



Littlehampton Arun East Bank  
Tidal Walls Flood Defence Scheme  
Environmental Statement  
Volume Three - Appendices  
May 2013



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## Environmental Statement

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## EIA Quality Mark



This Environmental Statement, and the Environmental Impact Assessment (EIA) carried out to identify the significant environmental effects of the proposed development, was undertaken in line with the EIA Quality Mark Commitments.

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- EIA Presentation
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# Introduction

This document forms Volume Three, the Appendices of the Environmental Statement prepared to support the application for planning permission for the Littlehampton Arun East Bank Tidal Walls Flood Defence Scheme.

The Appendices contained in this document provide the supporting information for the main text of the Environmental Statement, which is contained in Volume Two. It contains the following:

- Appendix A Scoping Report
- Appendix B Alternative scheme options appraisal
- Appendix C Summary of consultation responses
- Appendix D Acoustics
- Appendix E Archaeology (Heritage Statement)
- Appendix F Biodiversity
- Appendix G Ground conditions
- Appendix H Landscape specifications and arboricultural report
- Appendix I Traffic Management and Logistics Plan
- Appendix J Water Framework Directive assessment
- Appendix K Flood Risk Statement

# Appendix A - The Scoping Report

This appendix contains a copy of the Scoping Report prepared during the outline design stage of the scheme.

Readers should note that not all of the appendices contained within the original Scoping Report have been reproduced here. This is partly due to the large file size of these document, but mainly because the information contained in the original appendices has been included either within Volume One (the main text) of the Environmental Statement, or (in its original or an updated form) within other appendices of this volume, Volume Two of the Environmental Statement.

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## Littlehampton Arun East Bank Tidal Walls Scoping Report

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# Summary

## Littlehampton Arun East Bank Tidal Walls Scoping Report

This document presents the results of a scoping study undertaken as part of the EIA process for the Littlehampton Arun East Bank Tidal Walls project.

The project aims to progress the findings of the Rivers Arun to Adur Flood and Erosion Management Strategy, which identified an urgent need to raise and improve the flood defences along the east bank of the River Arun at Littlehampton and recommended works to provide flood defence to a consistent 1 in 300 year standard for the next 100 years.

The options considered comprised the Do Nothing option, Maintain and four improved options (New or Raised) Riverward Defences, namely a Base scheme, Mitigated scheme, Enhanced scheme and Visionary scheme.

The preferred option is the Mitigated scheme, which comprises a range of flood defence improvement works along the river frontage, including steel sheet piling, concrete or brick flood walls, embankments and scour protection. Promenades in Arun Parade and Pier Road will be raised and widened, and access provided to the river where possible. Managed realignment works are proposed in the northern section to mitigate a loss of intertidal mudflat habitat downstream and create new saltmarsh. Any pontoons affected will be replaced or improved and appropriate access will be maintained for lifeboats and other craft at slipways. Further improvement opportunities exist, and these are captured in the Enhanced and Visionary scheme options. While these options have not been ruled out, they are reliant on contributions from third party such as from Arun District Council.\*

There is a Conservation Area, but no other designated sites within the project area. The majority of the project area is urban, with residential development and a promenade along most of the riverside, and cafes and restaurants supporting tourism which is important to the local economy. An industrial area lies to the north of the residential area, with agricultural land lying further north (beyond the A259).

The key environmental issues are the potential effects on the quality of the landscape (townscape), especially on the views across the river, the high amenity value of the riverside area including the promenade, and ecological features to the north of the A259. Measures have been incorporated to mitigate adverse landscape, visual and amenity impacts (with indirect impacts on tourism and the local economy). The preferred option will result in a positive ecological outcome by creating additional areas of mudflat and saltmarsh. We will have to move (translocate) reptiles away from the area in order to protect them while works are carried out. Suitable sites have been identified and discussions have been held with landowners.

Issues scoped out of further assessment are air quality, noise (operational), protected species (water voles, aquatic invertebrates and otters) and traffic and transportation.

Consultation to date has included two separate public exhibitions on the scheme options and on the preferred options respectively, meetings with key stakeholders and a workshop with internal and external consultees, who were also invited to comment on the Scoping Consultation Document. No significant objections have been raised and the results of the consultation have been used to inform scheme design and this Scoping Report.

\*It was announced in October 2012, after the completion of this scoping study, that Arun District Council has committed more than £1.3 million to enhance the area around Arun Parade and Pier Road, through enhancements to the flood wall, riverside walkway, street furniture and access. The impacts of these enhancements will be included in the EIA for the flood defence scheme.

See <http://www.arun.gov.uk/main.cfm?type=EASTBANKENHANCEMEN&objectid=6034&searchtermredirect=east bank>

## Contents Amendment Record

This report has been issued and amended as follows:

Issue	Revision	Description	Date	Signed	Reviewed
1	0	Draft Scoping Report	January 2011	EJW	IB
1	0	Scoping Report	January 2011	EJW	IB/RW
2	0	Updated for Advert	January 2013	RW	PB

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## Abbreviations

<b>APF</b>	Annual Probability of Failure
<b>APO</b>	Annual Probability of Occurrence
<b>BAP</b>	Biodiversity Action Plans
<b>BGS</b>	British Geological Survey
<b>EAP</b>	Environmental Action Plan
<b>EIA</b>	Environmental Impact Assessment
<b>EU</b>	European Union
<b>FEPA</b>	Food and Environmental Protection Act
<b>ha</b>	Hectares
<b>LVIA</b>	Landscape and Visual Impact Assessment
<b>m</b>	Metres
<b>MAGIC</b>	Multi-Agency Geographic Information for the Countryside
<b>MMO</b>	Marine Management Organisation
<b>OMU</b>	Operational Management Unit
<b>PAR</b>	Project Appraisal Report
<b>RBMP</b>	River Basin Management Plan
<b>RNLI</b>	Royal National Lifeboat Institute
<b>SM</b>	Scheduled Monument
<b>SNCI</b>	Site of Nature Conservation Interest
<b>SSP</b>	Steel Sheet Piling
<b>SSSI</b>	Site of Special Scientific Interest
<b>Yr</b>	Year

# 1 Introduction

## 1.0.0.1 Background

The Rivers Arun to Adur Flooding and Coastal Erosion Strategy (Halcrow 2009) recommended an improvement of the standard of defence of 2.5km of tidal defences along the east bank of the River Arun extending north from the harbour mouth to a 1 in 300 (0.33%) chance of flooding in each year.

1.0.0.2 Following approval of the Strategy, the Environment Agency (Southern Region) commissioned Halcrow Group to undertake work to prepare a Project Appraisal Report (PAR) to progress the findings of the Strategy for the proposed improvement to the tidal defences on the east bank of the River Arun at Littlehampton.

## Aims of document

1.0.0.3 The aim of this Scoping Report is to present the findings of the scoping assessment undertaken as part of the Environment Agency's Environmental Impact Assessment (EIA) process for the Littlehampton Arun East Bank Tidal Walls project. More specifically, the purpose of this Scoping Report is to:

- Provide a record of the options appraisal and scoping process
- Identify key issues and the methods for the detailed EIA
- Identify what issues have been 'scoped' out of the EIA
- Identify opportunities for development as the project progresses

1.0.0.4 A Scoping Consultation Document (SCD) was issued to internal Environment Agency consultees, statutory bodies and other external interested parties for comment before the preferred option and scope of environmental issues to be addressed by the EIA had been finalised. This Scoping Report has been prepared with regard to comments received on the SCD, as discussed in Section 6 of this report.

1.0.0.5 This document stands alongside and is complementary to the Options Appraisal Report, which details the options selection and the design development process.

# 2 Baseline Summary

## 2.1 Context of the Project

### **2.1.1 Project Location**

2.1.1.1 The project is located on the east bank of the River Arun at Littlehampton, West Sussex. The project boundary extends from the river mouth at Littlehampton (not including the wooden pier, Grid ref: 502827, 101315) to approximately 1km north of the A259 road bridge where the railway line passes beneath the A259 (Grid ref: 501498, 103069).

2.1.1.2 A site location plan (also showing the extent of potential flooding) is presented in Figure 1.

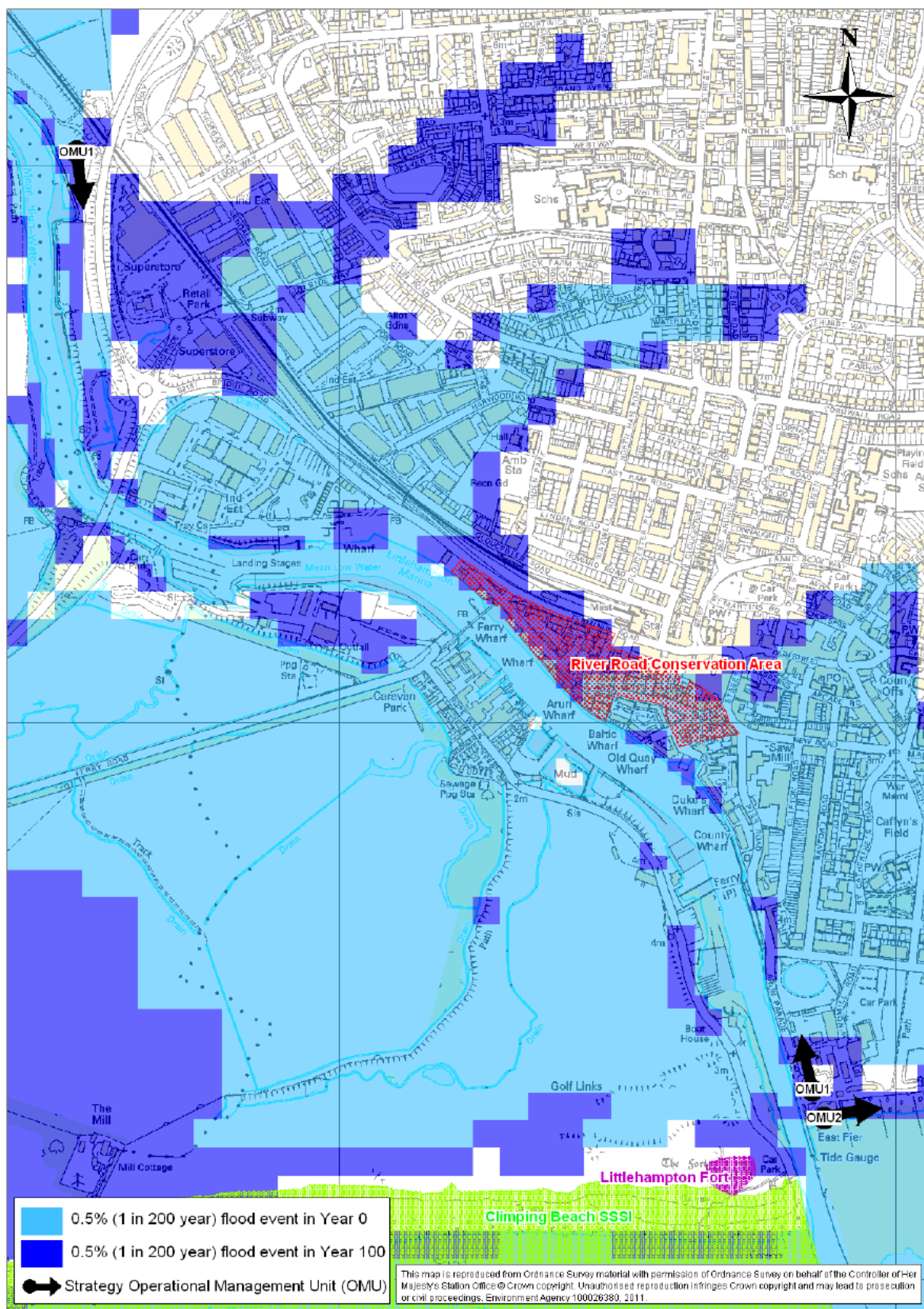
### **2.1.2 The Need for the Project**

2.1.2.1 The Strategy identified an urgent need to raise and improve the flood defences along the east bank of the River Arun.

- 2.1.2.2 Many of the defences along this stretch have a short residual life (less than 10 yrs) and/or a low crest height. As a result, the defences will need significant works or replacement to prevent failure or a breach that would result in significant flooding and damage to the settlements they are protecting.
- 2.1.2.3 Areas at risk of flooding include Littlehampton harbour, Littlehampton town (including residential and commercial properties), highways infrastructure, railway line and station, the industrial area south of A259 road bridge and recreational assets including rights of way, public slipways and public green areas. The total number of properties currently at risk from flooding on this frontage and the beach east of the River Arun from 1 in 200 year event (0.5%) is 781 residential properties and 336 commercial properties. The number of properties at risk in 2109 is predicted to rise to 1,417 residential properties and 520 commercial properties
- 2.1.2.4 The Rivers Arun to Adur Flood and Erosion Management Strategy recommended works to provide a standard of defence to a consistent 1 in 300 year standard for the area covered by the scheme.

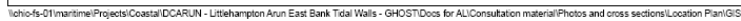
### **2.1.3 Project Description**

- 2.1.3.1 The study area for the project has been divided into six reaches and further sub-reaches and sections according to the nature of existing defences, current land ownership and responsibilities for flood protection, the recommendations from the Strategy and the anticipated scope of the proposals. A plan showing the location and extent of the reaches and sub-reaches is provided in Figure 2.
- 2.1.3.2 The work proposed includes a range of flood defence improvement works, including steel sheet piling, concrete or brick flood walls, embankments and scour protection.
- 2.1.3.3 The height of the defences will be raised in accordance with the recommendations of the Strategy to provide a 1 in 300 year standard of defence for the next 100 years.
- 2.1.3.4 In addition to wall or embankment raising, promenades will be raised and widened to provide amenity value and access to the river for all users where possible. Particular attention has been given to explore visual amenity opportunities, local landscaping and pedestrian facilities within the urban areas where tourism is important to the local economy. Where space is currently restricted to construct new defences, this will entail abutting onto the existing wall with some minor encroachment into the river. Managed realignment works will be undertaken in the northern section in part to mitigate a loss of intertidal mudflat habitat downstream, with the remainder provided to allow ecological outcomes. Any pontoons affected by the works will be replaced or improved. Works will also ensure that appropriate access is retained for lifeboats and other craft at slipways.
- 2.1.3.5 Further details of the proposed works are provided in Section 4.3.



**Figure 1      Site Location Plan and Flooding Potential**





**Environment Agency** Littlehampton Arun East Bank Tidal Walls

## 2.2 Existing Baseline

### 2.2.1 Introduction

2.2.1.1 This section presents a summary of information on the existing environment gathered to date. Information has been gained from desk studies, data searches, field work, workshops and consultation with internal and external consultees and the public. Specific sources of information are referenced where appropriate. More general sources include:

- Sussex Biological Records Centre
- Multi-Agency Geographic Information for the Countryside (MAGIC) website ([www.magic.gov.uk](http://www.magic.gov.uk))
- Sussex Biodiversity Action Plan
- West Sussex Structure Plan

2.2.1.2 There is only one environmentally designated area within the project area, namely:

- River Road Conservation Area on the east bank of the River

2.2.1.3 The wider study area of the project contains a number of additional designated areas, all on the west side of the River Arun. These are:

- Climping Beach Site of Special Scientific Interest (SSSI)
- West Beach Local Nature Reserve within the SSSI
- Littlehampton Golf Course and Atherington Beach Site of Nature Conservation Interest (SNCI)
- Littlehampton Fort Scheduled Monument (SM)

2.2.1.4 Littlehampton is a historic harbour town with a local economy heavily dependant on tourism. The promenades behind the flood defences form a critical part of the tourist attractions and there are further Conservation Areas within the town and along the sea front (East Street and Seafront Conservation Areas respectively).

2.2.1.5 A summary of the existing environment is provided below in the main text of this document. A more descriptive version is provided in Appendix 1, supplemented by any detailed technical reports as indicated in separate appendices. The location and extent of key environmental features are shown in the Environmental Site Appraisal Plans, Figures 3 and 4.

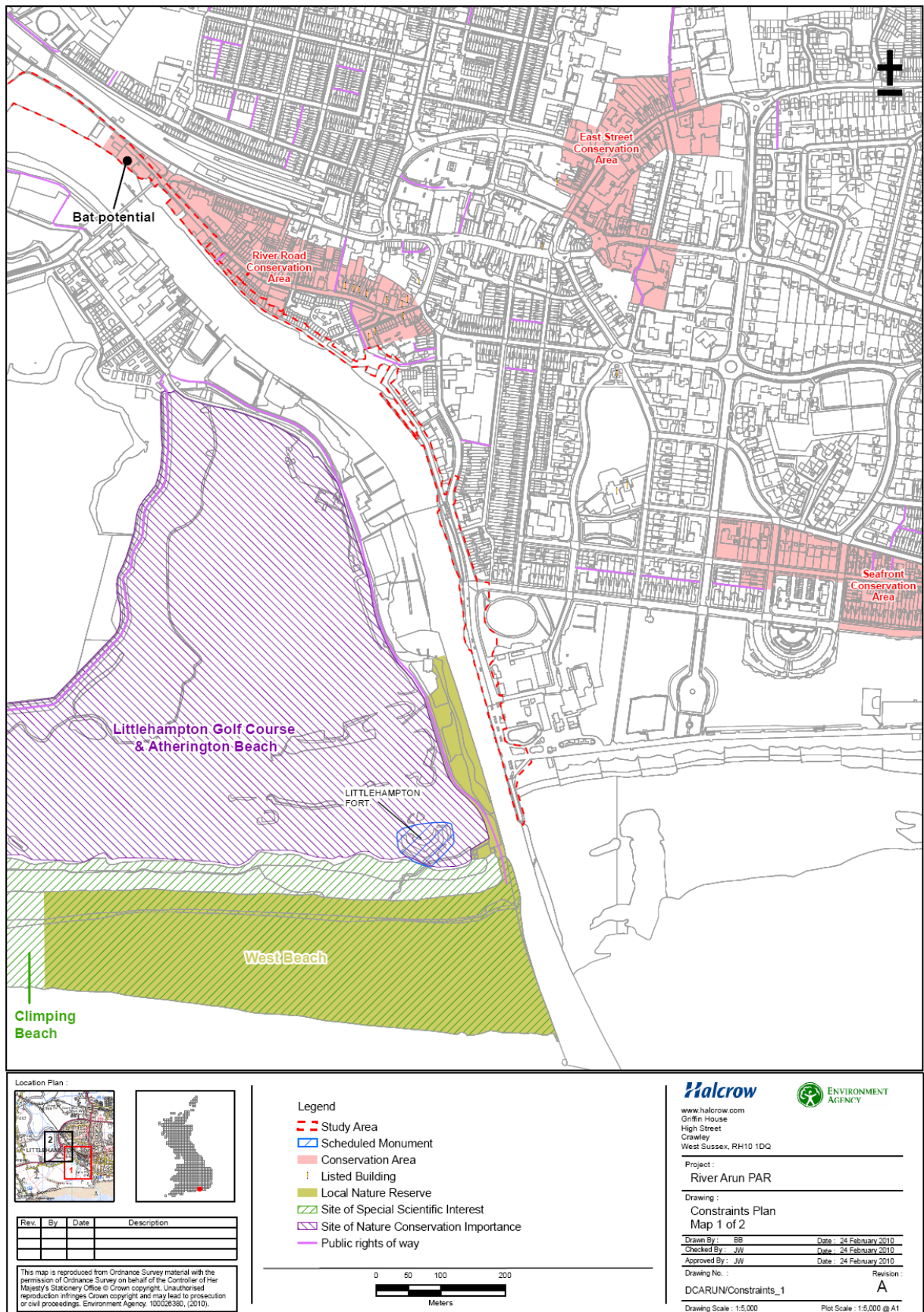
### 2.2.2 Human Beings (Land Use and the Local Economy)

