Design concepts

All of the flood defences are designed for a maximum predicted water level of 6.9mAOD as derived in the Phase 1 study for the 1 in 200-year tidal flood event with sea level rise to 2115. Additional allowances (freeboard) of between 150mm and 300mm have been made for each defence to account for uncertainties in the predicted water level. Technical drawings showing all of the design concepts can be found in the appendices, a brief summary of the development of the concepts is given below.



#### 2.3.1 Pilton Park

The starting point for the flood defences through Pilton Park was the realignment of the River Yeo considered in the Phase 1 study. In the earlier commission, it was considered that a new channel would be constructed through the park by installing two lines of sheet piles running parallel to Pilton Causeway from Pilton Bridge to the southern end of the park. This would obviously represent a major change to Pilton Park. Throughout this study we have sought to address concerns over the visual impact of a new channel and sought to understand its environmental and geomorphological impacts. This study has also sought to address the issue of what would happen with the existing channel and has identified the need for a wider masterplan covering the entire park to allow for the successful integration of the new channel.

The proposed design concept comprises a new channel formed from two earth embankments. The new channel would be of equivalent dimensions to the current channel and would be aligned as close to Pilton Causeway as possible. The embankments are to be no steeper than 1 in 2 on the river side and 1 in 3 on the landward side. The river corridor would be designed to provide adequate erosion resistance and would be planted appropriately to provide new habitat. Two short sections of steel sheet piling are proposed to cut off the existing channel. The location of the new channel would require the demolition or relocation of the existing toilet blocks as well as the loss of a number of trees. It is proposed that a new drainage pipe will be laid in the bed of the existing channel and connected to the existing surface water outfalls. The old channel will largely be filled although there are a number of potential landscape and environmental enhancements that should be considered as part of a wider park masterplan. Connection details with existing structures are potentially quite complex and would need to be developed during detailed design.

In considering the design of the new channel it has been identified that there is a clash with an existing underground electricity cable (33kV) and a water main. At this stage details of the depth of these services are not known. It has been assumed that they can either be diverted or adequate protected but consultation with the utilities companies will be required.

#### 2.3.2 Mills Way (Port Mill Court)

The existing flood defence for the residential properties off Mills Way comprises a number of elements. Along the channel of the River Yeo steel sheet piles form part of the bank. The piles extend up to the existing ground level in the vicinity of Rolle Street Bridge but reduce in height as you move upstream into Pilton Park. The ground level of the Mills Way development was raised during construction and in the absence of the sheet piles to ground level the site is retained by a concrete retaining wall with a grassed bank between the lower level piles and the wall.

To achieve the required defence height, the proposal at Mills Way is to increase the height of the concrete capping beam along the sheet piles and to raise the height of the concrete retaining wall. As the raising of the capping beam is typically less than 750mm it is considered that there should be adequate capacity within the piles to take the additional loading although this would be subject to a full structural analysis at the detailed design stage. There is very limited knowledge of the existing retaining wall and in the absence of exploratory investigations it is not possible to confirm whether it could be raised. There is however sufficient space to allow for a full replacement of the wall if required.

#### 2.3.3 Rolle's Quay

The flood defence at Rolle's Quay was reconstructed as part of the 1980s scheme. The defence extends from Rolle Street Bridge down to the slipway at the Sea Cadets' building and from a visual inspection appears to be a masonry clad flood wall. Reviewing original design drawings, it is in fact a much more complex structure, comprising a concrete flood wall built on to a reinforced concrete relieving slab. The slab itself is supported on raked steel bearing piles. The reason for the complexity is concerns over the integrity of the original river wall below.

At Rolle's Quay we have proposed two potential defence options, both of which involve raising the existing defence. The first option is to remove the existing coping and join a new section of reinforced concrete flood wall to the existing structure, this would then be clad to match the existing wall and the coping replaced. The second option is to install flood glass panels on top of the existing wall. The use of flood glass would enable existing visibility over the defence to largely be retained but is expected to be more expensive than just raising the wall. Both options have been considered in assessing the structural capacity of the existing defence to be raised.

We understand that North Devon District Council are considering commissioning a masterplan of this area which should contribute to a preferred choice of flood defence.

#### 2.3.4 Mill Road Depot & Sea Cadets

This reach comprises the most downstream section of the River Yeo and was also upgraded during the 1980s scheme. The defences in this section comprise as series of low height concrete flood walls that tie in with the Tarka Trail embankment by the swingbridge. The external wall of the sea cadets building also forms part of the defence line and there is a derelict concrete jetty which is in a poor state of repair.

There is a significant opportunity in this area to completely rethink the alignment of the flood defences and either look to maximise developable land behind the defences or alternatively to create additional mooring facilities. This was discussed at the design workshop and for the purposes of this study it was assumed that the existing defence line should largely be retained. The current proposal shows the complete replacement of the existing concrete floodwall with a new structure as the foundations of the existing wall are considered inadequate. The concrete jetty would be removed on the basis of its current condition. The route of the flood defence in the vicinity of the Sea Cadets building requires consultation with the present users as there a number of possible alignments which could be considered. If this were not considered acceptable an alternate set-back line of defence is also shown on the drawings. The final element in this frontage is the provision of a flood gate on the existing slipway.

#### 2.3.5 Pilton Causeway

Although originally considered outside the scope of this commission, we have considered it necessary to look at improving the flood defence along Pilton Causeway. At present the defence comprises a masonry clad flood wall tight along the left bank of the River Yeo. The defence does not quite extend to Rolle Street Bridge as it joins into an area of raised ground running along the back of the small mooring area adjacent to the bridge. It is understood that the existing wall was strengthened during the 1980s flood protection scheme.

The options presented along this frontage are quite straightforward. The height of the existing flood wall is such that simply raising it is unlikely to be acceptable therefore it is proposed to install flood glass panels on top of the wall. On the raised ground around the mooring it is proposed to construct a low height flood wall which will be clad to match the existing flood wall further upstream. There are a number of complex tie-ins with other defences required which will need to be considered in more detail during a detailed design stage.

### 2.4 Pricing of defence concepts

To provide North Devon District Council with an indication of the amount of expenditure required to improve the flood defences an experienced contractor has been approached to provide a budget cost estimate.

The contractor's cost estimate (Table 2-1) split the works into five frontages (as set out in Section 2.3) and we asked them to price both options for Rolle's Quay. They have priced for each frontage as a separate scheme so there would be some efficiencies if they were to be constructed as one larger package of works. Their raw prices do not include an optimism bias and we have added a figure of 30% commensurate with the rate suggested for use on sufficiently developed schemes within the Defra FCERM Appraisal Guidance. The value of 30% has been selected as further development of the options has been undertaken since the Phase 1 study however it should be noted that there are a number of factors that could result in the need to substantial revisions to the design and therefore the value presented may not be representative of the outturn cost.

Frontage	Raw budget cost	Cost including 30% optimism bias
Pilton Park	£2,100,000	£2,730,000
Pilton Causeway	£350,000	£455,000
Mills Way	£340,000	£442,000
Rolle's Quay - Option 1 -Wall	£480,000	£524,000
Rolle's Quay - Option 2 Flood Glass	£560,000	£728,000
Mill Road Depot	£180,000	£234,000

Grand Total*	£3,530,000	£4,589,000

\* assumes flood glass used at Rolle's Quay

### 2.5 Next steps

This commission has taken forward the design of flood defences along the River Yeo originally suggested in the Phase 1 report. There are however a number of areas where additional investigation will be required before commencing detailed design:

- Completion of a geotechnical investigation in the areas of interest
- Additional consultation on the line of defences at the Mill Road Depot & Sea Cadets frontage
- Wider masterplanning of Pilton Park to resolve details around the existing channel
- Discussions with utilities companies regarding the need to divert services

JBA consulting

# 3 Landscape appraisal

### 3.1 Baseline

The aim of the landscape appraisal was to identify any landscape or townscape designations and receptors, along with potential visual receptors, that may be impacted upon by options put forward for proposed flood defences and realignment of the river channel along the River Yeo from Pilton Bridge to Swingbridge in Barnstaple.