2.2.2.1 Key aspects of land use and the local economy are as follow:

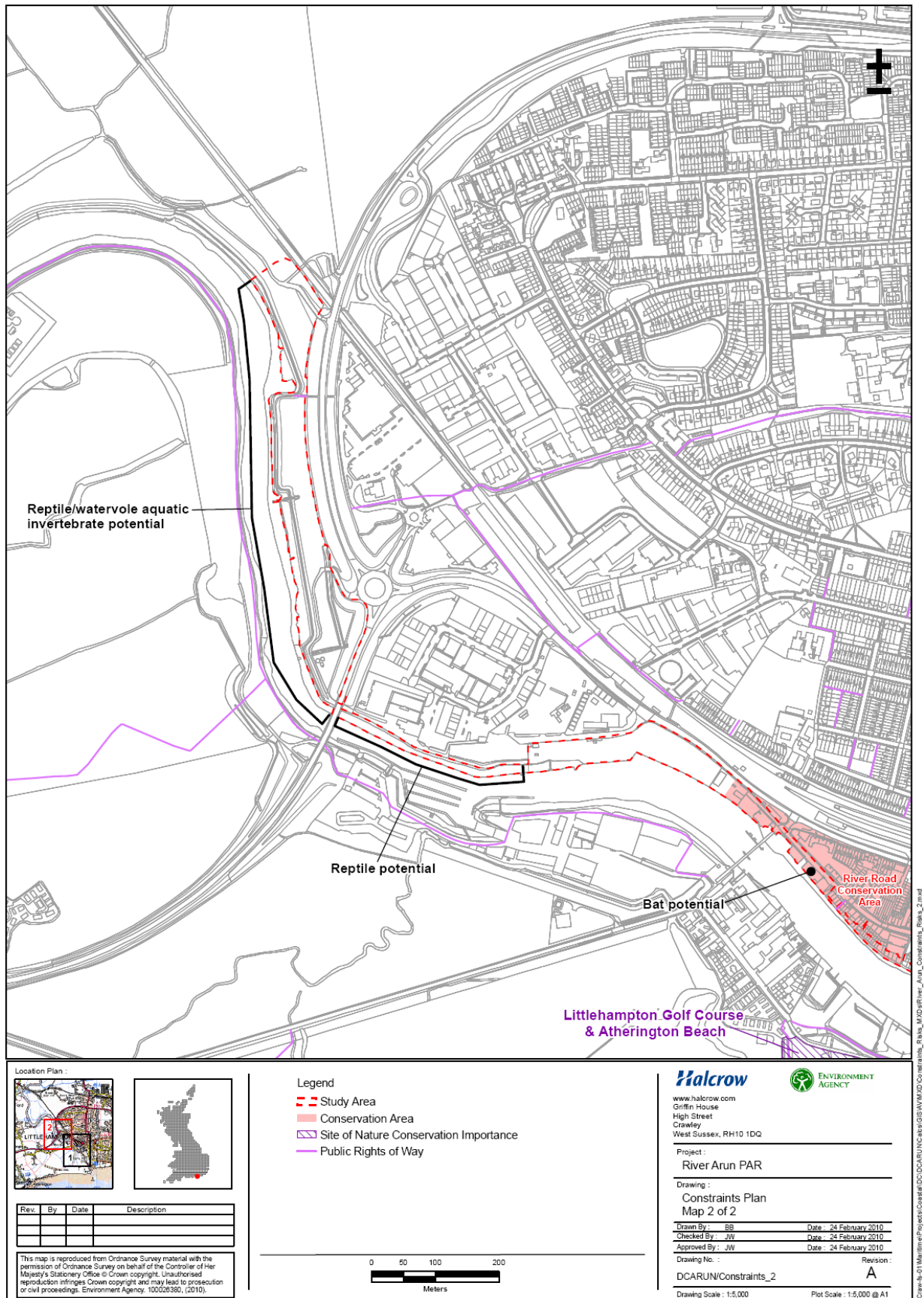
- Littlehampton is a coastal town located at the mouth of the River Arun, which forms a focal point of the town
- The main town, including the town centre and residential and commercial areas, is located to the east of the river
- Tourism comprises an important part of the local economy. Key attractions include the beach, an amusement park, the promenade, the harbour and moorings, the Oyster Pond, cafes and restaurants
- Substantial and recent residential development is located along the riverside, between the Harbour Board building and Arun View public house
- A promenade runs from the pier in the south to the end of Riverside Walk
- Industrial activity takes place between the Arun View public house and the A259
- Agricultural land is located to the north of the A259

2.2.2.2 A more descriptive account of land use within the study area is presented in Appendix 1.





**Figure 3 Environmental Site Appraisal Plan (1 of 2)**



**Figure 4 Environmental Site Appraisal Plan (2 of 2)**

### **2.2.3 Flora and Fauna**

- 2.2.3.1 This section presents a summary of designated sites and other flora and fauna of interest. A more detailed description is presented in Appendix 1.
- 2.2.3.2 An ecological scoping study was carried out for the project in February and March 2009. The study comprised a desk-based review of existing records and an extended phase 1 habitat survey to identify the nature of existing habitats and the potential for protected flora and fauna. A copy of the report with accompanying plans is provided in Appendix 2.
- 2.2.3.3 A specialist survey of bats roosts was undertaken prior to ground investigations for the project in December 2009 at Riverside Autos. A copy of a technical note prepared following the survey is presented in Appendix 3.
- 2.2.3.4 Based on previous records and the high suitability of habitat on the flood embankments and in the northern part of the project area, a survey to establish the presence of reptiles and population densities was carried out in June 2010. A copy of the survey report is presented in Appendix 4.

#### Designated Sites

- 2.2.3.5 Designated sites within the study area comprise:
- Climbing Beach SSSI (national value)
  - Littlehampton Golf Course and Atherington Beach SNCI (county value)
- 2.2.3.6 Both sites are located on the west side of the river. There is also a Local Nature Reserve (West Beach), located within the SSSI.

#### Other Flora and Fauna

- 2.2.3.7 Other flora and fauna of interest include:
- Three protected plant species (located at least 200m to the north of the project area)
  - Fourteen JNCC habitat types recorded within the project area during the habitat survey, including the following BAP habitats: brackish water, coastal floodplain grassland, drainage ditches, inter-tidal mud, inundation vegetation and saltmarsh
  - A low potential for badgers on the highways embankment in Reach 6
  - A generally low to negligible potential for bats in trees on highways embankment in Reach 6
  - Bird communities including two Red List species (house sparrow and starling)
  - Potential invertebrates in drainage ditches in Reach 6
  - A low density population of reptiles (slow worms and lizards) along the embankments to the north and south of the A259 road bridge, and a slightly higher density population (low to medium) of reptiles along the railway edge and in field margins and small areas of unploughed grassland just north of the project area
  - No signs of water voles recorded, although a highly suitable habitat (a drainage ditch) for water voles is located in Reach 6
  - Coarse and sea fish in the River Arun
  - Japanese knotweed in Reach 6, south of the A259 road bridge
- 2.2.3.8 The project area is considered unsuitable for great crested newts and other amphibians.

### **2.2.4 Air & Climate**

- 2.2.4.1 Air quality within the district of Arun is typical of a mixed urban/rural area. The main source of air pollution is transport-related (notably, from the A27 and the A259). No national air quality objectives for human health were exceeded in 2008 and no Air Quality Management Areas have been designated within the project area.



2.2.4.2 No notable point sources of pollutants have been identified in the vicinity of the project.

### **2.2.5 Landscape & Visual Amenity**

2.2.5.1 An outline Landscape and Visual Impact Assessment (LVIA) has been undertaken as part of this project. A summary of the local landscape is provided in Appendix 1, and the full description of the overall and local landscape character of the project area and its surroundings, and the key landscape issues, is provided in the LVIA report, presented in Appendix 5. Key features are also shown on the Indicative Landscape Plans (see Section 5).

2.2.5.2 No information on Tree Preservation Orders has been made available to date, but none is anticipated along the riverside.

#### Local Landscape Character

2.2.5.3 The local landscape has been characterised into a number of character areas. These comprise:

- East beach and The Green (extending eastwards from the harbour mouth to include the beach and the coastal promenade, The Green, the Oyster Pond the amusement park, the lighthouse, the Coast Guard lookout building, and car parking along Arun Parade)
- The dunes (located in the west bank of the river, comprising sand, marram grass and scrub, the golf course and Littlehampton Fort scheduled monument )
- Riverside marinas (comprising almost continuous development of marinas and boatyards along the west bank of the river, ranging from well managed boat clubs with floating pontoons to fixed timber jetties and landing stages within the mud flats and some that are poorly maintained)
- Pier Road and South Terrace (marking the transition from The Green to the residential and commercial area north east, dominated by the wide junction with parked cars, with two-story properties, the majority with a commercial ground floor - mainly comprising cafes and restaurants - along Pier Road)
- Littlehampton Harbour Board to River Road (with Riverside Walk extending from the Harbour Board building to the Waterside on River Road, comprising almost continuous residential development. Riverside Walk won a Conservation Design Award in 2005. The buildings comprise three storey blocks, with occasional buildings of four and five stories, varying in style, rooflines and finishes. A public slipway is located at Fisherman's Quay by the Look and Sea Centre. Further north, gardens extend directly to the sheet pile edge of the flood bank, whilst the walkway is routed onto the footpath along River Road on the landward side of the residential properties.)
- The footbridge to Wharf Road (comprising a more open and disjointed area, River Road and Bridge Road close to the River, railway tracks on the approach to the railway station, individual buildings set within car parks, the gasometer and footbridge)
- Industrial area (comprising an open area used mainly for coal and gravel storage)
- Rural landscape, to the north of the A259 (comprising open arable and grazing fields with ditches adjacent to the river with the A259 on a planted embankment and the railway passing beneath the road)

2.2.5.4 Planning policy and development strategies that have potential to affect the future character of Littlehampton are discussed in Section 2.2.10.

### **2.2.6 Water Environment**

- 2.2.6.1 The main water features within the project area are the River Arun, the sea and a number of small drainage ditches and outfalls that drain either into the River or directly into the sea. Arun District Council state that there have been no major pollution incidents in the River Arun in the recent past, but there is a risk of pollutants spreading through the ditch system.
- 2.2.6.2 There is a Secondary (A) aquifer immediately beneath the scheme area, comprising the shallow Raised Beach and Raised Marine deposits. These are underlain by the White Chalk, which is classified as a Principal aquifer. Although there are no public water supply source protection zones nearby, these aquifers are sensitive to pollution. No information on private abstraction points has been made available to date.
- 2.2.6.3 In accordance with the Bathing Waters (Classification) Regulations 1991, there is one European designated bathing beach in Littlehampton (Coastguards). A new waste water treatment works was commissioned at Ford Aerodrome in 2001, which should further improve bathing water quality. It is likely that Littlehampton beach will be classified as 'Excellent quality' in accordance with the revised, more stringent standards and objectives set by the revised Bathing Water Directive (2006/7/EC).
- 2.2.6.4 The Water Environment (Water Framework Directive) (England and Wales) Regulations 2003 require that measures are in place to improve or maintain the quality of all water bodies, with the objective of achieving at least good ecological status (or good potential in the case of artificial and heavily modified water bodies) by a set timescale. River Basin Management Plans (RBMP) have been developed for each River Basin District in England to determine how the Directive will be delivered.
- 2.2.6.5 The RBMP for the South East River Basin District classifies the River Arun as a transitional water body that is heavily modified and currently has Moderate Ecological Potential and Moderate Status for fish. The status objective is to achieve Good Ecological Potential by 2027. Various mitigation measures are identified to help the Environment Agency achieve the status objectives. There are two further water bodies (Ryebank Rife and Sussex Coastal) adjacent to the scheme.
- 2.2.6.6 The groundwater body underlying the project area (a Chalk aquifer) is the Littlehampton Anticline East. The current status is Poor with a status objective to achieve Good status by 2027.

### **2.2.7 Cultural Heritage, Archaeology & Material Assets**

- 2.2.7.1 An archaeological desk-based assessment was carried out in December 2009 to March 2010. The full report is presented in Appendix 6, together with accompanying plans showing the location of archaeological features. A summary is presented in Appendix 1.
- 2.2.7.2 There are no scheduled monuments, listed buildings, registered battlefields, registered historic parks and gardens or world heritage sites within the project area.
- 2.2.7.3 A scheduled monument, Littlehampton Fort (MWS 3361), is located in the wider study area at the southern end of the project area, on the west side of the harbour mouth.
- 2.2.7.4 The proposed project runs through the western side of the River Road Conservation Area, which includes a large stretch of the river frontage. Two further Conservation Areas; East Street and the Seafront, lie at the eastern edges of the project area (approximately 300m to the east).

- 2.2.7.5 There are no listed buildings within the project area. One Grade II listed building, The Cairo Club, is located to the east, near the RNLI station. There are a further two buildings, which although not listed, are important locally as rare local survivals of post-medieval buildings on the east bank which form part of the tidal walls. These are 47 River Road, an early flint and brick warehouse, and an adjoining warehouse of the mid 19<sup>th</sup> century, which currently house Riverside Autos. These properties are currently being redeveloped for residential use.
- 2.2.7.6 A range of further archaeological monuments, historic buildings and find spots were also identified (see Appendix 1). Some of these (the site of a swing bridge, a harbour and a windmill) are located along the line of the defences and may have associated buried remains. In addition, there is potential for unrecorded remains such as barges within the inter-tidal area.
- 2.2.7.7 West Sussex has also been subject to an Extensive Urban Survey. The project area passes through four historic urban character types: The Station, River Road, New Road and The Seafront. The Survey also evaluates the historic environment value according to a five-point scale with 1 representing lowest value through to 5, representing highest value. The Station, New Road and The Seafront have all been assigned a value of 1. River Road has been assigned a value of 2.

## **2.2.8 Traffic & Transport**

- 2.2.8.1 The main transport infrastructure in the locality comprises the A259 coastal road that links to Chichester in the west and Worthing and Brighton in the east. The A259 crosses the River Arun via Bridge Road to a three-way roundabout with the B2184 (Bridge Road and Terminus Road) that connects past the railway station into Littlehampton town centre in the south, and the A27 main east-west road to the north via the A284.
- 2.2.8.2 The local road network within the project area is shown on the Indicative Landscape Plans (Section 5). Most of these roads are space-restricted, with roadside parking on one or two sides. Although a 30 mile per hour speed limit generally applies, average traffic speeds are likely to be considerably lower.

## **2.2.9 Soil, Geology & Hydro-geology**

- 2.2.9.1 The British Geological Survey (BGS) for the project area indicates that soils of different geological origin are present within the wider area, including Blown Sand, Tidal River deposits, Raised Beach Deposits and Aeolian Deposits (Brickearth). These soils are all classified as minor aquifers under the Agency's Policy and Practice for the Protection of Groundwater.
- 2.2.9.2 The underlying bedrock geology is Upper Chalk, the depth of which varies along the length of the project area. The Upper Chalk is classified as a major aquifer under the Agency's Policy and Practice for the Protection of Groundwater.
- 2.2.9.3 Although Made Ground is not marked on BGS Sheet 317/332, the commercial, residential and light industrial development along the southern half of the project area will have given rise to quite an extensive lateral and vertical profile of fill material.
- 2.2.9.4 The River Arun is tidal along the study length. On the retained side of the flood defences groundwater may be encountered perched above the lower permeability alluvial soils as well as within the more permeable granular drift soils and the major chalk aquifer. Levels may be influenced by the tide and by rainfall runoff.
- 2.2.9.5 Twelve areas of potentially contaminated land have been identified within the study area. Ground investigations undertaken for the scheme revealed that within the groundwater



various inorganic and organic determinands exceed their respective assessment criteria within the shallow sand and gravel deposits. Soil quality contamination levels are generally low with relatively few exceedances of the stringent screening values. Further information with regard to the contaminants encountered is provided in the Halcrow Phase 2 Interpretative Geotechnical Report.

#### **2.2.10 Planning Context**

- 2.2.10.1 A Local Development Framework for Littlehampton is currently being prepared by Arun District Council in accordance with the National Planning Policy Framework (March 2012) and the timetable set out in the Local Development Scheme. The Framework will include a new Local Plan, which will bring together the previously proposed Core Strategy and other Development Plan Documents and supporting documents. The South East Plan and the Regional Strategy is to be revoked. At the local level, the saved policies of the Arun District Local Plan 2003 provide the planning policy for Littlehampton.
- 2.2.10.2 Policies and recommendations contained in the following plans will also be taken into account during the EIA:
- South Foreland to Beachy Head Shoreline Management Plan
  - Sussex BAP
- 2.2.10.3 In addition to the planning framework established by the above documents consideration will be given to the Littlehampton Waterfront Strategy, which aims to help Littlehampton to become one of the leading seaside towns on the south coast. The strategy proposes a key objective to create a robust identity and bring together the three elements of Littlehampton, comprising the Town, the Green and the Harbour. Key factors are to:
- create an eco-friendly landscape and retain and enhance the unique existing natural landscapes
  - complete the pedestrian connections towards the river and celebrate the river as a central public space
  - create public walkways and spaces along the river and integrate and redevelop Pier Road
  - make flood defences an integral part of the riverfront in order to retain a strong interaction between the waterfront and the town
  - develop an environment that adapts to flooding and promote experimental design solutions
  - activate the riverfront and build on the existing maritime activities
- 2.2.10.4 The Littlehampton Vision of 2004 is a further high level strategy document which proposes a framework for development over the next 15 years and creates a context for a number of regeneration projects aimed at improving the economic vitality of the town. The consultation stage of the study recognised the importance of the River Arun as a defining feature of the town and is important for its marine and leisure activities.
- 2.2.10.5 A number of vision statements have direct relevance to the current project (for example, enhancing the character of the town, high quality development and improving access and movement) and several more detailed studies, including plans for Railway Wharf and Oyster Pond are also of relevance.
- 2.2.10.6 The Littlehampton Harbour Strategy report by the Director Operations Community Services, guided by Littlehampton Vision with the project partners (West Sussex County Council, Arun District Council, Littlehampton Harbour Board and Littlehampton Town Council), was set up to examine leisure expansion in the harbour. The Littlehampton Harbour Board resolved to pursue a leisure only future for the Harbour, with marine (mooring expansion) and land opportunities located on the west bank. Pier Road, Harbour

Park and Railway Wharf were recognised as sites where redevelopment and redesign could contribute to regeneration of the town.

## 2.3 EIA Methodology

### 2.3.1 Introduction

- 2.3.1.1 The scope of issues to be included in the EIA as the project progresses towards detailed design has been determined with due regard to baseline conditions and consideration of the characteristics of the construction and final form of the preferred scheme. Potential environmental receptors in the study area have been identified and their environmental value or sensitivity evaluated using accepted EIA methods. The nature and scale of potential impacts arising due to the proposed scheme has then been assessed independent of the value of the resources, and the significance of potential impacts then assigned by combining these two factors.
- 2.3.1.2 However, the focus has not been to provide precise levels of significance at this stage. The key objective throughout has been to identify those impacts that could be of significance in order that they could inform scheme design and help shape a coherent mitigation strategy and deliver maximum biodiversity outcomes within the realistic engineering and economic constraints of the project.
- 2.3.1.3 As a result of this process, some issues have been identified as minor and can be scoped out of the future EIA process. Others have been identified as potentially key issues that will need to be considered further and may require further surveys or investigation.

### 2.3.2 Summary of Key Issues and Design Parameters

- 2.3.2.1 There are a number of the environmental issues that are potentially significant and will require further detailed consideration in the detailed design stage of the project's EIA process. Issues that fall within this category are listed below, together with a summary of the key design issues that should inform the detailed design of the project.

#### Human Beings

- 2.3.2.2 The project will result in a major beneficial impact for the population and socio-economy of Littlehampton due to the reduced risk of inundation from overtopping or failure of the existing defences along the River. There is also potential for a beneficial impact resulting from minor changes to the road layout, and improvements to pedestrian and cyclist facilities, access to the river for disabled and wheelchair users and the visual amenity of the local streetscape along the promenade. These benefits may also indirectly benefit the local economy. These issues have already been addressed, but will need further consideration and evaluation as the project progresses to ensure that potential benefits are maximised and any potentially adverse impacts are mitigated within the detailed design.
- 2.3.2.3 A potential adverse impact on the gradient of the slipway will need to be considered, as will the potential for long term impacts on vessel owners and pontoons, particularly at Pier Road where these are vulnerable to wave propagation on flood tides with a surge of the river upstream and South or Southwest winds.
- 2.3.2.4 Potential negative temporary impacts may result from construction. The timing and potential disruption caused by construction activities with respect to the tourist season and vessel owners will need to be considered. Potential impacts due to noise affecting both tourists and local residents will need to be considered. Potential long term damage to buildings resulting from vibrations caused during construction activities will also need to

be considered. Potential temporary impacts on pedestrians and cyclists (as well as other road users discussed under traffic and transportation below) will also need consideration.

- 2.3.2.5 Potential impacts in terms of the forthcoming Environment Agency Enjoying Water Strategic Priorities (in preparation and not available at present) will need to be considered.

#### Flora and Fauna

- 2.3.2.6 No direct impact on Climping Beach SSSI or other designated sites is envisaged. The scheme and SSSI are located within the River Arun estuary, very close to the mouth of the river. Within this system, water levels are always dominated by sea levels, therefore, by changing the level of defences or width of channel there would not be any direct impact on the habitats covered by the Climping Beach SSSI (flora and fauna).
- 2.3.2.7 Without mitigation, there would be an overall maximum loss of 0.2ha of mudflat due to encroachment into the River. However, under the preferred option, there will be a potential creation of 0.3ha mudflat within Reach 6B resulting from the managed realignment proposals (a net gain of 0.1ha).
- 2.3.2.8 Saltmarsh is present within Reach 6B. Under the preferred option, no loss of saltmarsh is envisaged and disturbance to existing saltmarsh will be minimised, and approximately 0.75ha of new saltmarsh will be created, resulting in a net gain of BAP habitat.
- 2.3.2.9 The overall effect in terms of impacts on Biodiversity Action Plan habitats, protected species and the Environment Agency National Encroachment Policy for Tidal Rivers and Estuaries will need to be taken into account.
- 2.3.2.10 Reptiles will be affected by disturbance during construction works and loss of habitat along the embankment within Reach 6 (both Reaches 6A and 6B). A programme of translocation will be undertaken to mitigate potential impacts on reptiles prior to construction with suitable receptor habitat located at two sites to the east and west of the railway line (see Indicative Landscape Plan, Section 5 and Reptile Survey Report, Appendix 4).
- 2.3.2.11 Any tree felling in Reach 6B should be undertaken at least three months in advance of construction (ideally during September or October) to allow time to mitigate in the unlikely event that bats are present.
- 2.3.2.12 No further survey works are anticipated for aquatic invertebrates, water voles, otters, badgers or great crested newts. However, if the proposed works change in design, particularly if the drainage ditch in Reach 6B is likely to be affected, further survey work may be required. Appropriate mitigation works will need to be put in place with regards to working in and around watercourses prior to construction works commencing.
- 2.3.2.13 The presence and potential spread of invasive plant species, particularly Japanese Knotweed already identified, will need consideration as the project progresses and an early removal programme put in place. A survey to check for any new areas will also be required.
- 2.3.3.14 Any vegetation clearance works will need to be carried out outside the main bird breeding season (March to August) with all reptiles being removed from working areas (between April to September), particularly in Reach 6A and 6B, prior to construction works commencing. Potential impacts on overwintering birds will also need consideration.
- 2.3.2.15 Potential impacts on fish from piling operations and mitigation measures will need to be considered. Restrictions are likely to apply for piling.

#### Air and Climate

- 2.3.2.16 The proposed project will not affect air quality in the long term. Long term impacts may therefore be scoped out.
- 2.3.2.17 There is potential for short term effects on air quality resulting from emissions and dust from construction plant and activities. These issues will need to be considered and reported during the detailed design stage, but can normally be addressed by appropriate mitigation and the application of considerate construction practices, such that no detailed assessment will be required.
- 2.3.2.18 This project has potential to affect greenhouse gas emissions through the type, quantity, provenance and general sustainability of resources (i.e., materials) used in construction. The sustainability of resources used, therefore, will need to be considered and assessed during detailed design, in accordance with Environment Agency policy. However, this issue will be addressed as part of the assessment of material assets (see below).