Barnstaple is a former river-port exporting wool and later developed industries in shipbuilding, foundries and sawmills. The town grew to the south of the River Yeo with Pilton Village separated from Barnstaple by tidal marshy ground and the River Yeo. The town has grown and developed with residential properties infilling land between Barnstaple and Pilton, although Pilton Park remains as an open space and public park. The townscape is varied along the course of the river with a range of residential property types, retail and commercial properties, light industrial units and public open green space. Views are relatively well contained by built form enclosing views to within 200-300m of the development.

### 3.2 Appraisal

The landscape character of the area under consideration was assessed at a variety of different scales, from National to site based. A number of existing published studies provided a basis for the assessment of the landscape character and impacts; these included, National Character Area (NCA) 145: Exmoor, Devon Landscape Character Area (DCA): Taw Torridge Estuary, and Devon Landscape Character Type (LCT) 7: Main cities and towns. NCAs are high-level, strategic assessments, which cover a comparatively wide area. It is considered unlikely that the proposed flood defence works will have an influence on landscape character at a National Area scale. Given the nature and scale of the proposed development—within a relatively small area of the local DCA and LCT—a notable impact is not expected on the DCA or LCT as a whole.

Site and desk based studies within the study area identified a broad baseline for townscape and landscape character. All options through Pilton Park are likely to have a notable effect on the fabric and landscape character of the site during operation, prior to any mitigation and enhancement measures. These arise from the sensitivity and value of important, often historic features within the landscape fabric—such as Pilton Bridge, existing walls and entrances into Pilton Park, Barnstaple Town Centre Conservation Area and Pilton Conservation area—and the contribution these make to the overall character and perception of the area. It should also be noted that the park is situated within the Pilton Street character zone, whilst Rolle's Quay is within the High Street character area of Barnstaple Town Centre Conservation Area, which runs through the site. The park may effectively be severed by the new channel.

Landscape designations including Exmoor National Park, North Devon Area of Outstanding Natural Beauty and Youlston Park Registered Park and Garden were identified; however, given the distance from site the proposed flood defence works were not considered to have an effect on these designations.

Pilton Conservation Area includes Pilton Park which forms a key element of the conservation area and informs the wider setting and approaches to Pilton Street. The realignment of the river channel and alterations to the existing channel and landscape features within Pilton Park and Conservation Area is likely to have a significant effect which is notable.

Visual receptors are people that may experience views of the landscape. These may include residents and visitors to settlements, roads, footpaths, trails, visitor facilities or particular viewpoints. Visual effects are likely to be notable where the construction or operation will impact on key views or aspects from sensitive receptors, particularly where these have historic or aesthetic value, are directly oriented towards or are in close proximity to the works. Notable visual effects during construction and operation are likely on:

- a large number of residential receptors, many of which are in close proximity to and have valued views of the river
- the footpath around Pilton Park and footpath along the right embankment adjacent to Fair View car park
- existing views within and surrounding Pilton Park and Pilton Conservation Area by altering the historic channel which informed the development of the park, which historically separated Barnstaple and Pilton and is a valued green space.



• existing views for users of the South West Coast Path and the Tarka Trail

Short-term notable effects through construction are expected for road receptors of Pilton Causeway, Pilton Bridge and Rolle's Quay.

#### 3.3 Conclusions

It is recommended that potential effects on the setting and views from cultural heritage assets including the Grade II listed Pilton Bridge and Pilton Conservation Area —are covered in a separate Heritage and Archaeological Assessment. The presence of these designations results in high landscape sensitivities within the immediate site area.

The course of the river has been subject to management for more than 200 years and has played a key part in the historic growth and layout of the town, including the development of Pilton Park. However, the height of existing flood defences in some areas has meant the visual link and setting of the river in relation to the town has become compromised.

Construction effects are considered to be adverse, but short-term and are likely to be outweighed by the flood prevention benefits of the scheme. Operational effects may be adverse, but considered and appropriate design and detailing may mitigate and reduce these effects, such that they become neutral or even beneficial in the longer term.

The development of this scheme is an iterative process by which potentially adverse impacts should be addressed through continual appraisal and revision, including responses from public and stakeholder consultation. Mitigation of adverse impacts may include development of design aspects such as layout, circulation (steps, ramps) and wall height; finishes, such as cladding materials, boundary treatments and street furniture; and choice or layout of new planting, including trees. These should be appropriate to the context, setting and view where possible; for example, natural materials should be specified within the Conservation Area or where new features will impact on valued residential views. The local vernacular includes rubble stone walls with granite coping stones. Not all may be suitable for walling or cladding due to engineering and structural constraints, availability and cost. Sheet piling with concrete coping and concrete walls have also been used along sections of the river which may be appropriate in less sensitive locations. The inclusion of public art, a considered approach to detailing of street furniture and balustrading and sympathetic, natural paving materials could also better relate to the setting of the scheme. Planting strategies should balance ecological and biodiversity value with visual, seasonal and structural qualities appropriate to what is an important element within local Green Infrastructure.

The proposed realignment of the river channel with flood embankments offer an opportunity to masterplan and redesign Pilton Park, raising the quality and amenity of this valued green space. Whilst not all of these would be part of the flood protection remit, the redesign could introduce new entrances into the park, relocation of play equipment and infrastructure such as toilets, seating and lighting; as well as new planting and habitat creation that would increase biodiversity and ecological value. There are also opportunities for the scheme to facilitate the wider enhancement of the river frontage, particularly downstream where the visual link between the town and river has become compromised.

# 4 Preliminary Ecology Appraisal

JBA Consulting were commissioned by North Devon District Council to undertake a Preliminary Ecological Appraisal (PEA) to identify any potential ecological constraints associated with the proposed re-alignment of the River Yeo, as a flood defence. The potential impacts associated with the proposed flood defence scheme such as habitat loss and the impact on UK protected species and habitats, and designated sites, was assessed and, where necessary, further surveys and / or appropriate mitigation and enhancement measures recommended.

This appraisal was conducted using the findings of a field survey, supplemented by a desk-based study and data search provided by Devon Biodiversity Records Centre (DBRC) and the Environment Agency (EA). The data search returned records of protected and notable species within 2 km of a central grid reference point, extended to 4 km for bats. A number of species records were provided including bats, birds, invertebrates, amphibians and reptiles. The EA provided numerous data about the river to include macrophytes, macroinvertebrates and fish.

The majority of the works will take place within Pilton Park itself. Pilton Park is largely dominated by amenity grassland with hardstanding. There is a children's play area within the centre of the park and a toilet block at the south east corner. The park is bordered on three sides by the River Yeo. The flood scheme proposals also incorporate a length of the River Yeo to the south of Pilton Park and further downstream to its outfall into the River Taw.

Several of the mature trees were identified as having bat roosting potential. The small area of scrub, coastal grassland and areas of less intensively managed amenity grassland have the potential to support reptiles and amphibians in their terrestrial phase. The mature trees provide roosting opportunities and foraging habitat for bats as well as nesting opportunities for birds. The river provides habitat for a variety of aquatic invertebrates as well as a foraging resource for bats. The toilet block was also found to have bat roosting potential.