#### Landscape and Visual Issues

- 2.3.2.19 The proposed scheme will result in a change of the visual amenity of the local townscape character. However, through early consideration of landscape and visual issues, the preferred options have incorporated the key mitigation measures as described in the outline landscape and visual assessment (Section 5 and Appendix 5). The visual effects of the increases in the height of the preferred options have been mitigated wherever possible, and landscape opportunities incorporated. None-the-less, the potential impacts on visitors, residents, pedestrians and cyclists will need continued consideration as the project progresses. Any changes to the visual appearance of any footpaths will also need consideration and agreement with the local authority.
- 2.3.2.20 The integration of the scheme with other development proposals will also need to be considered. In particular, the final design of other enhancements delivered by additional Arun DC funding in Pier Road and Arun Parade will be included in the scope of the EIA for the main flood defence scheme.

#### Water Environment

- 2.3.2.21 An assessment for likely WFD compliance has been undertaken and can be found in Appendix 7.
- 2.3.2.22 The assessment concluded that the scheme is expected to be compliant with Articles 4.8 and 4.9.
- 2.3.2.23 Of the six mitigation measures listed for the Arun transitional water body in Appendix B of the SE RBMP, none are currently in place. The assessment showed that the scheme does contribute to the objectives of the RBMP where feasible by achieving contributions to four of the six mitigation measures in the northern section. Thus the scheme will contribute towards the water body achieving Good Ecological Potential by 2027.
- 2.3.2.24 Since the scheme is not expected to cause deterioration in any of the quality indicators for the relevant water bodies, is not expected to prevent any water bodies reaching their objective, and contributes to required mitigation measures that are not yet in place where feasible, it is concluded that the scheme is compliant with the WFD and that an Article 4.7 exception test will not be required.
- 2.3.2.25 The proposed works are not expected to impact significantly or permanently upon groundwater quality or quantity and, therefore, with respect to the WFD Assessment, groundwater can be scoped out of the EIA.

2.3.2.26 If planning permission is sought, a flood risk assessment will need to be undertaken and submitted with the application in line with PPS25.

2.3.2.27 Various contaminants have been identified within the shallow sand and gravel deposits. There is the potential for these to be mobilised during construction (particularly where existing impermeable flood defence structures, such as sheet piling, are to be removed), resulting in pollution of the underlying Chalk aquifer or the adjacent River Arun. No further assessment is deemed necessary as methods for preventing pollution during construction will be incorporated at the detailed design stage.

#### Archaeology and Cultural Heritage

2.3.2.28 The proposed scheme will pass through the River Road Conservation Area. The detailed design of the scheme will need to take account of policies relating to development (in particular the materials used) within Conservation Areas. Conservation Area Consent is likely to be required.

2.3.2.29 Littlehampton Fort Scheduled Monument is approximately 100m to the west of the proposed scheme (on the west bank). No direct effect will occur, and potential impacts on the setting of the Fort are unlikely to be significant.

2.3.2.30 One Grade II listed building (The Cairo Club) lies near the flood defences. Potential impacts on the setting of this building will need to be considered. Planning requirements applicable to the Conservation Area designation will need to be addressed.

2.3.2.31 The Old Fort, located with the amusement park to the east of the scheme will not be affected by direct effects. However, there is potential to incorporate interpretative materials to provide enhancement to the historic value of this site.

2.3.2.32 There are three further sites located along the proposed scheme: the site of a swing bridge, a harbour and a windmill, which may have associated buried remains. As with any project working within the foreshore, there is also a possibility of buried timber within the river corridor (e.g., boat or ship wrecks, timber revetments, structures associated with wharves or quaysides) which may be affected by sheet piling but are currently unidentified. Consideration of any potential impacts and possible mitigation strategies will be made as the scheme progresses.

2.3.2.33 In addition, ground investigations have shown that palaeoenvironmental deposits (with potential for microfossils and plant remains in peaty deposits interweaved with alluvium) are likely to exist in the intertidal areas that could be affected by construction works (particularly piling).

#### Traffic and Transportation

2.3.2.34 There will be potential impacts on vehicle travellers and other road users resulting from possible changes to the road layout and parking within Reaches 1 and 2. These impacts will need further consideration and assessment during the detailed design.

2.3.2.35 There is also likely to be temporary disruption to vehicle travellers (as well as cyclist and other road users) during the construction period. These issues, and particularly those affecting the A259 and the residential and commercial facilities in the southern part of the project area, will need to be considered and reported during the detailed design stage, but they can normally be addressed by appropriate mitigation such as programming and the application of suitable traffic management plan, such that no detail assessment will be required.

#### Soil and Ground Conditions

- 2.3.2.36 A potential risk has been identified to construction workers from concentrations of contaminants within the soil and groundwater at the site. This issue will need to be considered during the detailed design stage prior to construction in order to prevent exposure of site workers or the public to contaminants, or contamination of the river or groundwater. Reaches 5B and 6 are likely to be the areas of greatest concern. The information presented in the Halcrow Phase 2 Interpretative Geotechnical Report should be used to inform the Construction Contractor as a guide to the potential signs on site from ground contamination. It is recommended that standard working practice for brownfield development sites is adopted across the entire site.
- 2.3.2.37 A Site Waste Management Plan will be developed during the later stages of the project. This will address the classification of waste streams along with proposed management and disposal options for each waste stream, but no detailed assessment is envisaged.

#### Material Assets

- 2.3.2.38 The materials balance of the embankment to be removed in Reach 6 and that required to raise the ground level behind the old line of defence to create saltmarsh and mudflat has been considered and will minimise any requirement for material import or export. All reusable material will be re-used on site. However, construction of proposed defences is likely to require the use of natural resources. The assessment will need to consider the sustainability of the sources of materials use and specify environmental best practice to be used when selecting products, suppliers and contractors for the works.

#### Planning Context

- 2.3.2.39 The proposed scheme is likely to result in some degree of change within the urban area of Littlehampton in Reaches 1 to 5, as well as in the more rural area of Reach 6. The assessment will therefore need to examine how the proposals comply with and further local planning policy and the Waterfront Strategy, and identify any areas of potential conflict.

### **2.3.3 Summary of Scoped Out Issues**

- 2.3.3.1 A number of potential issues are considered likely to be of relatively minor significance, and whilst appropriate management will be required during the construction and/or operation of the scheme, they will not require further detailed consideration through the EIA process. These are:
- Air quality (during construction and operation). No long term impacts are envisaged. Due to the temporary nature of any construction-related impacts it is not expected that work on the structures will have any significant impacts on the environment. Any temporary decreases in air quality (caused by dust and traffic emissions) can be mitigated through the adoption of appropriate considerate construction methods.
  - Noise (during operation). No long term impacts are envisaged.
  - Protected species - water voles, otters and aquatic invertebrates (construction and operation). No disturbance to or indirect impacts on these species are envisaged.
  - Traffic and transportation (during construction and operation). A traffic management plan will be required, but due to the temporary nature of the works, no long term impacts are envisaged and no detailed assessment is envisaged.

### **2.3.4 Further Work**

- 2.3.4.1 Due to the scale of the project, and the potential for significant environmental effects, the Environment Agency has determined that a detailed EIA will be required (see Section 2.4.1). The scope of issues to be addressed will include those identified in Section 2.3.2.

Those issues identified in Section 2.3.3 will not be addressed in detail, although measures to avoid or mitigate potential impacts will be included.

### **2.3.5 Assessment Criteria**

- 2.3.5.1 In the next stage of the project, the significance of impacts on environmental receptors and resources will be identified in accordance with the following outline environmental assessment and methodology:
- Evaluation of the value or importance of a resource according to a five-point scale (i.e. very high, high, medium, low, negligible) and the sensitivity of a receptor to the type of change or impact proposed
  - Assessment of the magnitude of each impact considering factors such as nature, extent, duration, directness, reversibility etc; and classification of the magnitude as minor, moderate or major positive or negative
  - Determination of the significance of the effect resulting from an impact (of a certain magnitude) on a resource (of a particular importance) or receptor (of a particular sensitivity) and classification as minor, moderate or major beneficial or adverse.
- 2.3.5.2 Defined criteria will be used at each stage of this process. These will be specific to each environmental subject and will be identified using industry accredited guidance. Current best practice will be followed in the absence of any such guidance.

## **2.4 Legislative and regulatory requirements**

### **2.4.1 EIA**

- 2.4.1.1 The majority of the proposed works will be carried out using the Environment Agency's permitted development rights as set out in the Town and Country Planning (General Permitted Development) Order (1995). However, planning permission will be required under the Town and Country Planning Act (1990) for the proposed managed realignment in Reach 6. A statutory EIA will be undertaken and an Environmental Statement (ES) prepared for the entire scheme. The ES will be submitted with the planning application for the realigned section in Reach 6 to the local planning authority (Arun District Council) in accordance with the Town and Country Planning (Environmental Impact Assessment) Regulations (2011). The ES will also be advertised and made publicly available prior to undertaking the remainder of the works under permitted development rights in accordance with Environmental Impact Assessment (Land Drainage Improvement Works) Regulations (1999).
- 2.4.1.2 It has been confirmed by the Marine Management Organisation that a statutory EIA is not required under the Marine Works (EIA) Regulations 2007 as amended.
- 2.4.1.3 The regeneration of the promenade along Arun Parade and Pier Road proposed by Arun District Council will be covered by a separate planning application.

### **2.4.2 Other Consents and Approvals**

- 2.4.2.1 Other consents and approvals required for the proposed preferred options are as follows:
- Flood Defence Consent and Land Drainage Consent from the Environment Agency and Arun District Council under the Water Resources Act 1991, the Land Drainage Act 1991, the Southern Region Land Drainage and Sea Defence Bylaws 1981 for works affecting flood defences and watercourses and changes to the drainage of watercourses
  - Marine licence from the Marine Management Organisation under the Marine and Coastal Access Act (2009) for the works that are below the high tide mark (Mean High Water Springs)

- Consent from Littlehampton Harbour Board under Section 43 of the Littlehampton Harbour and Arun Drainage Outfall Act 1927 for and building or work in the bed or on the banks of the harbour
- Consent from the Duke of Norfolk (Angmering Park Estate) for any piling into the river bed in the Duke of Norfolk's ownership
- Conservation Area Consent for works within the Conservation Area
- Diversion Orders relating to Rights of Way

2.4.2.2 No requirement for licenses relating to protected species is envisaged at present, although the possibility of a license for the disturbance of bats will be kept under review. As there are no international/European designated wildlife sites within or near the project area, the scheme does not require assessment under the Conservation of Habitats and Species Regulations (2010).

## 2.5 Uncertainties

2.5.0.1 The survey and assessment work undertaken during the scoping stage of the project has identified and reduced the risk of potential environmental impacts and risks to the delivery of the project. However, the risk of encountering unknown archaeology, particularly within the inter-tidal area, could affect project costs and programme. A number of additional uncertainties outside the EIA remit remain which have potential to affect the progress of the project. These uncertainties are as follow:

- Lack of agreement for changes to parking by the promenade
- Lack of agreement to changes to the Pier Road – South Terrace junction
- Uncertainty concerning the layout of road and pedestrian facilities
- Uncertainty concerning options available to incorporate additional landscaping enhancements, particularly in Reaches 1 and 2
- Uncertainties concerning development proposals on the west bank of the river
- Conflict with timing of redevelopment of engineering works (Riverside Autos) or alternative redevelopment proposals to south of footbridge or on land leased by Tarmac

## 2.6 Project and environmental objectives

2.6.0.1 The over-riding objectives of the proposed project, in accordance with the objectives of the Rivers Arun to Adur Flood Erosion Management Strategy are:

- To reduce the risk of life to human beings and protect and enhance their well-being
- To protect commercial and residential property and existing infrastructure
- To protect and enhance biodiversity, cultural heritage and landscape

2.6.0.2 Scheme-specific objectives to assist in achieving the overall objectives are:

- Deliver the recommendations of the Strategy to improve the standard of protection to Littlehampton to 1 in 300 years over the next 100 years
- Maximise the opportunities to integrate flood defences with the local plans of the town such as Littlehampton Waterfront Strategy to help improve the socio-economic situation of the town through regeneration potential
- Maximise the potential of working in partnership with the local authority and other stakeholders and seek opportunities for contributions
- Improve the ecological value along the Arun estuary and preserve its heritage value



- To reconcile the need to protect people and properties with enhancement of community engagement and considering public aspiration
- Maintain the interest and access to the estuary of the many sailing groups and local residents

2.6.0.3 Environmental objectives have also been proposed. These are:

- Minimise encroachment onto existing mudflats and saltmarsh, and provide compensatory habitat where loss is unavoidable
- Seek opportunities to extend and enhance quality of BAP habitat and protected species
- Maintain and, where possible, improve access to riverside and water
- Maintain privacy of private households along riverside where possible
- Maintain and, where possible, enhance visual appearance of riverside and promenade. Design all new structures with due regard for the townscape character
- Maintain and, where possible, improve the setting of scheduled monuments and listed buildings, and enhance their educational value where possible
- Avoid where possible, or otherwise minimise impact on buried archaeology
- Avoid deterioration in water quality resulting from construction and operation of the scheme
- Seek to make use of existing materials (residual life of existing structures) and minimise use of new materials where possible

## 3. Opportunities

3.0.0.1 Measures to mitigate potentially adverse impacts resulting from the proposed scheme will be incorporated within scheme design or within the Contractor's construction requirements. These currently include the following:

- Translocation of reptiles to a suitable reptile receptor habitat and use of a reptile fence to exclude any remaining reptiles from the working area
- Mitigation for a potential loss of approximately 0.2ha (worst case) of inter-tidal mudflat
- Mitigation for potential impacts on protected species in accordance with accepted guidelines and license requirements
- Landscaping design to mitigate adverse visual impacts caused by the proposed scheme
- Archaeological measures to evaluate and avoid or minimise potential impacts on archaeological resources
- Design to avoid potentially adverse impact on the public slipway
- Design to mitigate any adverse impacts on vessels or pontoons
- Measures to mitigate potentially adverse impacts on construction workers, the public, water quality (including any impacts associated with past land use), noise and vibration, and air quality during construction
- Timing of construction activities to avoid adverse impacts on breeding and wintering birds and salmonids

3.0.0.2 Opportunities to provide favourable biodiversity and social outcomes have also been sought. The creation of approximately 0.3ha of mudflat, resulting in an estimated net gain of 0.1ha of mudflat, and approximately 0.75ha of saltmarsh has been incorporated within

the design of the scheme. This opportunity to create BAP habitat will be progressed into detailed design.

- 3.0.0.3 The opportunity to provide a widened visually acceptable promenade within Reaches 1 and 2 will be incorporated within the scheme design, as well as a widened pedestrian footpath in Reach 4 and improved disabled access to the pontoons in Reach 2. Additional design features may also need to be incorporated to address requirements for works within the Conservation Area. This will aim to mitigate the increased defence height by providing a neutral effect to this public environment.
- 3.0.0.4 The scheme improves public access to the water through the inclusion of a new pontoon bridge to new design standards linking the promenade to the floating pontoons in Reach 2. This will facilitate any future passenger ferry to the west bank if others pursue this in the future.
- 3.0.0.5 Additional opportunities to incorporate measures over and above these measures have also been examined throughout the option appraisal process. There is scope to tie the scheme in with the Littlehampton Waterfront Strategy, with specific regard to public realm improvements to Arun Parade and Peir Road, and these opportunities are currently being progressed in partnership with Arun District Council.
- 3.0.0.6 Details of specific environmental opportunities are outlined later in this document.

# 4. Alternatives

## 4.1 Strategic Context

- 4.1.0.1 The 1997 Beachy Head to Selsey Bill Shoreline Management Plan (SMP) and the 2006 review (SMP2) cover the study area of the Littlehampton Arun East Bank Tidal Walls project, recommending a preferred policy option of “hold the line”.
- 4.1.0.2 The Rivers Arun to Adur Flood and Erosion Management Strategy (Halcrow, 2009) selected an Improve (raise defences) option as the preferred option. This would address the significant public and operational health and safety issues and would enable the implementation of the Rivers Arun and Adur Flood and Erosion Management Strategy.
- 4.1.0.3 The optimisation of the Strategy preferred option for the study area resulted in a requirement to provide a standard of defence to a consistent 1 in 300 year standard for the full study area (which is one interconnected flood cell). The preferred Strategy option has been carried forward without revisiting the discounted strategy options.

## 4.2 Options

- 4.2.0.1 During the current study, a number of alternative options have been identified to deliver the preferred strategic option.
- 4.2.0.2 In general, a sequential approach was adopted. A long list of options was subject to a high level technical, environmental and economic appraisal to produce a shorter list which would be subject to more detailed appraisal. The long list of options comprised the following generic options for each reach:
  - Repair and raise the existing defences
  - Rock revetment
  - Embankment
  - New defences (landward)
  - New defences (riverward)
- 4.2.0.3 Only options that would provide an acceptable long term technical solution, a clear positive economic case which would be competitive with other options and a positive score in meeting environmental objectives were short-listed. In generic terms, the short list of options comprised:
  - Do-Nothing
  - Maintain
  - New (or raised) riverward defences (Base scheme)
  - New (or raised) riverward defences (Mitigated scheme)
  - New (or raised) riverward defences (Enhanced scheme)
  - New (or raised) riverward defences (Visionary scheme)
- 4.2.0.4 For each reach, the Do Nothing and Maintain options have been considered. The Do Nothing option comprises no further work along the frontage, including maintenance. Under this option, the defences would deteriorate over time and fail, resulting in flooding. The Maintain option represents the minimum expenditure required to maintain the defences in their current alignment and form. It does not include works to raise the

defences in response to predicted sea level rise. Thus, the standard of defence afforded would fall over time. These were therefore not considered viable options, but were included for comparative purposes.

- 4.2.0.5 For some reaches, only one or two viable engineering solutions for new (or raised) defence options were proposed. For others, a number of different engineering options or solutions were proposed that fall within each of these categories. The resulting short list of reach options (with a range of illustrations to show how these may look in practice) was presented to the public and key stakeholders in March 2010 as part of a three-day consultation period at the Look and Sea Centre in Littlehampton. Additional targeted stakeholder meetings provided further specific information and opinion feedback. A detailed appraisal of the short listed reach options was then undertaken by internal and external consultees at an options appraisal workshop held in March 2010.
- 4.2.0.6 The short-listed options for each reach were subsequently subject to further appraisal and refinement following the feedback provided from consultation to determine the most economically viable reach options which meet environmental objectives and reflect the views of the public and statutory consultees. A weighted matrix was developed to summarise the key issues. This is available within the Options Appraisal Report, which can be made available to interested parties on request.
- 4.2.0.7 The short list of options are outlined in Table 2 (please note that SSP indicates Steel Sheet Piling). The key positive and negative impacts for each of the Improve options for each reach (focusing on the key differences between options, but not including the Do Nothing and Maintain options) are outlined in Table 3.