The finalised details of the proposals are unknown at this time, but it is known that the river around Pilton Park will be diverted. It is anticipated that the majority of habitats of ecological value will be retained and improved. As a result of the diversion of the river, a length of approximately 290 metres of riparian habitat will be lost. In addition, the toilet block building will be removed. Vegetation clearance is anticipated to be limited to small areas of scrub, shrub, a small number of mature trees and areas of amenity and coastal grassland. Construction and landscaping activities have the potential to impact upon nesting birds, wetland birds, roosting bats, reptiles and amphibians (if found to be present) and foraging and commuting bats.

Depending upon the nature of the final designs, further surveys are required to establish the presence of protected species and enable a full assessment of the impacts any future flood defence scheme may have. These include reptile presence / absence surveys, bat activity surveys, a bat emergence survey of the toilet block and an inspection of the potential roost features in the trees. A further river corridor survey is also required to assess the coastal grassland and riverine habitat. Depending on the findings of these surveys, specific mitigation and compensation recommendations may be required.

As part of the flood defence scheme, there is scope for ecological enhancements that would improve what is of relatively low ecological value into a mosaic of habitats with improved ecological value which could benefit a number of plant and animal species. Recommendations include the creation of wetland habitats such as ponds, areas of species-rich grassland to benefit invertebrates and the introduction of shelter for various species such as bat and bird boxes. There is also scope for Pilton Park to be used as an environmental educational resource for all users and consideration could be given to installing interpretation panels. These would benefit all users, but there is particularly value to local educational groups that could use the biodiversity features as a learning resource.

It is recommended that a Biodiversity Management Plan is produced to ensure successful and effective delivery of mitigation and enhancement measures.

# 5 Hydromorphology assessment

### 5.1 Overview

JBA Consulting was commissioned by North Devon District Council to investigate potential solutions to address future fluvial and tidal flood risk in Barnstaple. This high-level assessment will consider the re-routing of the River Yeo in terms of the hydromorphological element of the Water Framework Directive for the area of channel realignment through Pilton Park.

### 5.2 Assessment findings

The waterbody is heavily modified, incised and has been managed over a long time period. As a consequence in channel morphological processes have been impacted, resulting in a uniform channel with few morphological features. During low tidal conditions visible mudflat areas can be seen, which is some cases are part vegetated suggesting a degree of stability.

Through the existing reach from YEO19 to (Pilton Causeway) to YEO07 (Rolle Street) the maximum modelled velocities range from approximately 0.4m/s to 1.2m/s. In general, the reach is moderately erosional during the 2-year flood event, with modelled velocities indicating that flows are capable of eroding partially consolidated sediments, especially in the upper portion of the reach. Minimum velocities vary between approximately -0.1m/s and -0.4m/s. Negative velocities indicate that tidal forces are dominant for a portion of the hydrograph, with water flowing upstream on the flooding tide. During this time, some fine suspended sediments will be deposited, although these are likely to be re-entrained as the tide ebbs and fluvial forces become dominant.

### 5.3 Conclusions and recommendations

The proposed works are likely to result in a steeper gradient over the shortened channel length, which may lead to localised increases of in-channel velocities. Due to the steeper gradient the new channel may be more erosional, rather than depositional.

Interrogation of hydraulic modelling results of the proposed new channel (including in channel velocities and shear stress values) is recommended to better understand whether the proposed new channel will be depositional or erosional. This will also allow an assessment to be made on the future risk of bank instability and on the impact of mudflat and salt marshes downstream of the site (in the adjacent Taw- Torridge Estuary SSSI). Although there will be no overall change in flow moving to downstream reaches, velocities may change due to the realigned channel which may act to change existing morphological features. Further hydraulic modelling is recommended during detailed design to investigate possible erosion mitigation measures, such as channel widening, to ensure that incision is minimised.

# 6 Conclusions

### 6.1 Engineering design

- A complete set of concepts for the upgrading of flood defences to provide a 1 in 200-year standard of protection through to 2115 along the River Yeo within the study area has been produced.
- The scheme is split in to five frontages which could be progressed independently of each other.
- Prior to the start of detailed design, a Ground Investigation should be undertaken along with consultation of the utilities companies.
- There are wider opportunities for regeneration and masterplanning that should be considered alongside the provision of flood defences.
- The overall cost estimate for the scheme is £4.6 million including an optimism bias of 30%.

### 6.2 Landscape assessment

- It is recommended that potential effects on the setting and views from cultural heritage assets—including the Grade II listed Pilton Bridge and Pilton Conservation Area —are covered in a separate Heritage and Archaeological Assessment.
- Construction effects are considered to be adverse, but short-term and are likely to be outweighed by the flood prevention benefits of the scheme. Operational effects may be adverse, but considered and appropriate design and detailing may mitigate and reduce these effects, such that they become neutral or even beneficial in the longer term.
- Mitigation of adverse impacts may include development of design aspects such as layout, circulation (steps, ramps) and wall height; finishes, such as cladding materials, boundary treatments and street furniture; and choice or layout of new planting, including trees.
- The inclusion of public art, a considered approach to detailing of street furniture and balustrading and sympathetic, natural paving materials could also better relate to the setting of the scheme.
- Planting strategies should balance ecological and biodiversity value with visual, seasonal and structural qualities appropriate to what is an important element within local Green Infrastructure.
- The proposed realignment of the river channel with flood embankments offer an opportunity to masterplan and redesign Pilton Park, raising the quality and amenity of this valued green space.
- There are also opportunities for the scheme to facilitate the wider enhancement of the river frontage, particularly downstream where the visual link between the town and river has become compromised.

## 6.3 Ecology

- Several of the mature trees were identified as having bat roosting potential.
- The small area of scrub, coastal grassland and areas of less intensively managed amenity grassland have the potential to support reptiles and amphibians in their terrestrial phase.
- The mature trees provide roosting opportunities and foraging habitat for bats as well as nesting opportunities for birds.
- The river provides habitat for a variety of aquatic invertebrates as well as a foraging resource for bats. The toilet block was also found to have bat roosting potential.
- As a result of the diversion of the river, a length of approximately 290 metres of riparian habitat will be lost. In addition, the toilet block building will be removed.
- Construction and landscaping activities have the potential to impact upon nesting birds, wetland birds, roosting bats, reptiles and amphibians (if found to be present) and foraging and commuting bats.
- Depending upon the nature of the final designs, further surveys are required to establish the presence of protected species and enable a full assessment of the impacts any future flood defence scheme may have. These include reptile presence / absence surveys, bat activity surveys, a bat emergence survey of the toilet block and an inspection of the



potential roost features in the trees. A further river corridor survey is also required to assess the coastal grassland and riverine habitat. Depending on the findings of these surveys, specific mitigation and compensation recommendations may be required.

- As part of the flood defence scheme, there is scope for ecological enhancements that would improve what is of relatively low ecological value into a mosaic of habitats with improved ecological value which could benefit a number of plant and animal species.
- Recommendations include the creation of wetland habitats such as ponds, areas of species-rich grassland to benefit invertebrates and the introduction of shelter for various species such as bat and bird boxes.
- There is also scope for Pilton Park to be used as an environmental educational resource for all users and consideration could be given to installing interpretation panels. These would benefit all users, but there is particularly value to local educational groups that could use the biodiversity features as a learning resource.
- It is recommended that a Biodiversity Management Plan is produced to ensure successful and effective delivery of mitigation and enhancement measures.