**Table 2**      **Reach descriptions and short listed options**

					Short List of PAR Options (composite Reach Options)					
Sub Reach Number	Reach Description	Current Defences	Current Standard of Protec. (lowest)	Reach Option  Yr 0 works [Phased capital works stated in brackets]	Do Nothing	Maintain	Improve 1	Improve 2	Improve 3	Improve 4
							Baseline	Mitigated	Enhanced	Visionary
1	Arun Parade promenade	Vertical walls: concrete and SSP	1in50	Riverward SSP + Raised Footpath			x			
				Riverward SSP + Promenade (simple)				x		
				Riverward SSP + Promenade + Features + Retain Parking					x	
				Riverward SSP + Promenade + Pedestrianisation ++ Features						x
2	Pier Road	Revetment: concrete with floodwall	1in100	Riverward SSP + Raised Footpath			x			
				Riverward SSP + Promenade				x		
				Riverward SSP + Promenade + Features					x	
				Riverward SSP + Promenade + Pedestrianisation ++ Features + Ferry						x
3A	New residential development	Vertical walls: SSP	1in300	No Capital Works [+ Raise Concrete Cap in Yr 20]			x	x	x	x
3B	Private riverside residences	Vertical walls: Concrete and SSP	1in50	Raise Concrete Cap [+ Riverward SSP in Yr 20]			x			
				Riverward SSP				x		
				Riverward SSP + Public Footpath					x	x
4A & 4B	Riverside Autos and Ferry Wharf south of footbridge	Vertical walls: Concrete and masonry	1in1	Patch Repair Flint Wall + Raise Walls [+SSP in Yr 20]			x			
				Riverward SSP				x		
				Riverward SSP + Glass + Reclaimed Public Area					x	
				Landward SSP + Glass + Promenade + Pontoons						x
5A	Arun View Pub north of footbridge	Vertical walls: concrete	1in50	Raise Concrete Wall [+ Riverward SSP in Yr 20]			x			
				Raise Concrete Wall + Glass + Rebuild Extension				x		
				Riverward SSP + Glass Floodwall + Footpath					x	x
5B	Tarmac site (Railway Wharf and UMA Wharf)	Vertical walls: SSP	1in10	Raise flood wall [+ Riverward SSP for UMA Wharf in Yr 20]			x	x		
				Raise flood wall + Riverward SSP for UMA Wharf					x	x
6	Riverside Industrial Estate and farmland	Embankment	1in5	Raising existing embankment			x			
				Raising existing embankment + Realignment				x	x	x

**Table 3 Key impacts of short listed Improve options (by reach)**

Reach	Improve Option	Description	Key Positive Impacts	Key Negative Impacts
1	1	Riverward SSP + Raised Footpath		Encroachment Low quality public environment Visual intrusion of defences Loss or tourism/business Restricts pedestrian access
	2	Riverward SSP + Promenade (simple)	Recreates existing environment Manages visual impacts through raised promenade, opportunities for new planters, refurbished handrails and use of materials sympathetic to existing. Improves pedestrian access and interconnectivity	Encroachment Regeneration aspirations not met
	3	Riverward SSP + Promenade + Features + Retain Parking	Regeneration opportunities met Improved tourism/business Opportunity to incorporate additional areas of natural planting	Encroachment Reliant on external funding
	4	Riverward SSP + Promenade + Pedestrianisation ++ Features	High quality public space with space for community events and pedestrianisation/shared space Significant town regeneration Significant tourism boost Space for arts/community events Cycle lane Opportunity to incorporate additional areas of natural planting	Encroachment Reliant on external funding Loss of parking
2	1	Riverward SSP + Raised Footpath		Encroachment Low quality public environment Visual intrusion of defences Loss or tourism/business Restricts pedestrian access
	2	Riverward SSP + Promenade	Recreates existing environment Manages visual impacts through raised promenade, opportunities for new planters, refurbished handrails and use of materials sympathetic to existing. Improves pedestrian access and interconnectivity	Encroachment Regeneration aspirations not met
	3	Riverward SSP + Promenade + Features	Regeneration opportunities met Improved tourism/business Opportunity to incorporate additional areas of natural planting	Encroachment Reliant on external funding
	4	Riverward SSP + Promenade + Pedestrianisation ++ Features + Ferry Regeneration Improvements	High quality public space with space for arts/community events and pedestrianisation/shared space	Encroachment Reliant on external funding

			<p>Significant town regeneration</p> <p>Significant tourism boost</p> <p>Improves west bank connection</p> <p>Cycle lane</p> <p>Opportunity to incorporate additional areas of natural planting</p>	
<b>3A</b>	1 - 4	No Capital Works [+ Raise Concrete Cap in Yr 20]	<p>Makes use of residual defence life</p> <p>Retains award winning features</p> <p>Retains existing environment</p>	<p>Only defers capital spend</p> <p>No opportunity for enhancements</p>
<b>3B</b>	1	Raise Concrete Cap [+ Riverward SSP in Yr 20]	Retains privacy and berthing	<p>Only defers capital spend</p> <p>Impact on Conservation Area</p>
	2	Riverward SSP	<p>Long term solution</p> <p>Retains privacy and berthing</p> <p>Allows Conservation Area requirements to be met</p>	<p>Encroachment</p> <p>Piling impact</p> <p>Impact on Conservation Area</p>
	3 & 4	Riverward SSP + Public Footpath	<p>Long term solution</p> <p>Improved public access to riverside</p> <p>Allows Conservation Area requirements to be met</p>	<p>Additional encroachment</p> <p>Loss of privacy and house value</p> <p>Long term maintenance of footpath</p> <p>Resistance from residents</p>
<b>4A &amp; 4B</b>	1	Patch Repair Flint Wall + Raise Walls [+SSP in Yr 20]	Allows development to progress	<p>Only defers capital spend</p> <p>Impact on Conservation Area</p>
	2	Riverward SSP	<p>Neutral impact on intertidal habitat</p> <p>Mitigates extra defence height through raised viewing areas to defence height with intermediate planters and use of materials sympathetic to existing.</p> <p>Allows Conservation Area requirements to be met</p>	<p>Potential impact on inter-tidal archaeology</p> <p>Impact on Conservation Area</p>
	3	Riverward SSP + Glass + Reclaimed Public Area	<p>Public amenity area</p> <p>Allows Conservation Area requirements to be met</p>	<p>Encroachment</p> <p>Resistance from residents</p> <p>Potential impact on inter-tidal archaeology</p> <p>Impact on Conservation Area</p>
	4	Landward SSP + Glass + Promenade + Pontoons	<p>Recreational benefits</p> <p>Improved public land use</p> <p>Allows Conservation Area requirements to be met</p>	<p>Boat security and access/parking</p> <p>Potential impact on inter-tidal archaeology</p>
<b>5A</b>	1	Raise Concrete Wall [+ Riverward SSP in Yr 20]	Low initial impact on business	<p>Disruption to business in medium term</p> <p>Encroachment in medium term</p> <p>Impact on Conservation Area</p>
	2	Raise Concrete Wall + Glass + Rebuild Extension	<p>No encroachment</p> <p>Mitigates impact on business</p> <p>Allows Conservation Area requirements to be met</p>	Impact on Conservation Area
	3 & 4	Riverward SSP + Glass	Opportunity to improve business	Encroachment

		Floodwall + Footpath	Allows Conservation Area requirements to be met	Piling impact
<b>5B</b>	1 & 2	Raise flood wall [+ Riverward SSP for UMA Wharf in Yr 20]	Potential for future developers to subsidise improvement works	Encroachment in medium term Impact on reptiles
	3 & 4	Raise flood wall + Riverward SSP for UMA Wharf	Maximises land value for development (public owned)	Encroachment Impact on reptiles
<b>6</b>	1	Raising existing embankment	Retains existing environment	No mitigatory habitat provision Impact on reptiles
	2 - 4	Raising existing embankment + Realignment	Mitigatory and additional BAP habitat provided  Reduced future maintenance	Land acquisition Impact on reptiles

## 4.3 Preferred Option

4.3.0.1 The short-listed engineering solutions and options for each reach were subject to a systematic appraisal using an options appraisal matrix. Environmental, engineering, construction, maintenance and cost factors were considered and given a weighted score. The detailed breakdown of this process has been reported in the Options Appraisal Report.

4.3.0.2 Each short listed option was also appraised according to whether it achieved a series of project objectives as outlined in Table 4, where 'environmental enhancement' includes enhancement of biodiversity, cultural heritage and landscape, and 'social benefits' and 'recreation enhancement' cover risk of life of humans and protection and enhancement of their well being. 'X' indicates achievement of the objective.

**Table 4 Environmental appraisal of options**

Objective	Improve 1	Improve 2	Improve 3	Improve 4
<b>1/300 SOP (for 100-yrs)</b>	X	X	X	X
<b>Regeneration</b>			X	X
<b>Contributions/ Partners</b>			X	X
<b>Ecological outcomes</b>		X	X	X
<b>Social benefits</b>			X	X
<b>Recreation outcomes</b>			X	X

4.3.0.3 The preferred options for improving the standard of protection to 1 in 300 years is provided by a combination of preferred options for each reach. As shown in Tables 3 and 4, Improve Option 1 does not provide the necessary ecological mitigation, or mitigation for visual (social) or recreational impacts. It is not therefore an environmentally acceptable option. Improve Option 2, due to the landward re-alignment of the defences, provides ecological mitigation for habitat loss due to encroachment and also results in ecological habitat gain through the landward re-alignment of the defences, and mitigates social and recreational impacts through raising of the promenade, maintaining the visual character and avoiding impacts on the tourist economy to provide a neutral effect. Improve Options 3 and 4 also provide the same ecological outcome as Improve Option 2, and provide social and recreational enhancements over and above those required to mitigate adverse impacts. Therefore, in purely environmental terms, Improve Options 3 and 4 are the preferred options, but Improve Option 2 is more than acceptable.



- 4.3.0.4 An economic analysis of the scheme options found that as Improve Option 1 does not attain the higher standard of protection, and the benefits of Improve Options 3 and 4 do not justify the increased costs. In addition, it found if Improve 1 were to be progressed, the opportunity for collaboration with Arun District Council, West Sussex County Council and Littlehampton Harbour Board to deliver benefits to the wider area of Littlehampton would be lost.
- 4.3.0.5 Therefore, Improve Option 2 is the lowest cost option that provides suitable mitigation; it provides ecological outcomes, maintains the character of the area and avoids impacts on the tourist economy. Specifically, Option 2 will:
- Provide environmental mitigation for habitat lost to encroachment
  - Provide environmental mitigation for encroachment into the river
  - Provide mitigation for visual intrusion of raised defences
  - Provide a sympathetic public environment in key tourist areas
  - Meet some of the aims of key council strategies without additional cost
  - Be likely to gain planning permission
  - Be likely to receive support from Natural England
  - Meet some of the aspirations of the public/stakeholders
  - Achieve WFD compliance
- 4.3.0.6 Improve Option 2 (Mitigated scheme) is the preferred scheme option.
- 4.3.0.7 Descriptions and plans of the preferred options for each reach are provided in Appendix 8. A list is provided in Table 5.

**Table 5 Scheme preferred options**

Reach	Option	Description
<b>Reach 1</b>	Improve Option 2 (Mitigated scheme)	Raised new vertical flood defence to full height and raised wide promenade with steps down to Arun Parade
<b>Reach 2</b>	Improve Option 2 (Mitigated scheme)	Raised new vertical flood defence to full height and a landscaped promenade down to Pier Road
<b>Reach 3A</b>	Improve Option 2 (Mitigated scheme)	No capital works in Yr 0, followed by the raising of the existing flood defence using concrete
<b>Reach 3B</b>	Improve Option 2 (Mitigated scheme)	Raised new vertical flood defence to full height.
<b>Reach 4A</b>	Improve Option 2 (Mitigated scheme)	Raised new vertical flood defence to full height
<b>Reach 4B</b>	Improve Option 2 (Mitigated scheme)	Raised new vertical defence to full height following an optimised alignment
<b>Reach 5A</b>	Improve Option 2 (Mitigated scheme)	Existing defences raised to full height
<b>Reach 5B</b>	Improve Option 2 (Mitigated scheme)	Delay construction of a new vertical flood defence by raising existing flood defence in front of existing
<b>Reach 6A</b>	Improve Option 2 (Mitigated scheme)	Raise existing flood defences
<b>Reach 6B</b>	Improve Option 2 (Mitigated scheme)	Raise existing embankment (downstream) and set back existing flood embankment to create saltmarsh/mudflat habitat (upstream) and protect A259 embankment (Managed Realignment).

- 4.3.0.8 The Mitigated scheme includes for a range of landscape mitigation measures, which have been established through consultation with the stakeholders. The Mitigated scheme does

however fall short of delivering wider social and regeneration benefits to the town as outlined in the Enhanced and Visionary options, particular for Reaches 1 and 2.

- 4.3.0.9 Discussions undertaken to date with Arun District Council have been extremely positive and have resulted in a pledge of £1.3m in additional funding for regeneration in Arun Parade and Pier Road. This funding has been underwritten by the Council and will be used to supplement the Improve 2 Option (Mitigated scheme) and realise some of the enhancements proposed as part of the Enhanced or Visionary schemes. Arun DC consulted on these regeneration proposals in 2012 and they will be further progressed alongside the detailed design of the flood defence scheme.

#### **4.3.1 Key Design Issues**

- 4.3.1.1 As indicated in Section 3, there are opportunities to incorporate significant enhancements over and above those already included within the preferred option, but the inclusion of such measures depends on the availability of additional funding. Based on the proposals for the Mitigated scheme, key design issues that will need to be considered during the detailed design are as follow:

##### **4.3.1.2 Reach 1**

- Visual impact of the flood defences in terms of views across the river from the promenade and The Green to the east, and from the river and west bank towards the town
- Potential to provide an enhanced pedestrian amenity along the river side promenade in terms of space and the quality of street furniture, materials and overall landscape design
- Potential loss of parking provision along Arun Parade
- Potential to incorporate enhanced viewing and interpretative materials relating to the old fort on the east bank of the river
- Potential noise and vibration from piling and other forms of construction works affecting pedestrians and visitors
- Noise and vibration during construction (particularly during piling) affecting migratory fish. Piling to be undertaken in accordance with agreed restrictions
- Works to be undertaken outside the summer season in order to minimise impact on tourist economy

##### **4.3.1.3 Reach 2**

- Potential loss of views across the river and west bank from commercial properties along Pier Road
- Potential to provide enhanced pedestrian amenity alongside Pier Road in terms of space, the quality of materials used and overall landscape design
- Likely closure of footpath and possibly also the road in front of local businesses due to operational requirements of crane required for construction, which may lead to a potential impact on the local economy during construction. Use of jack-up barge to minimise disruption
- Temporary removal of pontoons during construction. Pontoon bridges to be replaced to maintain access to pontoons (and possibly future ferry)
- Noise and vibration during construction in proximity to residential properties and visitors
- Noise and vibration during construction (particularly during piling) affecting migratory fish. Piling to be undertaken in accordance with agreed restrictions
- Investigate use of 'Silent piling' to minimise disruption with survey to assess building damage
- Works to be undertaken outside the summer season in order to minimise impact on tourist economy

- Potential for impacts on vessels and pontoons due to wave propagation
- Potential for improved access to the river for disabled and wheelchair users, with attention to surfacing materials required
- Any loss of mudflat due to encroachment to be mitigated

#### 4.3.1.4 *Reach 3*

- Potential loss of views across the river and west bank from residential properties
- Access to promenade and river to be maintained from residential gardens abutting the promenade
- Privacy of residents along promenade to be maintained
- Temporary removal of pontoons during construction.
- Noise and vibration during construction in proximity to residential properties and visitors. Investigate use of 'Silent piling' to minimise disruption with survey to assess building damage
- Noise and vibration during construction (particularly during piling) affecting migratory fish. Piling to be undertaken in accordance with agreed restrictions
- Any loss of mudflat due to encroachment to be mitigated

#### 4.3.1.5 *Reach 4*

- Privacy of residents to be maintained
- Views from residents' gardens and footpath to be maintained
- Archaeological potential of inter-tidal mudflat
- Potential noise and vibration from piling and other forms of construction works. Investigate use of 'silent rig' to minimise risk of building damage from driving piles with survey to assess building damage
- Noise and vibration during construction (particularly during piling) affecting migratory fish. Piling to be undertaken in accordance with agreed restrictions

#### 4.3.1.6 *Reach 5*

- Views from Arun View public house to be considered
- Future land use at Tarmac site to be considered
- Potential contamination associated with past land use at Tarmac site to be considered
- Noise and vibration during construction (particularly during piling) affecting migratory fish. Piling to be undertaken in accordance with agreed restrictions

#### 4.3.1.7 *Reach 6*

- Potential to mitigate for estimated loss of 0.2ha of mudflat from other reaches. Possible disturbance of saltmarsh within this reach but net gain in 0.1ha of mudflat and 0.75ha of saltmarsh by managed realignment of the flood bank
- Removal of trees under ecological supervision in October, and at least three months in advance of construction works to avoid any potential delay to programme if bats are found and an European Protected Species Licence is required
- Proposal to retain the existing alignment immediately north of the road bridge to minimise any disturbance of the drainage ditch and associated habitats and wildlife
- Requirement to mitigate for potential disturbance to reptiles with potential to provide a translocation site to east and west of railway. No disturbance to reptile habitat outside working area. Translocation programme (which will take a minimum of 60 working days of suitable weather) to be undertaken by qualified ecologist to be accommodated within programme
- Loss of tree planting screening the A259. Requirement to mitigate through replanting

- Potential contamination associated with sewage works
- Under seepage of shallow founded flood defences could pose a potential flooding risk during high river levels
- Potential disturbance to breeding birds. Vegetation to be cleared under ecological supervision outside the bird breeding season (which is March to August inclusive)
- An area of invasive plants to be removed and/or treated to avoid spread

## 5. Constraints Plan

- 5.0.0.1 The key environmental sensitivities within the study area, including environmentally designated sites in the area, proposed mitigation measures and opportunities for environmental outcomes are shown in the Indicative Landscape Plans presented in Appendix 9.

## 6. Consultation

### 6.1 To date

- 6.1.0.1 An Engagement Plan that outlines the key requirements for consultation during the project has been prepared. The plan has been revised appropriately as the project has progressed.
- 6.1.0.2 The short list of reach options was presented to the public and key stakeholders in March 2010 as part of a three-day consultation period at the Look and Sea Centre in Littlehampton. A number of targeted stakeholder meetings were undertaken during and following the three-day period to provide further specific information and opinion feedback.
- 6.1.0.3 Shortly after the consultation, an options appraisal workshop was held with statutory consultees and key internal and external consultees to explain the need for the scheme, discuss each reach and option in detail and ascertain feedback. Consultees were provided with an Options Briefing Note and an options appraisal feedback matrix in advance of the workshop. Any consultee not able to attend the workshop was invited to provide written feedback using the matrix.
- 6.1.0.4 Further consultation was then undertaken on the preferred options in October 2010. Internal and external consultees and other key stakeholders were invited to make comment on the Scoping Consultation Document, and a public exhibition was held in Littlehampton. This Scoping Report has been prepared with due regard to responses received from the latter consultation.
- 6.1.0.5 A list of those invited to and attending the workshops and meetings or consulted on the Scoping Consultation Document is provided in Appendix 10.

### 6.2 Response to the preferred option

- 6.2.0.1 The overall response from consultees to the Scoping Consultation Document and the preferred options presented within it was positive. No major concerns were raised, and useful comment was provided. The responses have been incorporated within this Scoping Report and will be used to inform the detailed design as appropriate. A summary of all responses is presented in Appendix 10.

## 6.3 Future consultation

- 6.3.0.1 Consultation will continue throughout the development of the scheme.
- 6.3.0.2 Following approval of funding to progress with the detailed design and the EIA, the following consultation is proposed:
- Meetings and ongoing consultation as required with affected stakeholders (in particular Natural England, landowners affected by the project and internal Environment Agency specialists) throughout all future stages of the project to agree the requirements for the mitigation of significant impacts and the design of enhancement proposals
  - Issue of the draft Environmental Statement (ES) and Environmental Action Plans (or relevant parts thereof) to key stakeholders for comment during the EIA process
  - Submission of ES with planning application for Reach 6 works not undertaken under permitted development rights and public advertisement of ES for remainder of works.

# 7. Conclusion

## 7.1 Conclusions

- 7.1.0.1 The proposed scheme has been developed to deliver the recommendations of the Rivers Arun to Adur Flood Risk Management Strategy.
- 7.1.0.2 The preferred options for the scheme include the construction of new sheet piled walls and embankments, with some managed re-alignment in the rural area, and improved pedestrian and amenity facilities along the urban river front of Littlehampton.
- 7.1.0.3 Careful consideration has been given to minimise any potentially adverse impacts and maximise the benefits of the scheme. Mitigation can be incorporated to avoid most potentially adverse impacts, but further work will be required to ensure that these are realised and fully addressed during detailed design and assessment process. Issues that will need particular attention include:
- Reptile mitigation and other ecological impacts
  - Landscaping design and visual amenity
  - Pedestrian facilities
  - Archaeological potential
  - Water quality
  - Construction programme and timing with respect to the local economy and ecological constraints

## **7.2 Recommendations**

- 7.2.0.1 It is recommended that the following actions are undertaken following receipt of funding approval to complete the environmental impact assessment process:
- Develop detailed designs for the mitigation and enhancement works with Arun District Council
  - Produce an Environmental Statement for the proposed scheme
  - Produce an Environmental Action Plan (EAP) as part of the EIA process
  - Continue consultation with affected stakeholders and landowners to address specific issues raised during the consultation
  - Initiate advance works required to implement the environmental mitigation requirements

# Appendix 1 – Description of Existing Environment

## **Introduction**

This appendix provides a description of the existing environment for land use and the local economy, ecology and biodiversity, air quality and climate, local landscape character, and archaeology, cultural heritage and material assets.

## **Land Use and the Local Economy**

Littlehampton forms part of the extensive coastal strip along the south coast. The town lies to the east of the River Arun, which forms a natural barrier from the open dunes to the west. Large scale residential development extends towards Brighton in the east. The A259 encloses the town to the north, with farmland beyond.

The River Arun forms an important feature of the town, although the main town centre is further east. The River mouth provides the entrance to the harbour, with a lighthouse and coast guard lookout building located at the entrance. A wide promenade and a road with parking behind extend northwards from the pier along the riverfront towards the town. An area known as The Green, which contains the artificial 'Oyster Pond' extends eastwards along the East Beach. An amusement park separates The Green from the beach. Residential property extends eastwards along South Terrace, facing onto The Green.

The promenade extends north along the River, but to the north of The Green, Pier Road provides vehicular access along the River with parking along one side. The area contains a mix of commercial and tourist facilities including numerous cafes and restaurants, forming a focal point for tourism.

The Littlehampton Harbour Board office marks a point at which the road separates away from the River again, with the promenade carrying on north along Riverside Walk. From the Harbour Board office, substantial recently constructed residential development extends northwards along the river front on the landward side of the promenade. A public slipway, a lifeboat station and some further commercial facilities (restaurants) are located along this stretch of the River.

To the north of Riverside Walk, there is a short stretch of river where private residential gardens extend to the river, with the Riverside Autos workshop and a small area of open space just to south of a footbridge across the River. There is no public access along the river to the north of Riverside Walk.

A public house, The Arun View, is located immediately north of the footbridge. From the Arun View northward to Bridge Road (the A259), there is industrial land use, with an area leased to Tarmac used mainly for storing gravel and aggregate.

The A259 forms a boundary between the built up area of the town and the open agricultural land to the north, which is protected from flooding by an earth embankment. The A259 sweeps north to follow the line of the River for approximately 400m before curving off to the east at a point where the railway line crosses in a north westerly direction towards Arundel. An informal footpath extends along the top of the flood embankment. Access to the path can be gained from either the north or south of the A259 bridge. Agricultural land extends north from the project area.

Tourism, which is focused primarily in its southern reaches of the River with the promenade, cafes and the amusement and leisure activities, and the moorings located along the River, together with the beach that stretches eastwards from the river and the golf course to the west of the River, is an important aspect of the local economy.



## **Ecology and Biodiversity**

### **Nationally Designated Sites**

Climping Beach SSSI is located to the west of the River Arun and comprises a stretch of coastline with a vegetated shingle beach, behind which is a sand dune system. The inter-tidal zone supports important populations of wintering birds including numbers of wintering sanderling (*Calidris alba*) (up to 300 recorded) which are of European importance.

The site is of national value.

### **Locally Designated Sites**

Littlehampton Golf Course and Atherington Beach SNCI, located to the west of the River Arun, comprises calcareous grassland, ditch and shingle beach. Littlehampton Golf Course is of outstanding botanical importance.

The site is of county value

### **Other Flora and Fauna Interests**

Recent records show the following protected flora within 2km of the project area:

- Borrer's saltmarsh-grass (*Puccinella fasciculata*) (1997, c.250m north of the project area)
- Marsh stitchwort (*Stellaria palustris*) (1997, c.1km north of the project area)
- Marsh-mallow (*Althaea officinalis*) (1997, c.200m upstream of the project area)

The east bank of the river comprises predominantly urban habitats with residential housing, light industrial premises and footpaths or roads that extend to vertical pilings that form the water's edge. At low tide, there is a strip of inter-tidal mud along both sides of the River, with a foreshore of shingle, mud and sand at the river mouth. At the up-stream, to the north of the A259 Road Bridge, there is an area of grassland, which opens up to form an extensive area of coastal grazing marsh and drainage ditches, with a dense strip of scrub and trees along the road embankment of the A259.

Fourteen JNCC habitat types were recorded during the habitat survey. Of these, the following are within the scheme and meet the criteria for UK Biodiversity Action Plan Priority habitats:

- Brackish water within the River, likely to support 'corse' and sea fish.
- Coastal floodplain grassland at the northern end of the project area and relatively unmanaged tall grassland in marginal habitats along the ditch banks and river embankments.
- Drainage ditches in the northern part of the project area, mainly slow-flowing, flanked by common reed.
- Inter-tidal mud, in a narrow strip along both sides of the River that is exposed at low tide, consisting of soft mud and sand and potentially supporting large populations of marine invertebrates, which in turn support wading birds and wildfowl.
- Inundation vegetation, tall reed-dominated vegetation in strips along drainage ditches within the northern part of the project area, which may support important species such as birds, molluscs and moths.
- Saltmarsh, in narrow strips along the berms of the River in the northern part of the project area, typically no more than 3m wide and containing a typical range of saltmarsh species such as sea purslane (*Halimione portulacoides*), sea beet (*Beta vulgaris*), common saltmarsh-grass (*Puccinellia maritima*) and sea aster (*Aster tripolium*).

Where sufficient areas of these habitats exist in a favourable condition, these habitats may have up to national value. Other habitats are of lower value, although higher value features may be present within them.

A small area of Japanese knotweed *Fallopia japonica* has been recorded along the boundary in Reach 6B.

#### Badgers

No indications of the presence of badger setts or activity within the project area were identified during the survey. Much of the habitat, which is prone to seasonal flooding, is unsuitable for badgers, although the raised embankments may be suitable. However, as not all areas were available for examination at the time of survey, there is potential for setts within these more suitable areas, albeit a low potential.

#### Bats

Bat roosts may occur within the industrial or residential buildings within the project area. A specialist survey of bats roosts was undertaken prior to ground investigations for the project in December 2009 at Riverside Autos as the buildings and surrounding landscape were considered collectively to provide numerous roosting, foraging and commuting opportunities for bats. The results of the survey revealed no evidence of winter roosting but, although the buildings were not considered suitable as a maternity roost site, they may provide a summer roost for a limited number of bats. This building has since been demolished for redevelopment.

The grassland and scrub habitats within the project area are generally sub-optimal as foraging or commuting habitat. There are a number of trees located along the highways embankment to the north of the A259 road bridge. A walkover survey has indicated that the trees along the top of the highways embankment are relatively young and have negligible potential for roosting bats. Lower down, there are some mature trees with ivy cover located to the south of the steps that hold low to medium potential, whilst those to the north of the steps are also mature, but hold low to negligible potential. Overall, there is a low to negligible potential for bat roosts within these trees generally, although some areas hold a low to medium potential.

A copy of the technical note on bats is provided in Appendix 3.

Bat species are protected under EU law and could be, if present, of value up to international level.

#### Birds

The inter-tidal zone within the River supports a range of bird species. A number of widespread garden bird species were also observed during the habitat survey, including the house sparrow (*Passer domesticus*) and starling (*Sturnus vulgaris*), both of which are Red Listed Birds.

The bird community within the project area may be of value up to the national level.

#### Great crested newts and amphibians

No potential breeding ponds for great crested newts were identified within the project area and there are no records within 500m. The coastal grassland and scrub habitat on the eastern river bank in the northern part of the project area provide suitable habitat, but are cut off from other suitable habitats by the River, the A259 and the railway line. The project area is therefore not considered suitable for this species or other amphibians.

### Invertebrates

The drainage ditches within the northern part of the project area may contain ecologically important and diverse communities of invertebrate species, which may be of value up to the national level. No detailed survey of the ditches within the project area has been undertaken to date.

### Reptiles

Based on previous records and the high suitability of habitat on the flood embankments and in the northern part of the project area, a survey to establish the presence of reptiles and population densities was carried out in June 2010. The survey indicated that there is a low density population of reptiles (slow worms and lizards) along the embankments to the north and south of the A259 road bridge, and a slightly higher density population (low to medium) of reptiles are present along the railway edge and in field margins and small areas of unploughed grassland just north of the project area.

A copy of the reptile survey is provided in Appendix 4.

Reptiles are of value up to the national level.

### Water voles

No obvious signs of water vole activity were recorded during the habitat survey although the drainage ditch in the northern part of the project area was considered highly suitable. Other drainage ditches within the vicinity of the immediate project area may also be suitable for water voles, with slow-flowing water and sloping densely vegetated bank-sides. No detailed survey of the ditches in the project area has been undertaken to date.

Water voles, if present, may be of value up to the national level.

### Fisheries

A wide range of coarse and sea fish are present within the River Arun including species such as bass species, golden grey mullet *Liza aurata*, gurnard species and stringrays. No further information on fisheries has been available to date.

## **Air and Climate**

Air quality within the district of Arun is typical of a mixed urban/rural area. The District Council states that whilst some air pollution derives from outside the district, the main source of air pollution is transport-related (notably, from the A27 and the A259). The latest air quality updating and screening assessment prepared by Arun District Council in 2009 stated that no national air quality objectives for human health were exceeded in 2008 and therefore no detailed assessment will be required for 2010. No Air Quality Management Areas have been designed within the project area.

No notable point sources of pollutants have been identified in the vicinity of the project.

## **Local Landscape Character**

### *East Beach and The Green*

East Beach extends eastwards from the harbour mouth with long views along the beach and the coastal promenade. The Green is an open area located between the promenade and South Terrace. East Beach Café and the planned 'longest bench in the world' will add a sense of creative design to the seafront which may influence future development.

The amusement park separates The Green from the River and is on a slightly elevated position. The castle, lighting and other buildings are therefore dominant features. The lighthouse and Coast Guard lookout building are also dominant features.

The riverside along this stretch of the River is visually cluttered by small scale buildings and features, walls and planters, and by the mix of materials of railings, bollards, seating, bins, lighting, walls and paving. Further north, towards Arun Parade, views to the east are more open and less cluttered, but views are dominated by parked cars on Arun Parade. At the junction with South Terrace, the Oyster Pond is a dominant feature enclosed by trees but allows views to the east.

#### *The Dunes*

The dunes are located on the west bank of the River between the beach and the golf course. The dunes comprise sand, marram grass and scrub and contrast with the open expanse of the golf course. They limit views westwards from the riverside parade, but there are open views across the golf course. The Littlehampton Fort scheduled monument is located within the golf course, but it is low lying and not a dominant visual feature in views from the east bank.

#### *Riverside Marinas*

There is almost continuous development of marinas and boatyards along the west bank of the river. They range from well managed boat clubs with floating pontoons to fixed timber jetties and landing stages within the mud flats and some that are poorly maintained. The sound of rigging against masts adds to the distinctive waterside and marina character.

#### *Pier Road and South Terrace*

The junction of Pier Road and South Terrace forms an important part of the town, marking the transition from The Green to the residential and commercial area north east, where visitors travelling by car meet the river. It is dominated by the wide junction with parked cars. The Nelson public house is a distinctive building on the landward corner, with fine three storey terraced houses extending eastwards.

Buildings face one side of Pier Road. Along the southern part these are two-story properties, the majority with a commercial ground floor (mainly comprising cafes and restaurants). Cars park along one side of the road, and footpaths are relatively narrow, further restricted by litter bins and street lights.

The flood defences are formed by a low brick wall, with a sloping concrete bank and occasional steps to the water and a floating jetty that runs parallel to the river's edge. Further north, there are individual buildings with timber cladding and flint walls (The Dutch Bike Shop and The Scout Hut).

The narrow footpath and poor condition of the concrete bank reduces the landscape quality in this area.

#### *Littlehampton Harbour Board to River Road*

Riverside Walk extends from the Harbour Board building at the point where Pier Road diverges inland away from the River, to the Waterside on River Road. This section of the River comprises almost continuous residential development. Except for at the Tourist Information Centre and lifeboat station, the promenade is characterised by a concrete capped wall with a metal balustrade, black street furniture and lighting, bespoke seating and metal artwork and concrete block paving. Riverside Walk won a Conservation Design Award in 2005.

The buildings comprise predominantly three storey blocks, with occasional buildings of four and five stories. They vary in style, rooflines and finishes, but a consistent feature is the balconies on ground floor level opening onto small gardens. Further north, gardens extend directly to the sheet pile edge of the flood bank, whilst the walkway is routed onto the footpath along River Road on the landward side of the residential properties.

#### *The Footbridge and Wharf Road*

To the north of the residential property on Riverside Walk, there is a distinctive change to the character of the river front. The streetscape becomes more open and disjointed, with River Road and Bridge Road closer to the River, railway tracks on the approach to the railway station becoming more evident, and individual buildings set within car parks (such as at The Arun View public house). The gasometer and footbridge form dominant features, as do the older flint and brick buildings with tin sheet roofs (incorporating Riverside Autos) that form the river defences. They are currently in a poor state of repair and are subject to partial demolition under a planning application for residential development.

Between Riverside Autos and the footbridge, there is a mainly unused open area of private land laid out for car parking, and an area of mud flat where the defences are set back against the road. The footbridge is enclosed by a distinctive parapet and cast iron railing.

The Arun View is located immediately north of the footbridge, with windows set into the wall that forms the river defences.

The west bank to the south of the footbridge comprises an extensive area of boatyards with slipways and jetties and a range of workshops buildings clad in sheet metal.

#### *Industrial Area*

From just north of the footbridge to Bridge Road (the A259), the landscape is industrial in character. It is enclosed by the planting on the embankments of the A259 and by the B2187, but open to the river. It comprises an open area used mainly for coal and gravel storage. On the west bank there are landing stages for pleasure boats, boat storage areas and two caravan/ mobile homes sites.

#### *Rural Landscape*

To the north of the A259, the landscape changes to a rural character. The road is on a planted embankment which screens the road and the town from the countryside to the north and west. The area comprises open arable and grazing fields with ditches adjacent to the river with ditches. A railway line passing beneath the road at the northern end of the project area forms a distinctive feature.

### **Cultural Heritage, Archaeology & Material Assets**

There are no scheduled monuments, listed buildings, registered battlefields, registered historic parks and gardens or world heritage sites within the project area.

A scheduled monument, Littlehampton Fort (MWS 3361), is located in the wider study area at the southern end of the project area, on the west side of the harbour mouth on what is now Littlehampton golf course. The monument, which comprises earthworks and upstanding stone walls, is currently heavily vegetated and derelict.

The proposed project runs through part of the River Road Conservation Area, which is located approximately halfway along the scheme. The proposed project runs through the

western side of the Conservation Area, which includes a large stretch of the river frontage. The majority of the designated area lies to the east of the project area, however, incorporating a mostly residential area.

Two further Conservation Areas; East Street and the Seafront, lie at the eastern edges of the project area (approximately 300m to the east).

There are no listed buildings within the project area. One Grade II listed building, The Cairo Club, is located to the east, near the RNLI station. There are further two buildings, which although not listed, are important locally as rare local survivals of post-medieval buildings on the east bank which form part of the tidal walls. These are 47 River Road, an early flint and brick warehouse, and an adjoining warehouse of the mid 19<sup>th</sup> century, which current house Riverside Autos. Both properties are due for partial demolition under planning permission for residential development.

A range of further archaeological monuments historic buildings and find spots were also identified. These range from a prehistoric axe, a Neolithic axe and pottery, Roman coins, the later medieval village Littlehampton, to the more recent sites of a gun battery dating to 1759, a former swing bridge, a harbour and saw mill and a World War II perimeter fence and anti-tank cylinders.

West Sussex has also been subject to an Extensive Urban Survey to characterise urban areas through a historic assessment of their form. The project area passes through four historic urban character types: The Station, River Road, New Road and The Seafront. The Survey also evaluates the historic environment value of each urban area based on its townscape rarity, time-depth (antiquity), completeness, visibility and historic association, according to a five-point scale with 1 representing lowest value through to 5, representing highest value. The Station, New Road and The Seafront have all been assigned a value of 1. River Road has been assigned a value of 2. Descriptions of these character types with plans showing their extent and historic value are included in Appendix 6.

# Appendix 2 – Ecological Scoping Study Report 2009

# Appendix 3 - Bat Survey at Riverside Autos Technical Note 2010



# Appendix 4 – Reptile Survey Report 2010

# Appendix 5 – Landscape and Visual Impact Assessment

# Appendix 6 – Archaeological Desk-based Assessment Report

# Appendix 7 – Water Framework Directive Assessment

## **Introduction**

This appendix presents the results of an assessment of the proposed scheme with respect to The Water Framework Directive.

## **Legislative background**

The Water Framework Directive (Directive 2000/60/EC) (WFD), as implemented in England and Wales by the Water Environment (WFD) Regulations SI 3242/2003, aims to protect and enhance the quality of our surface and ground water bodies.

The WFD has a number of key objectives, including:

- Preventing deterioration in and improving the status of aquatic ecosystems
- Aiming to achieve good status for all waters by 2015, or where justified, by 2012 or 2027
- Promoting the sustainable use of water
- Conserve habitats and species that depend on water
- Reducing or eliminate the release of harmful pollutants
- Reducing the effects of floods and droughts

WFD stipulates that all water bodies should meet good ecological status (GES) by the set timeframe. Ecological status is determined by a set of biological, hydromorphological and physico-chemical quality elements. The overall status is determined by the lowest status element.

If a surface water body cannot achieve good ecological status because it has had substantial changes to its physical character resulting from human modifications, it is designated as a heavily modified or artificial water body (HMWB or AWB) and its status objectives altered to good ecological potential (GEP). For A/HMWBs, mitigation measures are used as a proxy for biological indicators, and implementation of mitigation measures are required for a water body to achieve its GEP objective.

WFD requires the preparation of River Basin Management Plans (RBMPs), through which water bodies are assessed and designated, objectives are set, mitigation measures or actions for achieving the objectives are detailed and compliance with WFD is reported. The South East RBMP was published in December 2009.

## **Assessment requirements**

Article 4.7 of WFD stipulates that any new modification which has the potential to alter the hydromorphology or other characteristics of a water body should not cause deterioration in the ecological status or potential of a water body or prevent it from achieving its objectives as detailed in the River Basin Management Plan (RBMP). If this cannot be achieved, the scheme must meet all the conditions in Article 4.7 to be legally compliant.

The following assessment has been undertaken to determine whether new modifications to water bodies resulting from the preferred options for the Littlehampton Arun East Bank Tidal Walls scheme:

- 1) will meet the legal compliance requirements for 'no deterioration'
- 2) will not prevent the achievement of GES or GEP in any water bodies
- 3) will contribute to the delivery of the RBMPs.

The assessment will consider hydromorphological impacts and associated ecological impacts associated with the preferred option.

The impact of the scheme on other water bodies within the South East River Basin District must also be considered (Article 4.8) and protection given by existing Community legislation must be maintained (Article 4.9).

## **Baseline**

### **Scheme description**

The work proposed includes a range of flood defence works along a 2.5km stretch of the tidal defences along the east bank of the River Arun from the harbour mouth upstream to 500m north of the A259. The works per reach are described in the main text of the Scoping Report and Appendix 8 and include including steel sheet piling, concrete or brick flood walls, embankments and scour protection steel and plastic sheet piling, earth embankments, local land raising, scour protection and cladding. Plans showing the preferred option are included in Appendix 8.

Where space is currently restricted to construct new defences, there will be some encroachment into the river. However, managed realignment works will be undertaken in the northern section in part to mitigate a loss of intertidal mudflat habitat downstream, with the remainder provided to allow positive ecological outcomes.

The defences would be set back in the northern reach (Reach 6B) to create saltmarsh/mudflat habitat through managed realignment. The realigned defences would be constructed at the base of the A259 road embankment. The redundant existing flood embankments would be substantially removed and the excavated material redistributed to the rear of the site to create the conditions for the development of saltmarsh and mudflats habitat. The existing perpendicular sections of the existing flood embankment would remain in situ to protect the existing saltmarsh and to encourage additional saltmarsh colonisation and prevent the migration of the River Arun.

### **Aquatic and riparian ecology**

The proposed scheme will include work within the Arun estuary. There are no ecologically designated sites in the footprint of the scheme. Climping Beach Site of Special Scientific Interest (SSSI) is located on the coastal frontage to the west of the River Arun, 60m from the scheme at its closest point. This is noted for its vegetated shingle beach and sand dune system.

The east bank of the river comprises predominantly urban habitats with residential housing, light industrial premises and footpaths or roads that extend to vertical pilings that form the water's edge. At low tide, there is a strip of inter-tidal mud along both sides of the River, with a foreshore of shingle, mud and sand at the river mouth. Upstream, to the north of the A259 Road Bridge, there is an area of grassland, which opens up to form coastal grazing marsh and drainage ditches behind the embankment. Saltmarsh is present in narrow strips along the berms of the River in the northern part of the project area, typically no more than 3m wide.

There will be an overall maximum loss of 0.2ha of mudflat due to encroachment into the River for installation of the new steel sheet piling in the southern section of the scheme. However, there will be a potential creation of 0.3ha mudflat in the northern section within

Reach 6B resulting from the managed realignment proposals. This will result in a net gain of 0.1ha of mudflat.

No loss of saltmarsh is envisaged and disturbance to existing saltmarsh will be minimised, and approximately 0.75ha of new saltmarsh will be created due to the managed realignment proposals in the northern section, within Reach 6B.

The water body contains spawning grounds for cod, plaice, sand eel, lemon sole and sprat and nursery grounds for sole, lemon sole, plaice, thornback ray.

Potential construction impacts include disturbance to overwintering birds and migrating fish by steel sheet piling operations, and damage to intertidal habitat through plant movement. Piling works would principally be programmed during the winter months where there are no restrictions due to fish. It is envisaged that any adverse impacts can be avoided or managed through the use of appropriate construction practices such that there will be no permanent effects on ecology.

### **Water bodies potentially affected**

The project is on or adjacent to water bodies located within the South East River Basin Management Plan. The relevant water bodies are:

- 1) Arun Transitional (GB540704105000) – from Pulborough downstream to mouth of River Arun in Littlehampton, approximately 17.5 km to south, within footprint of scheme
- 2) Ryebank Rife (GB107041006620) - 160 m south of west bank of River Arun, adjacent to scheme
- 3) Sussex Coastal (GB640704540003) – coastline either side of the mouth of the River Arun , directly downstream of scheme
- 4) Littlehampton Anticline West (GB40701G504900) – groundwater to west of River Arun
- 5) Littlehampton Anticline East (GB40701G50340) – groundwater to east of River Arun

### **Arun Transitional:**

The Arun Transitional water body has been designated as heavily modified. The classification also noted the presence of raised man-made defences (concrete wall, steel piling wall, rock and earth embankments with vegetated crest) along the east bank of the channel, with sections of natural riverbank next to hard defences on the west bank. Its objective is to achieve GEP by 2027.

The biological elements (status) are Fish (Moderate). The supporting elements are Dissolved Inorganic Nitrogen (Moderate) and Dissolved Oxygen (High) and supporting conditions are Tidal Regime: freshwater flow (supports good).

The 'moderate' classification for fish has low confidence as historic data is poor. The Environment Agency is aiming over the next few years to improve confidence levels through multi-method surveying in order to better identify areas of concern that could lead to a programme of measures.

There are six mitigation measures listed for the Arun Transitional water body in Appendix B of the SE RBMP and one action for FCRM schemes in Appendix C (shown in Table A). The SE RBMP indicates that none of the mitigation measures for this water body are currently in place.

**Table A Mitigation Measures for the River Arun**

Mitigation Measure / Action	Status
<b>Annex B</b>	
Indirect / offsite mitigation (offsetting measures) Retain marginal aquatic and riparian habitats (channel alteration) Preserve and where possible enhance ecological value of marginal aquatic habitat, banks and riparian zone Structures or other mechanisms in place and managed to enable fish to access waters upstream and downstream of impounding works Removal of hard bank reinforcement / revetment or replacement with soft engineering solution	Not in place (All)
<b>Annex C</b>	
SE0125 (Bank rehabilitation / reprofiling)	N/A

**Ryebank Rife:**

Ryebank Rife river water body has not been designated as heavily modified and its objective is to achieve GES by 2027. Its ecological status is currently assessed as moderate with supporting conditions (quantity and dynamics of flow and morphology) supporting good. The RBMP states that the status and status objectives have been based on expert judgement.

**Sussex Coastal:**

Sussex Coastal water body has been designated as heavily modified due to coastal protection and fisheries its objective is to achieve GEP by 2027.

The biological elements (status) are Invertebrates (Good). The supporting elements are Dissolved Inorganic Nitrogen (Moderate) and Dissolved Oxygen (High).

There are nine mitigation measures listed for the Sussex Coastal water body in Appendix B of the SE RBMP (shown in Table B). The SE RBMP indicates that none the mitigation measures for this water body are currently in place.