### 6.4 Hydromorphology

- The waterbody is heavily modified, incised and has been managed over a long time period. As a consequence in channel morphological processes have been impacted, resulting in a uniform channel with few morphological features.
- During low tidal conditions visible mudflat areas can be seen, which in some cases are part vegetated suggesting a degree of stability.
- In general, the reach is moderately erosional during the 2-year flood event, with modelled velocities indicating that flows are capable of eroding partially consolidated sediments, especially in the upper portion of the reach.
- Negative velocities indicate that tidal forces are dominant for a portion of the hydrograph, with water flowing upstream on the flooding tide. During this time, some fine suspended sediments will be deposited, although these are likely to be re-entrained as the tide ebbs and fluvial forces become dominant.
- The proposed works are likely to result in a steeper gradient over the shortened channel length, which may lead to localised increases of in-channel velocities. Due to the steeper gradient the new channel may be more erosional, rather than depositional.
- Interrogation of hydraulic modelling results of the proposed new channel (including in channel velocities and shear stress values) is recommended to better understand whether the proposed new channel will be depositional or erosional. This will also allow an assessment to be made on the future risk of bank instability and on the impact of mudflat and salt marshes downstream of the site (in the adjacent Taw- Torridge Estuary SSSI).
- Although there will be no overall change in flow moving to downstream reaches, velocities may change due to the realigned channel which may act to change existing morphological features. Further hydraulic modelling is recommended during detailed design to investigate possible erosion mitigation measures, such as channel widening, to ensure that incision is minimised.

# 7 Next Steps and Communications

## 7.1 Next Steps

The following table provides a summary of the next steps discussed with North Devon District Council following the issue of the draft report along with those items identified in each of the sections within the report. The actions are presented in an approximate chronological order although there are many interdependencies.

Table 7-1: Next Steps

No.	Action	Comment
1	Commence informal engagement with key local landowners	
2	Consultation with utilities companies	This should be commenced as soon as practical to avoid delays further down the programme.
3	Wider consultation and engagement exercise	The purpose of this is to build up engagement with stakeholders and the wider public ahead of a planning submission. Requires the development of a communications and engagement plan.
4	Commence Masterplanning project for Pilton Park	To link with wider stakeholder engagement and consultation. A separate masterplan for the Mill Road Depot should also be undertaken. The focus of both will be reshaping these sights after construction of the defences
5	Heritage and Archaeological Assessment	
6	Ground Investigation	Can be undertaken any time but probably best to await outcome of Masterplan
7	Biodiversity Management Plan	Could possibly be undertaken alongside masterplanning project
8	Additional protected species surveys	This will be dependent on when it is sought to construct the scheme. They need to have been completed in the 18 months prior to submission of a planning application
9	Countryside Rights of Way Act Assessment	
10	Indentifying sources of, and making applications for, funding	Identifying potential funding sources should be an ongoing activity. Funding could be available for both the further assessments and eventual construction
11	Detailed Design	Timescales will depend on outcomes from earlier activities and availability of funds. The design could comprise the whole scheme or split into individual frontages
12	Planning Submission	This could be included as part of the detailed design process.
13	Construction	Construction of any element unlikely to commence before Summer 2019

## 7.2 Clarifications of construction costs

Following discussions with NDDC it was agreed that for the purposes of clarity that any exclusions from the construction costs presented should be clearly stated. The construction costs do not:



- Include improvements at the Rolle Street bridge which could comprise flood gates or solid parapets.
- Allow for raising the cyclepath east of Hobarts which forms the boundary between Flood Cells A and B.
- Allow for raising the height of Braunton Road which also form part of the boundary from Flood Cells A and B.
- Include any works to Pilton Bridge which forms the boundary with Flood Cell D.

It is not expected that any of the additional studies identified in Table 7.1 would substantially affect the construction costs although the master planning may identify additional enhancements not yet considered.



Appendices A Appendix



#### Offices at

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

#### **Registered Office**

South Barn Broughton Hall SKIPTON North Yorkshire BD23 3AE United Kingdom

t:+44(0)1756 799919 e:info@jbaconsulting.com

Jeremy Benn Associates Ltd Registered in England

3246693

Visit our website www.jbaconsulting.com