**Table B Mitigation Measures for the Sussex Coastal**

Mitigation Measure / Action	Status
<b>Annex B</b>	
Manage disturbance Site selection (dredged material disposal) Sediment management Operational and structural changes to locks, beach control, etc Preserve and where possible enhance ecological value of marginal aquatic habitat, banks and riparian zone Managed realignment of flood defence Bank rehabilitation / reprofiling Preserve and, where possible, restore historic aquatic habitats Removal of hard bank reinforcement / revetment, or replacement with soft engineering solution	Not In Place (All)



### **Littlehampton Anticline West:**

Littlehampton Anticline West is in current poor status with an objective to reach good status by 2027.

Quantitative elements are listed as impact on wetlands (good), impact on surface waters (poor), saline intrusion (good) and water balance (good). All chemical elements are currently good status.

### **Littlehampton Anticline East:**

Littlehampton Anticline East is in current poor status with an objective to reach good status by 2027.

Quantitative elements are currently impact on wetlands (good), impact on surface waters (poor), saline intrusion (good) and water balance (good). All chemical elements are currently good status.

### **Screening**

A statutory EIA is likely to be required under the Town And Country Planning (EIA) Regulations 1999 and the Environmental Impact Assessment (Land Drainage Improvement Works)(1999 as amended) Regulations. As the works are likely to include new modifications to the banks of water bodies, a WFD assessment is required.

### **Scoping of potential impacts**

The construction of raised embankments, steel sheet piled and concrete walls could potentially cause hydromorphological impacts which could affect the ecological characteristics of the Arun Transitional water body. The construction of the new defences also has potential to affect the chemistry of Arun transitional water body. However, the use of impermeable materials where appropriate and scheme design will prevent the formation of any new pathways for contaminants to the river to avoid any change to the chemistry of the water body. This aspect can therefore be scoped out of the assessment.

It is not clear at this stage whether the River Arun flows into Ryebank Rife but if this is the case, the supporting conditions of flow to the watercourse and bed morphology could potentially be affected by the scheme.

Sussex Coastal Water is situated immediately downstream of the scheme and the concentrations of supporting elements in this water body could potentially be affected by the disturbance of sediment in the river.

The proposed works are not expected to impact significantly or permanently upon groundwater quality or quantity. Various contaminants have been identified within the shallow sand and gravel deposits and there is the potential for these to be mobilised during construction (particularly where existing impermeable flood defence structures, such as sheet piling, are to be removed), resulting in pollution of the underlying Chalk aquifer or the adjacent River Arun. However, methods for preventing pollution during construction will be incorporated at the detailed design stage and therefore, with respect to the WFD Assessment, groundwater can be scoped out.

The nearest site under the protection of Community legislation is Pagham Harbour, located some 15km to the west. This is not expected to be affected. Therefore, the scheme is compliant with Article 4.9.

## **Impact Assessment**

The key factors that have potential to affect the quality of surface water bodies in the meaning of the WFD resulting from the proposed scheme are:

- Any permanent change in the alignment of the watercourse or the floodplain
- Any permanent change to the nature of the defences, particularly the form or nature of materials used, and any change to structures
- Any permanent or temporary change (damage) incurred during construction activities

Potential effects resulting from any change in the above include:

- Channel morphology (including changes to creeks and channels) resulting in changes in morphological diversity
- Changes in shading
- Changes to tidal prism and wave energy
- Changes to water levels, river capacity and floodplain capacity
- Changes to sediment balance
- Changes to flow (including localised flow)
- Changes to sedimentation/erosion
- Changes to water quality

Any change in these factors has, in turn, potential to affect river, riverbank or floodplain ecology, including BAP habitat such as saltmarsh and mudflat, and fish, and thereby has potential to affect the actual or target Ecological Status or Potential of the water body.

## **Arun Transitional**

### **Assessment against potential deterioration**

In the southern section of the scheme, the proposed works will involve replacement of existing defences with new defences, encroaching into the river, which will affect the riverbed immediately adjacent to the flood defences. The total loss of riverbed is estimated to be up to 0.2 ha. Whilst there will be some effect on the flow, this is likely to be small, as the new structures will be of a similar nature and material, and will be placed directly in front of existing hard-engineered defences and thus are not envisaged to alter the tidal regime, morphology, shading or water flow.

The creation of additional mudflat (0.3 ha, thereby resulting in a net gain of 0.1 ha over the scheme as a whole) and new saltmarsh (0.75 ha) in Reach 6B, is likely to cause a localised effect morphology and flow, but the retention of the two sections of existing embankment perpendicular to flow is expected to reduce any adverse effect on flow characteristics or alignment of the main river flow, such that no significant adverse impact on local or overall river flow or river capacity is envisaged.

The encroachment will also result in some loss of fish habitat in the southern section. However, the establishment of new areas of saltmarsh, with creeks and channels for ecological objectives, is expected to result in the creation of invertebrate and fish habitat

(for use as a nursery and feeding area) with an overall positive biodiversity outcome. No adverse impact on ecology, ecological diversity or fish is envisaged.

Construction will take place within the tidal zone of the water body. This has potential to affect fish. However, piling works would principally be programmed during the winter months where there are no restrictions due to fish, and any further restrictions will be put in place to ensure no adverse impact on fish. Construction will take place outside the SSSI and protective measures will be put in place to ensure no adverse impact to the designated area.

Therefore no deterioration on the biological quality elements of the Arun Transitional water body and consequently no deterioration in the status of the water body is envisaged.

### Assessment against mitigation measures

A summary of potential effects of the scheme against mitigation measures for the Arun Transitional water body is provided in Table C.

Of the six mitigation measures listed for the water body in Appendix B of the SE RBMP, none are currently in place. The table shows that the scheme does contribute to the objectives of the RBMP where feasible by achieving contributions to four of the six mitigation measures in the northern section. Thus the scheme will contribute towards the water body from achieving Good Ecological Potential by 2027.

**Table C Mitigation Measures for the River Arun**

Mitigation Measure	Effect	Explanation
Indirect / offsite mitigation (offsetting measures)	Contributes	Whilst new structures within the watercourse encroach slightly on existing habitats, more than 1 ha of intertidal mudflat and saltmarsh will be created upstream through managed realignment resulting in a net gain in ecological value.  This is expected to be beneficial for invertebrates and fish.
Retain marginal aquatic and riparian habitats (channel alteration)	Detracts / Contributes	
Preserve and where possible enhance ecological value of marginal aquatic habitat, banks and riparian zone	Contributes	
Structures or other mechanisms in place and managed to enable fish to access waters upstream and downstream of the impounding works.	No effect	There are no impounding works within the project area.
Bank rehabilitation / reprofiling	Contributes	Creation of saltmarsh and mudflat will contribute to a more natural form river bank overall. Elsewhere, bank re-profiling is not technically feasible due to space restrictions in a heavily built-up area.
Removal of hard bank reinforcement / revetment, or replacement with soft engineering solution	Contributes	Approximately 400m of the current hard bank will be removed to use saltmarsh as a natural defence. Elsewhere, this is not technically feasible due to space restrictions in a heavily built-up area.

## **Sussex Coastal**

Any adverse effects on Sussex Coastal water body are unlikely to be permanent. Potential impacts through sediment disturbance or flow alteration during construction and operation of the scheme are likely to lead to a temporary reduction in water quality, but given the minimal impact on overall water quality and water flow envisaged within the River Arun and the ability for the water body to recover rapidly from any changes, it is considered that the scheme will not result in deterioration to this water body and therefore will be compliant with Article 4.8.

## **Ryebank Rife**

It is not clear at this stage whether the River Arun flows into Ryebank Rife but any adverse effects on Ryebank Rife, which is located 160m south of the River Arun, are unlikely to be permanent. Potential impacts through sediment disturbance during construction and operation of the scheme are unlikely to cause any impact within Ryebank Rife. It is therefore considered likely that the scheme will be compliant with Article 4.8.

## **Conclusion**

Since the scheme is not expected to cause deterioration in any of the quality indicators for the relevant water bodies, is not expected to prevent any water bodies reaching their objective, and contributes to required mitigation measures that are not yet in place where feasible, it is concluded that the scheme is compliant with the WFD and that an Article 4.7 exception test will not be required.

### **Reference**

Environment Agency South East River Basin Management Plan, South East River Basin District, December 2009, Annex B & C

# Appendix 8 – Preferred Options, Descriptions and Plans

## **Introduction**

This appendix provides a description of the preferred option for each reach for the mitigated scheme. Plans are presented at the end of the appendix. In 2012 Arun DC consulted on further enhancements at Arun Parade and Pier Road that will be delivered with additional funding from the council. The final design of these enhancements will be progressed alongside the detailed design of the main flood defence scheme.

### **Reach 1**

Improve Option 2 (Mitigated scheme): Raised new vertical flood defence to full height and raised wide promenade with steps down to Arun Parade.

The existing concrete post and plank wall and the steel sheet piled wall would remain in-situ. A new steel sheet piled wall would be constructed directly in front of the existing defence with a crest level to the full design height. To reduce the embedded depth of the piles, tie rods would be used underneath the promenade. The void between the existing and the new defence would be filled and the promenade would be reinstated at a raised level and the width would be maximised by incorporating a retaining wall adjacent to the road. Intermediate steps would be provided to link the raised promenade with Arun Parade. The parking would be restricted to one side of the road on Arun Parade to incorporate the steps to the increased height promenade. Due to the length of the reach and its open nature, there is scope for a range of landscaping forms to tie into the constraints towards the south and the preferred option in Reach 2 to the north.

### **Reach 2**

Improve Option 2 (Mitigated scheme): Raised new vertical flood defence to full height and a landscaped promenade down to Pier Road.

The existing concrete wall would remain in-situ. A new steel sheet piled wall would be constructed in front of the existing defence with a crest level to the full design height. The alignment of the wall would tie into the defence line at Reach 1 (proposed) and Reach 3 (existing). This alignment would require some encroachment into the river and some breaking out of the existing concrete structure to the north of the reach. The void between the existing and new defence would be filled. The promenade would be raised to full height with steps down to the existing level of Pier Road and a realigned junction for Arun Parade/Pier Road. This option is in line with the option presented as part of the Arun Waterfront Strategy and mitigates for the increased flood defence height. The pontoon accesses would be realigned and one new pontoon bridge and landing pontoon would be provided. This new pontoon access will be designed to current guidelines and would provide improved disabled accessibility to the water.

### **Reach 3A**

Improve Option 2 (Mitigated scheme): No capital works in Yr 0, followed by the raising of the existing flood defence using concrete.

The majority of the defences in Reach 3A were constructed in 2000 as part of the recent redevelopment of this area and were constructed to a height at least 300mm higher than the other reaches. Therefore, the existing defences have significant residual life, both structurally and in terms of flood defence height. However, this scheme is looking to bring a higher standard of defence to Littlehampton and current required design crest levels are higher than during the redevelopment. Therefore, raising of the existing defences by up to 300mm is required in 2030. The raising of the pile cap would be constructed by dowelling in a new reinforced concrete cap, but the use of structural steel plates or reinforced glass panels could be considered. A bespoke solution for the slipway would need to be identified. By about 2050 it is expected that a new steel sheet piled defence to full (100-yr) height would be required.

### **Reach 3B**

Improve Option 2 (Mitigated scheme): Raised new vertical flood defence to full height.

The existing concrete wall and the steel sheet piled wall would remain in-situ. A new steel sheet piled wall would be constructed in front of the existing defence with a crest level to the full design height. Private pontoons would be reinstated and new access ladders would be provided.

### **Reach 4A**

Improve Option 2 (Mitigated scheme): Raised new vertical flood defence to full height.

A sheet piled wall would be constructed riverward of the existing defences to the full design height. The void between the existing and new defences would be filled. The space that is created between the existing land/building line and the new defence could be used for maintenance access. This option would be explored at detailed design and could offer overall cost savings.

### **Reach 4B**

Improve Option 2 (Mitigated scheme): Raised new vertical defence to full height following an optimised alignment.

The existing masonry/concrete wall would remain in-situ. A new steel sheet piled wall would be constructed to the full flood defence height immediately riverward of the existing defences. Dependant on land negotiations, the option for realigning at Pharos Quay to create additional intertidal habitat is viable and will be explored at detailed design. The void between the existing and new defence would be filled to allow room for a widened footpath. Raised sections forming viewing areas would be interspersed with raised planters to manage the visual impact of raised defences. The downstream edge of the footbridge abutment would be raised with engineering brick or concrete to tie the increased height into the bridge.

### **Reach 5A**

Improve Option 2 (Mitigated scheme): Existing defences raised to full height

The existing concrete wall would remain in-situ. The downstream section of the defence comprises of the walls of the pub extension. This extension would be rebuilt around the flood defences, which would be raised with a combination of new sheet piling and a raised reinforced concrete upstand with glass flood wall units. The upstream section of this defence currently comprises quay with handrail adjacent to a patio. This flood defence would be raised to full height using glass flood wall attached to a rebuilt concrete capping beam. The short section of new defence that connects into the footbridge abutment would remain as existing.

### **Reach 5B:**

Improve Option 2 (Mitigated scheme): Delay construction of a new vertical flood defence by raising existing flood defence in front of existing.

The existing defences would be raised by dowelling an extra section of reinforced concrete cap. The quay behind the raised cap would remain as existing. In the medium term, in approximately year 2030 (to tie into end of Tarmac's lease from Littlehampton Harbour Board), a new sheet piled defence to full height would be constructed riverward of the existing defence.

### **Reach 6A**

Improve Option 2 (Mitigated scheme): Raise existing flood defences

The existing embankment would be raised to full flood defence height (to year-100 level to account for the long design life of embankments). Due to space constraints and seepage risks, the existing embankment would be raised using a recycled plastic sheet piled cut off

(steel to be used in Tarmac's yard). This vertical defence would be cantilevered to provide the increase in height required. A 4m crest width behind the sheet piled upstand would provide Environment Agency access to the defence. The riverward face of the new embankment would be protected from scour and locally generated wave erosion from new/repared scour protection (rip rap).

## **Reach 6B**

Improve Option 2 (Mitigated scheme): Raise existing embankment (downstream) and set back existing flood embankment to create saltmarsh/mudflat habitat (upstream) and protect A259 road embankment (Managed Realignment).

The existing embankment in the downstream reach would be raised to full design height (to include for 100-years of SLR). The two culverts under the A259 and the existing ditch network would remain in situ to provide an area of flood storage for the tributaries. The existing sluice under the embankment would be extended to accommodate the increased embankment plan area. A low level vehicular access track would be formalised using earth filled paver cells and the embankments would be protected from scour and waves using rip rap and scour matting.

The A259 road embankment would provide the flood defence for the upstream reach. Low level trees and shrubs would be removed. To protect the road embankment, the flood defence would be built out at the toe to full flood height and an impermeable geotextile layer would prevent seepage. To provide a 4m wide vehicular access, a mass of granular fill would be added. The embankment would be protected from scour and waves by anti-scour matting.

The existing flood embankment in the northern reach would be substantially removed and the excavated material redistributed to the rear of the site to a level that would maximise the potential area of saltmarsh habitat (and mudflats). The existing perpendicular sections of the existing flood embankment would remain in situ to protect the existing saltmarsh and to encourage additional saltmarsh colonisation and prevent the migration of the River Arun. This option would constitute a full habitat creation managed realignment scheme by introducing saltwater to the area on a daily basis.

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# Appendix 9 – Indicative Landscape Plans

# Appendix 10 – Consultation Record

## **Introduction**

This appendix provides a list of the key consultees during the scoping process and a record of the responses to consultation on the Scoping Consultation Document.

Key external consultees consulted as part of the scoping process and/or invited to the consultee workshop included:

- Arun District Council
- English Heritage
- Littlehampton Harbour Board
- Inland Waterway Association
- Natural England
- Marine Management Organisation
- Royal Society for the Protection of Birds
- Sussex Wildlife Trust
- West Sussex County Council

Internal Environment Agency functions consulted include:

- Archaeology
- Development Control (land drainage consent)
- Environmental Management (water quality and waste)
- Environmental Planning (water resources, water quality and waste)
- Fisheries, Recreation and Biodiversity
- Contaminated Land
- Landscape Appraisal
- Planning Liaison (planning issues and baseline data)
- Recreation
- Strategic Environmental Planning (WFD)

Further stakeholders consulted during the course of the project either by letter, newsletter or by invitation to a meeting, include:

- Coastguard
- Commercial and industrial premises and bodies (those directly and indirectly affected)
- Council for the Protection of Rural England
- Crown Estate/Duke of Norfolk
- Defra
- Highways Authority
- Littlehampton Harbour Board
- Network Rail
- Regional Flood Defence Committee
- Residents (those directly and indirectly affected)
- Landowners
- Royal National Lifeboats Institute
- Service providers
- Town and Parish Councils
- User groups (including Sustrans and cyclist network, fishermen, sailing clubs)

Consultee responses to the consultation on the Scoping Consultation Document are summarised below.

## Consultation Record

Title of Project	Littlehampton Arun Tidal Walls (East Bank)		
Brief Description	Consultation Record for responses to the Scoping Consultation Document		
NEAS Officer	Richard Woodward	Project Manager	Peter Borsberry
Contact Details	01903 832 384	Contact Details	01903 832 311

### Internal Consultation

Scoping Consultation Document Consultee	Date Sent	Date Due	Date Received	Nature of Response
Stephen Kemp Archaeology	22/9/10	15/10/10	27/9/10	<ul style="list-style-type: none"> <li>Noted the future requirement for a FEPA consent</li> <li>Noted the potential for barges on the foreshore</li> </ul>
Richard Copas Landscape	22/9/10	15/10/10	-	<ul style="list-style-type: none"> <li>Highlighted the need to use materials in keeping with the local area, using materials to match existing or adjacent structures.</li> </ul>
Phil Hailey Development Control	22/9/10	15/10/10	12/10/10	<ul style="list-style-type: none"> <li>EA Encroachment Policy to be included within Scoping Report</li> <li>A Flood Risk Assessment will required as part of planning application, based on PPS25 and associated Practice Guide</li> <li>Noted that the planning system is under review</li> <li>Noted that flood defence consent will be required under the Water Resources Act 1991 and Southern Region Drainage and Sea Defence Byelaws 1981</li> </ul>
Keely Mowatt Development Control	22/9/10	15/10/10	12/10/10	<ul style="list-style-type: none"> <li>Deferred to Phil Hailey to respond</li> </ul>
Sarah King/Andrew Barnes Env. Management	22/9/10	15/10/10	19/10/10	<ul style="list-style-type: none"> <li>Disposal of waste generated by scheme will need to be considered.</li> </ul>
Damon Block FRB	22/9/10	15/10/10	-	<ul style="list-style-type: none"> <li>No response</li> </ul>
Daniel Lee/Alison Thorpe FRB (recreation)	22/9/10	15/10/10	18/10/10	<ul style="list-style-type: none"> <li>Noted that constraints exist that will preclude full implementation of recreation opportunities</li> <li>Noted that the forthcoming EA ' Enjoying Water Strategic Priorities' document (not available to date) will set the tone for the approach to recreation for future projects</li> <li>Supportive of approach to mitigation presented</li> <li>Would support provision of a passenger ferry to the west bank should the opportunity arise, but would nt support any loss of car parking</li> </ul>
Andrew Strudwick Flood Defence	22/9/10	15/10/10		<ul style="list-style-type: none"> <li>No response</li> </ul>

Operations				
Simon Deacon Contaminated Land	22/9/10	15/10/10	24/10/10	<ul style="list-style-type: none"> <li>No comment at present, but noted that further comment with respect to risk posed to surface water from contaminated land will be provided at the detailed design stage</li> <li>Noted that the main areas of concern are Reaches 5B and 6 where there is potential for encounter with contaminated land, although this can be addressed at the detailed design stage, within the Environmental Statement and Environmental Action Plan</li> </ul>
Catherine Macloed Planning Liaison	22/9/10	15/10/10		<ul style="list-style-type: none"> <li>Do not need to respond - require summary responses</li> </ul>
Dawn Theaker Env. Planning	22/9/10	15/10/10		<ul style="list-style-type: none"> <li>Deferred to Environmental Management to respond to avoid duplication of effort</li> </ul>
Jo Simmons Water Fr. Directive	27/9/10	15/10/10	13/10/10	<ul style="list-style-type: none"> <li>Noted that the EA is not responsible for achieving GEP objectives</li> <li>Noted that the assessment should address whether the scheme will contribute towards achieving GEP – further explanation of how this will be achieved will be required</li> <li>Post-monitoring may be required</li> <li>Agrees with the general conclusion that article 4.7 is not relevant and that the risk of deterioration of adjacent watercourses is adequately covered</li> </ul>

## External Consultation

Scoping Consultation Document Consultee	Date Sent	Date Due	Date Received	Nature of Response
<b>Statutory Consultees</b>				
Elaine Webster Natural England	23/10/10	22/10/10	4/11/10	<ul style="list-style-type: none"> <li>The detailed EIA will need to address potential direct and indirect effects on Climping Beach SSSI, including potential effects over the full 100 year design life in terms of effects on flooding</li> <li>Potential impacts on the landscape character and visual amenity will need to be considered and the design should seek to respect and enhance the local character and distinctiveness</li> <li>Support use of the Landscape Institute and Institute of Environmental Assessment and Management guidelines, 2002</li> <li>The EIA should detail measures to ensure a high standard of design</li> <li>Notes the list of key positive and negative impacts associated with the alternative scheme options and notes that the enhanced and visionary scheme also have potential to incorporate significant areas of natural planting that would contribute amenity and wildlife benefits</li> <li>Notes that NE supports proposals that encourage enjoyment of the countryside and notes that there are opportunities afforded by the scheme that can be further explored</li> <li>Potential impacts on the SNCI on the west bank will need to be addressed within the detailed EIA</li> <li>Noted that surveys of bats and reptiles have been undertaken and suggested consulting NE standard advice with respect to these species (NE website)</li> </ul>

				<a href="http://www.naturalengland.org.uk/regions/south_east/ourwork/standingadvice/protectedspecies/standingadviceconsultation/mitigation.aspx">http://www.naturalengland.org.uk/regions/south_east/ourwork/standingadvice/protectedspecies/standingadviceconsultation/mitigation.aspx</a> and <a href="http://www.naturalengland.org.uk/Images/Bats-draft_tcm6-21103.pdf">http://www.naturalengland.org.uk/Images/Bats-draft_tcm6-21103.pdf</a> ) <ul style="list-style-type: none"> <li>Supports proposals for managed realignment in Reach 6 and notes that habitat survey has been undertaken. The detailed EIA will need to report the results of any ornithological, botanical and invertebrate surveys</li> <li>The EIA will need to address any in combination effects resulting from the proposed scheme with any other projects that have been, will have been or are being carried out (subject to information and other limitations)</li> </ul>
Emma Kelman Natural England	23/10/10	22/10/10	-	<ul style="list-style-type: none"> <li>No response (NE response provided by Elaine Webster)</li> </ul>
Consent Team Marine Management Organisation	12/10/10	See response	21/10/10 27/10/10 and 11/1/11	<ul style="list-style-type: none"> <li>Initial response relating to the need for formal EIA indicated that the MMO would initially need to screen the works under the Marine Works (EIA) Regulation (MW Regs) during the consultation process. If the works are screened in, the MMO would require input to the scope of the EIA process, but if all issues raised are incorporated within the EIA produced under the Town and Country Planning or other EIA Regs, there should be no need for a separate EIA under the MW Regs.</li> <li>Consultation response requested from MMO consultees by 30 November 2010.</li> <li>Formal Screening Opinion provided on 1/1/11: Confirmed that impacts on vessels, vessel owners and pontoons, impacts due to wave prorogation and opportunities to improve access to the river for wheelchair users require further consideration as the scheme progresses. Confirmed that the scheme does not have potential to have significant effects on the environment and the MMO have screened the project out of the MW Regs. Raised to need to consider the requirement for an Appropriate Assessment.</li> </ul>
Roger Spencer Arun DC	22/9/10	22/10/10	14/12-10	<ul style="list-style-type: none"> <li>Confirmed that the Scoping Consultation Document provided a comprehensive account.</li> <li>Noted that there should be reference to long-distance views across the river and effects on views, and there may be impacts on views from the road in Reach 6B due to vegetation clearance.</li> <li>Supported creation of additional mudflat and saltmarsh in Reach 6B and enquired about public accessibility.</li> <li>Noted that the bat survey was undertaken during the dormant season and that further survey will be required.</li> </ul>
Eve Hearsey Arun DC – Planning	22/9/10	22/10/10	-	<ul style="list-style-type: none"> <li>No response - expected via corporate response (via Roger Spencer)</li> </ul>
Joe Russell-Wells Arun DC – Greenspace	22/9/10	22/10/10	-	<ul style="list-style-type: none"> <li>To respond via corporate response (via Roger Spencer)</li> </ul>
Clare Potter Arun DC - Regeneration	22/9/10	22/10/10	-	<ul style="list-style-type: none"> <li>No response</li> </ul>
Matthew Kennett Arun DC – Pollution/ Environmental Health	27/9/10	22/10/10	14/10/10	<ul style="list-style-type: none"> <li>Noted that the main concern is to prevent any potentially contaminated material being exposed to the public, but also it is unlikely that significant contamination or a pathway to the public will be created</li> <li>The river will be protected from contamination by the Water Framework Directive</li> <li>Noted that the Halcrow Phase 2 Interpretative Geotechnical Report had not been provided</li> </ul>
Helen Chalk WSCC – PRoW Officer	27/9/10	22/10/10	2/11/10	<ul style="list-style-type: none"> <li>Scheme welcomed overall, but design must be sympathetic to retain local character and feeling of informality in contrast to local built-up environments</li> <li>Recognition and provision of future public access in accordance with Marine Bill may be of relevance</li> <li>Any alteration of existing PROW to be approved by PROW team</li> <li>Any alteration of existing PROW to give consideration to disabled users. Toilet needs to be accommodated.</li> </ul>

				<ul style="list-style-type: none"> <li>• Scheme offers opportunity to enhance local access, especially in Reach 6, where shared cycleway/footpath could formalise informal access</li> <li>• All works to PROW should use materials and practices sympathetic to local environment</li> <li>• Expressed concern for any increase in erosion on west bank (and associated footpath) opposite Reach 5 caused by scheme proposals, exacerbating any erosion caused by wash created as boats manoeuvre near the east bank to drop off cargo</li> </ul>
Anne Carnegie Littlehampton Harbour Board	27/9/10	22/10/10	24/10/10	<ul style="list-style-type: none"> <li>• Requested reference be made to the slipway at Fisherman's Quay as the only public slipway on the East bank and mention of the regeneration opportunity at Railway Warf</li> <li>• Noted that there should be mention of temporary impact on vessel owners during construction and there may be opportunity to increase access to the water by wheelchair users</li> <li>• Noted that the Littlehampton Harbour Board has statutory duties in respect of the Littlehampton Harbour and Arun Drainage Outfall Act 1927</li> <li>• Noted that there may be an opportunity to incorporate HEP innovation involving small scale zero-head turbine powered by river flow</li> </ul>
Richard Massey English Heritage	27/9/10	22/10/10	-	<ul style="list-style-type: none"> <li>• No response</li> </ul>
John Mills/Mark Taylor WSCC – County Archaeologist	27/9/10	22/10/10	5/11/10	<ul style="list-style-type: none"> <li>• Noted that John Mills comments on the DBA had been taking into account in the finalised version presented within the Scoping Consultation Document</li> <li>• Noted that planning policy has since been updated. The finalised reports will need to reflect current policy</li> <li>• Noted that although the scheduled site may be described as heavily vegetated and derelict, there are agreements in place with the golf club, EH and the WSCC coastal ranger for volunteer parties to reduce ivy in anticipation of consolidation measures</li> </ul>
Graham Roberts WSCC – Ecology	27/9/10	22/10/10	-	<ul style="list-style-type: none"> <li>• No response</li> </ul>
Glen Westmore WSCC – Natural Resources	27/9/10	22/10/10	-	<ul style="list-style-type: none"> <li>• No response</li> </ul>
Laura Hoskins WSCC – Regeneration	27/9/10	22/10/10	21/10/10	<ul style="list-style-type: none"> <li>• Acknowledges uncertainties regarding the availability of funding to deliver the project, but wishes to be kept informed of any changes to the financial position and any impact this may have on project delivery, and future public engagement</li> </ul>
<b>Non-statutory consultees</b>				
Alison Giacomelli RSPB	23/10/10	22/10/10	22/10/2010	<ul style="list-style-type: none"> <li>• Confirmed support for the proposals at Littlehampton and no further comment.</li> </ul>
Fran Southgate Sussex Wildlife Trust	23/10/10	22/10/10	-	<ul style="list-style-type: none"> <li>• No response</li> </ul>
Brendan Whelan Inland Waterways Association	27/9/10	22/9/10	6/10/10	<ul style="list-style-type: none"> <li>• Noted that the public slipway should not be made more steep a result of the proposals</li> </ul>

# Appendix B - Alternative scheme options appraisal

This appendix contains a summary of the main alternative options considered during the outline and detailed design process.



# Consultation responses

This Appendix presents a summary of responses provided by key stakeholders during the scoping and detailed EIA stages of the scheme.

## 1 Consultation during preparation of the Scoping Report

Key external consultees consulted as part of the scoping process and/or invited to the consultee workshop included:

- Arun District Council (Arun DC)
- English Heritage
- Littlehampton Harbour Board
- Inland Waterway Association
- Natural England
- Marine Management Organisation (MMO)
- Royal Society for the Protection of Birds (RSPB)
- Sussex Wildlife Trust
- West Sussex County Council (WSCC)

Internal Environment Agency functions consulted include:

- Archaeology
- Development Control (land drainage consent)
- Environmental Management (water quality and waste)
- Environmental Planning (water resources, water quality and waste)
- Fisheries, Recreation and Biodiversity
- Contaminated Land
- Landscape Appraisal
- Planning Liaison (planning issues and baseline data)
- Recreation
- Strategic Environmental Planning (WFD)

Further stakeholders consulted during the course of the project either by letter, newsletter or by invitation to a meeting, include:

- Coastguard
- Commercial and industrial premises and bodies (those directly and indirectly affected)
- Crown Estate/Duke of Norfolk
- Defra
- Highways Authority
- Network Rail
- Regional Flood Defence Committee
- Residents (those directly and indirectly affected)
- Landowners
- Royal National Lifeboats Institute
- Service providers
- Town and Parish Councils
- User groups (including Sustrans and cyclist network, fishermen, sailing clubs)

The scoping report was also made available for public consultation in January 2013, in relation to our requirements under EIA (Land Drainage Improvement Works) Regulations which cover the work we will undertake as permitted development.

Consultee responses to the consultation on the Scoping Consultation Document are summarised below.

## Consultation Record

Title of Project	Littlehampton Arun Tidal Walls (East Bank)		
Brief Description	Consultation Record for responses to the Scoping Consultation Document		
NEAS Officer	Richard Woodward	Project Manager	Peter Borsberry
Contact Details	01903 832 384	Contact Details	01903 832 311

### Internal Consultation

Scoping Consultation Document Consultee	Date	Nature of Response (key points)
Stephen Kemp Archaeology	27/9/10	<ul style="list-style-type: none"> <li>Noted the future requirement for a FEPA consent</li> <li>Noted the potential for barges on the foreshore</li> </ul>
Richard Copas Landscape	-	<ul style="list-style-type: none"> <li>Highlighted the need to use materials in keeping with the local area, using materials to match existing or adjacent structures.</li> </ul>
Phil Hailey Development Control	12/10/10	<ul style="list-style-type: none"> <li>EA Encroachment Policy to be included within Scoping Report</li> <li>A Flood Risk Assessment will required as part of planning application, based on PPS25 and associated Practice Guide</li> <li>Noted that the planning system is under review</li> <li>Noted that flood defence consent required under the Water Resources Act 1991 and Southern Region Drainage and Sea Defence Byelaws 1981</li> </ul>
Sarah King/Andrew Barnes Env. Management	19/10/10	<ul style="list-style-type: none"> <li>Disposal of waste generated by scheme will need to be considered.</li> </ul>
Daniel Lee/Alison Thorpe FRB (recreation)	18/10/10	<ul style="list-style-type: none"> <li>Noted that constraints exist that will preclude full implementation of recreation opportunities</li> <li>Noted that the forthcoming EA 'Enjoying Water Strategic Priorities' document (not available to date) will set the tone for the approach to recreation for future projects</li> <li>Supportive of approach to mitigation presented</li> <li>Would support provision of a passenger ferry to the west bank should the opportunity arise, but would nt support any loss of car parking</li> </ul>
Simon Deacon Contaminated Land	24/10/10	<ul style="list-style-type: none"> <li>No comment at present, but noted that further comment with respect to risk posed to surface water from contaminated land will be provided at the detailed design stage</li> <li>Noted that the main areas of concern are Reaches 5B and 6 where there is potential for encounter with contaminated land, although this can be addressed at the detailed design stage, within the Environmental Statement and Environmental Action Plan</li> </ul>
Jo Simmons Water Fr. Directive	13/10/10	<ul style="list-style-type: none"> <li>Noted that the EA is not responsible for achieving GEP objectives</li> <li>Noted that the assessment should address whether the scheme will contribute towards achieving GEP – further explanation of how this will be achieved will be required</li> <li>Post-monitoring may be required</li> <li>Agreed with the general conclusion that article 4.7 is not relevant and that the risk of deterioration of adjacent watercourses is adequately covered</li> </ul>

**Environment Agency** Littlehampton Arun East Bank Tidal Walls

## External Consultation

Scoping Consultation Document Consultee	Date Received	Nature of Response (key points)
<b>Statutory consultees</b>		
Elaine Webster Natural England	4/11/10	<ul style="list-style-type: none"> <li>The detailed EIA will need to address potential direct and indirect effects on Climping Beach SSSI, including potential effects over the full 100 year design life in terms of effects on flooding</li> <li>Potential impacts on the landscape character and visual amenity will need to be considered and the design should seek to respect and enhances the local character and distinctiveness</li> <li>Support use of the Landscape Institute and Institute of Environmental Assessment and Management guidelines, 2002</li> <li>The EIA should detail measures to ensure a high standard of design</li> <li>Notes the list of key positive and negative impacts associated with the alternative scheme options and notes that the enhanced and visionary scheme also have potential to incorporate significant areas of natural planting that would contribute amenity and wildlife benefits</li> <li>Notes that NE supports proposals that encourage enjoyment of the countryside and notes that there are opportunities afforded by the scheme that can be further explored</li> <li>Potential impacts on the SNCI on the west bank will need to be addressed within the detailed EIA</li> <li>Noted that surveys of bats and reptiles have been undertaken and suggested consulting NE standard advice with respect to these species ( Supports proposals for managed realignment in Reach 6 and notes that habitat survey has been undertaken. The detailed EIA will need to report the results of any ornithological, botanical and invertebrate surveys</li> <li>The EIA will need to address any in combination effects resulting from the proposed scheme with any other projects that have been, will have been or are being carried out (subject to information and other limitations)</li> </ul>
Consent Team MMO	21/10/10 27/10/10 and 11/1/11	<ul style="list-style-type: none"> <li>Formal Screening Opinion provided on 1/1/11: Confirmed that impacts on vessels, vessel owners and pontoons, impacts due to wave prorogation and opportunities to improve access to the river for wheelchair users require further consideration as the scheme progresses. Confirmed that the scheme does not have potential to have significant effects on the environment and the MMO have screened the project out of the MW Regs. Raised to need to consider the requirement for an Appropriate Assessment.</li> </ul>
Roger Spencer Arun DC	14/12-10	<ul style="list-style-type: none"> <li>Confirmed that the Scoping Consultation Document provided a comprehensive account.</li> <li>Noted that there should be reference to long-distance views across the river and effects on views, and there may be impacts on views from the road in Reach 6B due to vegetation clearance.</li> <li>Supported creation of additional mudflat and saltmarsh in Reach 6B and enquired about public accessibility.</li> <li>Noted that the bat survey was undertaken during the dormant season and that further survey will be required.</li> </ul>
Eve Hearsey - Planning Arun DC	-	<ul style="list-style-type: none"> <li>Corporate response (via Roger Spencer)</li> </ul>
Joe Russell-Wells - Greenspace Arun DC	-	<ul style="list-style-type: none"> <li>Corporate response (via Roger Spencer)</li> </ul>

Matthew Kennett - Pollution/ Environmental Health Arun DC	14/10/10	<ul style="list-style-type: none"> <li>Noted that the main concern is to prevent any potentially contaminated material being exposed to the public, but also it is unlikely that significant contamination or a pathway to the public will be created</li> <li>The river will be protected from contamination by the Water Framework Directive</li> <li>Noted that the Halcrow Phase 2 Interpretative Geotechnical Report had not been provided</li> </ul>
Helen Chalk – PRoW Officer WSCC	2/11/10	<ul style="list-style-type: none"> <li>Scheme welcomed overall, but design must be sympathetic to retain local character and feeling of informality in contrast to local built-up environments</li> <li>Recognition and provision of future public access in accordance with Marine Bill may be of relevance</li> <li>Any alteration of existing PROW to be approved by PROW team</li> <li>Any alteration of existing PROW to give consideration to disabled users. Toilet needs to be accommodated.</li> <li>Scheme offers opportunity to enhance local access, especially in Reach 6, where shared cycleway/footpath could formalise informal access</li> <li>All works to PROW should use materials and practices sympathetic to local environment</li> <li>Expressed concern for any increase in erosion on west bank (and associated footpath) opposite Reach 5 caused by scheme proposals, exacerbating any erosion caused by wash created as boats manoeuvre near the east bank to drop off cargo</li> </ul>
Anne Carnegie Littlehampton Harbour Board	24/10/10	<ul style="list-style-type: none"> <li>Requested reference be made to the slipway at Fisherman's Quay as the only public slipway on the East bank and mention of the regeneration opportunity at Railway Warf</li> <li>Noted that there should be mention of temporary impact on vessel owners during construction and there may be opportunity to increase access to the water by wheelchair users</li> <li>Noted that the Littlehampton Harbour Board has statutory duties in respect of the Littlehampton Harbour and Arun Drainage Outfall Act 1927</li> <li>Noted that there may be an opportunity to incorporate HEP innovation involving small scale zero-head turbine powered by river flow</li> </ul>
John Mills/Mark Taylor– County Archaeologist WSCC	5/11/10	<ul style="list-style-type: none"> <li>Noted that John Mills comments on the DBA had been taking into account in the finalised version presented within the Scoping Consultation Document</li> <li>Noted that planning policy has since been updated. The finalised reports will need to reflect current policy</li> <li>Noted that although the scheduled site may be described as heavily vegetated and derelict, there are agreements in place with the golf club, EH and the WSCC coastal ranger for volunteer parties to reduce ivy in anticipation of consolidation measures</li> </ul>
Laura Hoskins– Regeneration WSCC	21/10/10	<ul style="list-style-type: none"> <li>Acknowledges uncertainties regarding the availability of funding to deliver the project, but wishes to be kept informed of any changes to the financial position and any impact this may have on project delivery, and future public engagement</li> </ul>
<b>Non-statutory consultees</b>		
Alison Giacomelli RSPB	22/10/2010	<ul style="list-style-type: none"> <li>Confirmed support for the proposals at Littlehampton and no further comment.</li> </ul>
Brendan Whelan Inland Waterways Association	6/10/10	<ul style="list-style-type: none"> <li>Noted that the public slipway should not be made more steep a result of the proposals</li> </ul>

## 2 Consultation during preparation of the EIA

Key external consultees consulted as part of the detailed design process included:

- Arun District Council (Arun DC)
- Littlehampton Harbour Board
- Natural England
- Marine Management Organisation (MMO)
- Royal Society for the Protection of Birds (RSPB)
- West Sussex County Council (WSCC)

Arun DC has been actively engaged with the detailed design of the project and has had representatives on the Project Team and Project Board.

Internal Environment Agency functions consulted include:

- Archaeology
- Flood Risk and Development Control
- Environmental Management (for water quality and waste)
- Environmental Planning (for water resources, water quality and waste)
- Fisheries and Biodiversity (including geomorphology)
- Groundwater and Contaminated Land
- Landscape Appraisal
- Planning Liaison (for planning issues)
- Recreation
- Marine (for WFD)

Further stakeholders consulted during the course of the project either by letter, newsletter or by invitation to a meeting, include:

- Commercial and industrial premises and bodies (those directly and indirectly affected)
- Crown Estate/Duke of Norfolk
- Highways Authority
- Network Rail
- Residents (those directly and indirectly affected)
- Landowners
- Service providers (eg Southern Water, BT)
- User groups

The input of stakeholders and consultees into preparation of the EIA are summarised below. The table does not include comments by private individuals and businesses which have also fed into the design of the scheme.

## Consultation Record

Title of Project	Littlehampton Arun Tidal Walls (East Bank)		
Brief Description	Consultation Record for responses to the draft Environmental Statement, prior to submission and also key feedback from meetings during detailed design.		
NEAS Officer	Richard Woodward	Project Manager	Peter Borsberry
Contact Details	01903 832 384	Contact Details	01903 832 311

### Internal Consultation

Consultee	Date	Nature of Response (key points)
Catherine Grindley Archaeology	02/05/13	<ul style="list-style-type: none"> <li>Watching brief in reaches 1, 2 and 6 should be targeted</li> <li>The design of replacement railings (or reuse of existing) in reach 4 is important</li> </ul>
Richard Copas Landscape		<ul style="list-style-type: none"> <li>Landscape plans for Reaches 1, 2 and 6 are comprehensive and well-developed. The text on the design intent is particularly useful</li> <li>The landscape plans for reaches 3, 4, and 5 would benefit from more detail.</li> <li>The ES should highlight the improvements to public realm that will be delivered by the enhancements in reaches 1 and 2.</li> </ul>
Keely Mowatt Development Control	08/05/13	<ul style="list-style-type: none"> <li>Refurbishment of existing tidal flaps may reduce flood risk for lower magnitude events</li> <li>Temporary flood defence works will require Flood Defence Consent</li> <li>The WFD assessment will need to be submitted with the Flood Defence Consent</li> </ul>
Mark Bennett Fisheries and Biodiversity	02/05/13	<ul style="list-style-type: none"> <li>Provided information on presence of migratory fish in the River Arun and advised on mitigation for avoiding impacts</li> <li>Highlighted the possibility of mitigating for any impact to the ditch in Reach 6</li> </ul>
Ros Bryant Groundwater and Contaminated Land	03/05/13	<ul style="list-style-type: none"> <li>There is a risk that piling into chalk may create a pathway for contaminants to the underlying aquifer. The risk is low but the risk assessment should be updated to show this.</li> <li>Details in the ES are satisfactory. Overall satisfied with the proposal to limit potential risk during construction by using standard good practice and hard standing to prevent infiltration. Support adherence to EA guidance and the implementation of a Piling Risk Assessment.</li> </ul>
Rebecca Westlake Geomorphology (WFD)	19/04/13	<ul style="list-style-type: none"> <li>The project appears to be naturalising the river as much as is possible considering the constraints.</li> <li>The habitat lost is likely to be low quality and this impact is mitigated by the habitat created in Reach 6</li> </ul>
Sigrun Schroeder Marine (WFD)	19/04/13	<ul style="list-style-type: none"> <li>Supported 'greening' of replacement scour protection</li> <li>Highlighted importance of ensuring no impact to Bathing Water Quality</li> </ul>

## External Consultation

Consultee	Date Received	Nature of Response (key points)
<b>Statutory consultees</b>		
Rachel Alderson - Principal Landscape Officer Arun DC	02/05/13	<ul style="list-style-type: none"> <li>The ES should better describe the improvements to public realm that will be delivered by the enhancements in reaches 1 and 2.</li> <li>Heritage boards removed during the works to Reaches 1 and 2 will not be replaced. Arun District Council will look into providing this information in a way that better compliments the design of the public realm enhancements, should funding become available</li> <li>Need to ensure that access for emergency services is maintained throughout construction</li> </ul>
Matthew Kennett - Environmental Health Arun DC		<ul style="list-style-type: none"> <li>The mitigation measures for the construction phase appear adequate for the sources of contamination discovered</li> </ul>
Planning and Conservation Officer – Arun DC	16/04/13	<ul style="list-style-type: none"> <li>Highlighted the importance of protecting heritage assets such as the locally listed buildings</li> <li>Likely need for Conservation Area Consent with regards to works in Reach 4 (Pharos Quay) and Reach 5 (Arun View Pub)</li> <li>If reuse of railing in Reach 4 is not possible, replacements should be sympathetic to the character of the Conservation Area.</li> </ul>
Angela Marlow Natural England	20/05/13	<ul style="list-style-type: none"> <li>Informal consultation. No concerns raised since no impacts on the SSSI are envisaged.</li> </ul>
Mark Taylor- Senior archaeologist WSCC	16/05/13	<ul style="list-style-type: none"> <li>Informal consultation.</li> <li>Provided additional information on sites/sensitivities in the study area (eg. old lime kiln and remnant wharf in Reach 6)</li> <li>Initial agreement on archaeological mitigation strategy proposed in the ES</li> </ul>
Graham Roberts – Principal ecologist WSCC	23/05/13	<ul style="list-style-type: none"> <li>Informal consultation. No initial concerns.</li> <li>Highlighted general support for any habitat enhancement opportunities.</li> </ul>
<b>Non-statutory consultees</b>		
Dave Burges RSPB	09/08/12	<ul style="list-style-type: none"> <li>Advised on any mitigation required to avoid or minimize impact to birds</li> </ul>



# Appendix C – Summary of consultation responses

This appendix contains a summary of responses provided by key stakeholders over the course of the project. The responses have been separated into those provided during preparation of the Scoping Report, and those provided during preparation of the Environmental Statement.

Comments have been made on how issues raised by consultees have been addressed either through the assessment process or in scheme design.

# Alternative scheme options appraisal

This Appendix presents a more detailed account of the alternative scheme options appraisal process that was undertaken during the scoping stage.

A copy of the reaches, with the sub-divisions considered during the options appraisal stage is presented at the end of this appendix.

## 1 Scheme options appraisal process

The study area for the current scheme was divided into six reaches with further sub-reaches according to the nature of the existing defences, current ownership and flood defence responsibilities, and the anticipated scope of the proposals.

A range of alternative options was identified to deliver the preferred (Improve) strategic option.

In general, a sequential approach to option appraisal was adopted. A long list of generic options was subject to a high level technical, environmental and economic appraisal on a reach by reach basis. The long list was filtered down to produce a shorter list of viable options, which were then refined and subject to more detailed appraisal. The main generic options that were assessed for each reach comprised:

- Defer works until required
- Repair and raise the existing defences
- New rock revetment
- New embankment
- New sheet piled defence, landward or riverward

Only options that would provide an acceptable long term technical solution, a clear positive economic case competitive with other options, and those that would meet the environmental objectives of the scheme were considered viable and taken forward for more detailed appraisal.

We assessed the options against environmental objectives which were defined during preparation of the Scoping Consultation Document. The objectives were to:

- Minimise the impacts on land use and the socio-economy, especially tourism
- Minimise encroachment onto existing mudflats and saltmarsh, and provide compensatory habitat where loss is unavoidable
- Seek opportunities to extend and enhance quality of BAP habitat and protected species
- Maintain and, where possible, improve access to riverside and water
- Maintain privacy of private households along riverside where possible
- Maintain and, where possible, enhance visual appearance of riverside and promenade. Design all new structures with due regard for the townscape character in accordance with the Littlehampton Waterfront Strategy prepared by Arun District Council

- Maintain or improve the setting of scheduled monuments and listed buildings and avoid, where possible, or minimize the impact on buried archaeology
- Avoid deterioration in water quality resulting from construction and operation of the scheme
- Seek to make use of existing materials (residual life of existing structures) and minimize use of new materials where possible

## 2 Option Appraisal

The key stages in the appraisal process were as follows:

**Deferring the works until a later date** was considered, as an over-arching principle, to be the default option where the condition of the existing works was adequate and where a raise is not yet required to meet a 1 in 300 year standard of defence. In the absence of an obvious need for environmental mitigation or enhancement, no alternative options were proposed where this option was considered viable. This was considered viable and appropriate for the **southern part of Reach 3** until Year 20, when intervention will be required to achieve the required standard of protection. No alternative option was proposed for this reach until Year 20. It was also considered as an option for the northern part of Reach 5 but, due to the nature and cost of intervention that would be required in Year 20, it was not progressed as a viable option.

**Raising the existing defences** was considered the next preferred option in terms of cost and environmental impact where the condition of the existing defences was adequate and where this was considered technically feasible, except where there was a need for environmental mitigation or enhancement. This was considered viable and appropriate for **Reach 3**, including that part to the south where works can be deferred until Year 20. It was considered viable in **Reach 4** and the **northern part of Reach 5**, where there will be a need for either further intervention to replace the defences in Year 20 or some repair and reinforcement to a building that forms part of the defence. In the northern part of Reach 3 and in Reach 4, the need for further intervention in Year 20 would have resulted in a high economic cost and similar levels of environmental impact in the long term to those associated with intervention in Year 0 without the benefits of environmental improvements in the short term, such that this option was rejected for these reaches. In the **southern part of Reach 5**, however, with some repair and reinforcement to a building that forms part of the defence, no further work will be required over the design life of the scheme, such that this option was considered viable. This option was also considered viable for part of the **northern part of Reach 5**, and for **Reach 6**.

**Construction of a new rock revetment** was not considered viable at any location due to space restrictions within the river and the adverse impact this would have on water flow and flooding.

**Construction of a new embankment** into the river was not considered a viable option along any reach due to unacceptable environmental and social impacts. Due to a lack of space on the landward side too, construction of a new embankment on the landward side was not considered viable in any reaches except the northern part of Reach 5 and Reach 6. In the northern part of Reach 5 sufficient space exists to allow construction of a new embankment in Year 20, but the landtake on land that would otherwise be suitable and has been allocated for redevelopment was considered unacceptable, and this option was therefore discounted for this part of Reach 5. Construction of a new, landward-realigned embankment was considered viable in the **northern part of Reach 6**, where this would allow compensation for saltmarsh and mudflat lost elsewhere to the scheme and the creation of additional such habitat.

**Construction of a new sheet piled defence**, either riverward or landward, was considered a viable option for **Reaches 1, 2, 3 (northern part), 4, 5**. However, due to the financial cost, technical difficulties and environmental impacts in terms of landtake from open space within the town, residential property or development land, construction landward of the existing defences was

discounted. Construction on the riverward side, however, was considered viable for these reaches. With the provision of suitable compensation for losses of saltmarsh and mudflat habitat in Reach 6 Realignment, riverward construction of a sheet piled wall, minimising landtake within the river was considered viable in these reaches. Construction of a new sheet piled defence was not considered appropriate for the rural setting of Reach 6.

The resulting short list of viable generic options for each reach was:

- Reach 1                                      New sheet piled defence, riverward
- Reach 2                                      New sheet piled defence, riverward
- Reach 3                                      Defer works until Year 20, with raise existing in Year 20 in southern part, with new sheet piled defence, riverward in north
- Reach 4                                      New sheet piled defence, riverward
- Reach 5                                      New sheet piled defence, riverward, with repair to existing building in southern part
- Reach 6                                      Repair and raise existing
- Reach 6 Realignment                      New embankment

For each viable option included on the short list above, a range of viable engineering options were generated, with only one or two viable engineering solutions for some reaches but more for others.

These options (with a range of illustrations to show how these may look in practice) were presented to the public and key stakeholders at the Look and Sea Centre in Littlehampton as part of a three-day consultation period in March 2010. Additional targeted stakeholder meetings provided further specific information and opinion feedback. A detailed appraisal of the short listed reach options was then undertaken by statutory internal and external consultees at an options appraisal workshop, also held in March 2010.

In addition to the viable engineering options, the Do Nothing and Maintain options were considered at this stage. The Do Nothing option comprised no further work along the frontage, including maintenance. Under this option, the defences would deteriorate over time and fail, resulting in flooding. The Maintain option represented the minimum expenditure required to maintain the defences in their current alignment and form. It would not include works to raise the defences in response to predicted sea level rise. Thus, the standard of defence afforded would fall over time.

Neither the Do Nothing nor the Maintain option was considered a viable option, but both were included for comparative purposes.

The short-listed options for each reach were subsequently subject to further appraisal and refinement following the feedback provided from consultation to determine the most economically viable reach options which meet environmental objectives and reflect the views of the public and statutory consultees.

### **Key issues affecting option selection/key alternative options considered**

Some of the key issues that affected the selection process are summarised below.

*Reaches 1 and 2:* The lack of space either riverward or landward, resulted in only one viable option – construction of a new sheet piled wall, immediately riverward of the existing wall. The aesthetic characteristics, views towards the river and amenity value of the promenade for residents, tourists and the local economy were considered key factors at this location, whilst the need to retain vehicle parking and access to leisure facilities was also recognised. Options were proposed to raise the footpath, the whole promenade and provide varying degrees of enhancement of the public realm,

including improvements to street furniture, finishes, landscaping and the wider open space behind the defences. Raising the whole promenade with improvements to handrails and complementary finishes to existing finishes was considered the preferred option to provide adequate mitigation for the loss of views and access to the water front and leisure facilities and change to the townscape from the raising of the defences. Further enhancements were considered desirable but could not be economically justified. However, since that time, further funds have become available to provide much more extensive enhancements than would otherwise have been possible for the Environment Agency to implement. The combination of the two projects allows significant efficiency savings that will produce benefits for the residents, visitors and business community of Littlehampton.

An option to construct a new ferry terminal in Reach 2 were considered, which would have provided further enhancements in terms of connectivity to the west bank and tourism, but the cost and reliance on additional external funding were considered significant disadvantages and the economic cost could not be justified.

An option to close the road immediately behind the defences (Pier Road) in Reach 2 to through traffic was also considered, which would have allowed enhancement to the pedestrian and amenity environment. However, the potentially adverse impact on traffic and businesses along the road, together with the cost were considered to preclude this option.

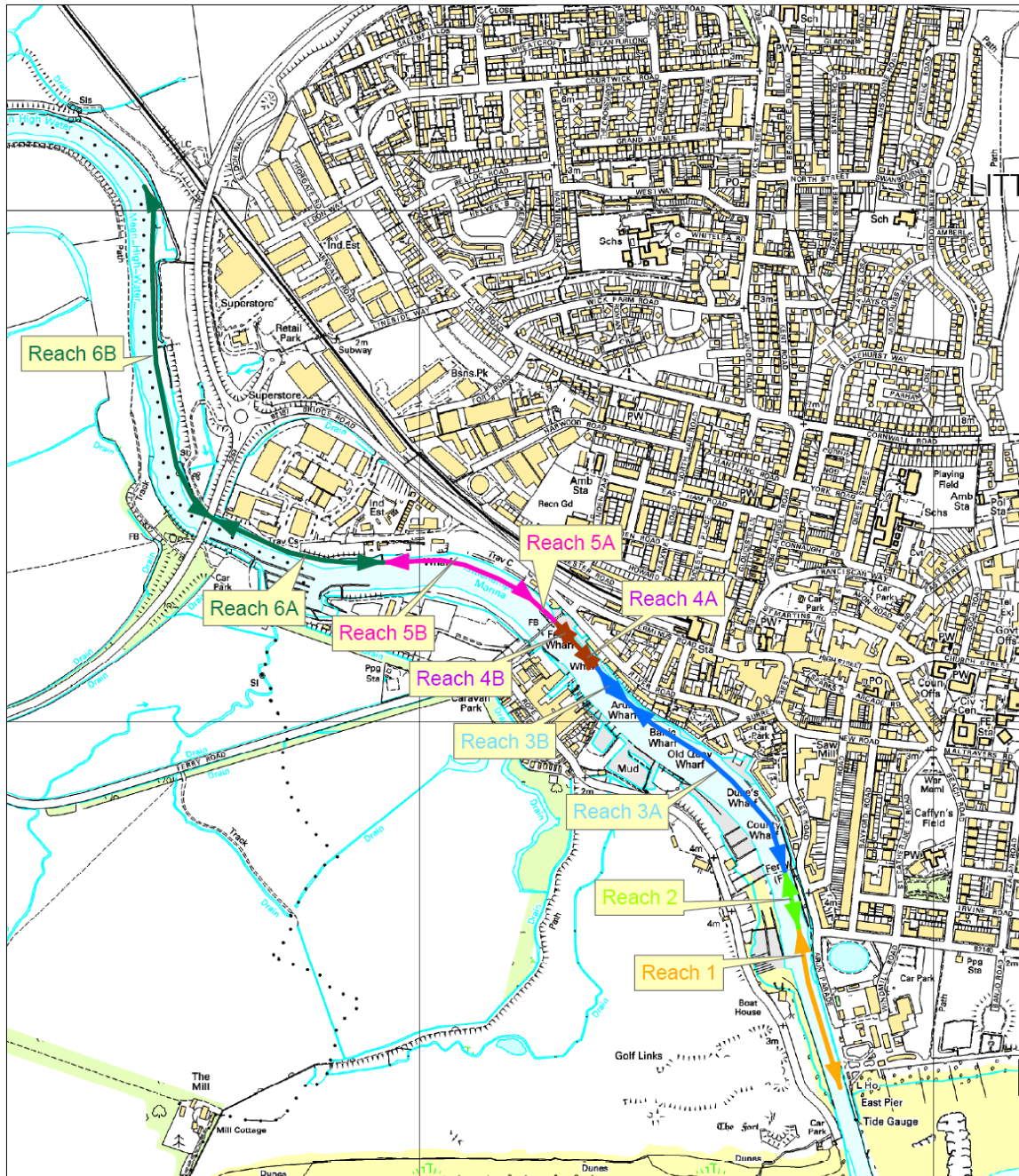
*Reach 3:* In the southern part of Reach 3 no alternative option was proposed and the deferment of works until Year 20, followed by raising the existing sheet piled wall was considered the best option, allowing retention of the award-winning features recently constructed, with no adverse environmental impacts, with a minimum of intervention and cost.

In the northern part of Reach 3, options were considered to introduce a riverside walk on land created by the new sheet steel piled wall. However, the resultant loss of privacy and berthing from residential properties and additional encroachment into the river was considered unacceptable.

*Reach 4:* In Reach 4, different alignments options were considered to construct the defences into the river in order to reclaim land for public amenity. However, the adverse impact on the inter-tidal habitat and possible impact on buried inter-tidal archaeology were considered to preclude these options. Options were also considered to incorporate glass within the defence wall to improve views across the river and construct additional pontoons along the defences. However, the additional cost associated with these options was not considered justified for the relatively small gain of public land/facilities.

*Reach 5:* Options to provide a riverside footpath were considered, but the encroachment into the river and inter-tidal habitat, and cost were considered to preclude these options.

*Reach 6:* Options for realignment in the southern part of Reach 6 were not considered feasible due to the space restrictions. Construction of an embankment was considered the most suitable option in the northern part of the reach due to the rural character and the use of the area for informal amenity. Landward realignment was proposed in order to allow compensation for the loss of inter-tidal habitat downstream to the scheme options and for future losses due to coastal squeeze. The proposed alignment was selected as that which provided a maximum habitat creation, whilst allowing continued informal pedestrian access along the river, adequate protection to the highways embankment and screening of traffic.



- Legend**
- Reach 1
  - Reach 2
  - Reach 3
  - Reach 4
  - Reach 5
  - Reach 6

Rev.	By	Date	Description

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**Halcrow**



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Project:  
Littlehampton Arun East Bank Tidal Walls

Drawing:  
Site Location Plan  
Figure 1

Drawn By: [Signature] Date: 11 February 2019

Checked By: [Signature] Date: 11 February 2019

Approved By: [Signature] Date: 11 February 2019

Drawing No.: [Signature] Revision:  
OCARUNSL\_Figure\_1 A

Drawing Scale: 1:2,000  
Plot Scale: 1:2,000 @ A3

# Appendix D - Acoustics

This appendix contains further details of the noise and vibration assessment. In particular, it contains an introduction to noise and how it is measured, a description of the methods used to undertake the assessment, baseline conditions and the results of the noise calculations. It also provides a glossary of the terms used.

# Noise & Vibration

This Appendix considers in more detail the noise impacts that will occur as a result of the proposed Littlehampton Arun East Bank Tidal Walls Flood Defences Scheme, West Sussex.

The aims of the assessment are:

- to establish the baseline noise conditions
- to identify the major potential impacts on residential properties
- to identify appropriate mitigation measures for the predicted impacts and to assess any residual effects

## Introduction to noise

### 1.1 Human perception

Noise is commonly defined as unwanted sound, and is therefore subjective. The human perception of noise is influenced by physical, physiological and psychological factors. Physical factors include the sound pressure level at the position of the listener, physiological factors include the acuity of hearing, and psychological factors include acclimatisation to steady noise and the activity that an individual is undertaking while the noise is present.

Sound consists of vibrations transmitted to the ear as rapid variations in air pressure which can be measured accurately. The more rapid the variations in air pressure the higher the frequency of the sound. Frequency is defined as the number of pressure fluctuations per second and is expressed in Hertz (Hz).

The ear can detect both loudness and frequency of sound. However, the sensitivity of the human ear varies with frequency, and therefore noise is commonly measured using the A-weighted filter network which mimics the frequency response characteristics of the human ear. The 'A' notation is used to indicate when noise levels have been filtered using the A-weighting network. Noise levels range from the threshold of hearing at 0dB(A) to levels of over 130dB(A) at which point the noise becomes painful. Noise levels over 80dB(A) are considered potentially damaging to hearing. The table below presents guide to the A-weighted sound pressure levels due to common objects and activities.

Source	Sound Pressure Level, dB(A)
Threshold of hearing – silent	0
Quiet bedroom	25-35
Quiet rural area	45-50
Suburban areas away from main traffic routes	50-60
Conversational speech at 1m distance	60-70
Busy urban street corner	70-80
Passenger car at 60Km/hr and 7m distance	72
Health & safety 'first action' level to prevent damage to hearing	80

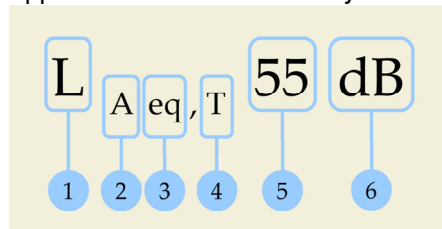


Source	Sound Pressure Level, dB(A)
Heavy diesel lorry at 40 Km/hr and 7 m distance	85
Pneumatic drill (un-silenced) at 7 m distance	95
Threshold of pain	130-140

Generally, a change of 3dB(A) in environmental noise is the minimum change perceptible to a human. A change of around 5dB is easily perceptible and most people perceive a 10dB change as halving or doubling the noise level.

## 1.2 Acoustic Descriptors

Outdoor noise levels fluctuate rapidly over time, and therefore to describe the acoustic environment it is necessary to collect statistical data on the distribution of noise levels during the period of interest. The nomenclature used to represent statistical acoustic quantities can appear complicated, however once understood it becomes a logical and efficient way of qualifying measures. Take for instance the upper limit recommended by BS8233 for noise levels in gardens and balconies of  $L_{Aeq,T}$  55dB:



The above descriptor is comprised as follows:

The first grouping ('L') indicates that the quantity is a sound pressure level. Other common quantities are sound intensity ( $L_I$ ) and sound power ( $L_W$ ).

The second grouping ('A') denotes that the sound pressure level is evaluated using the A-weighted filter network. There are two competing conventions regarding the position of this identifier, either immediately after the 'L' as shown in the example above, or alternatively in brackets following the units. Therefore whilst appearing different,  $L_{Aeq,T}$  55dB and  $L_{eq,T}$  55dB(A) are equivalent and may be used interchangeably. Which convention is used is a matter of preference; however it is considered good practice to remain consistent within a document for the convenience of the reader.

The third grouping of characters identify the statistical descriptor. In this example, the letters indicate that the quantity is in terms of the equivalent continuous noise level (eq), which has some similarities with the concept of an average noise level. Numerical values are also shown, and these indicate the level exceeded for n per cent of the measurement (e.g. a value of  $L_{A90,T}$  45dB indicates that the A-weighted sound pressure level exceeds 45dB for 90% of the period analysed).

The quantity ('T') shown after the statistical descriptor is the duration over which the quantity is evaluated. This is typically represented in minutes or hours, e.g. 15min, 16hr.

The fifth part of the statistical descriptor identifies its numeric value. This value is usually given as a whole number or to one decimal place.

The sixth and final group of characters indicate that the units of the sound pressure level are decibels.

A variety of statistical indices are used to quantify noise in different situations.

### 1.3 Road traffic noise

The index adopted by the Government to quantify traffic noise is the  $L_{A10,18hr}$  which is the arithmetic mean of the noise levels exceeded for 10% of the time in each of the 18 one-hour periods between 6am and midnight. The  $L_{A10,18hr}$  index has been shown to have the best relationship with annoyance caused by road traffic noise, which has a strong low frequency content and is often more steady over the course of a day than other sources of environmental noise.

### 1.4 Ambient noise level

General environmental noise from commercial, industrial or unidentified sources is often expressed in terms of the equivalent continuous sound pressure level over the time period of interest ( $L_{Aeq,T}$ ). This is the notional continuous constant noise that contains the same sound energy over the period of interest as the actual fluctuating noise. This is not an 'average' sound level over a period, but the concept has some similarities and provides a single figure quantity that can be used to compare noise levels which fluctuate with time.

### 1.5 Background noise level

The  $L_{A90,T}$  index identifies the noise level exceeded for 90% of the period of interest, and provides a good indication of the background noise level that remains in a location in the absence of any easily identifiable sources.

### 1.6 Maximum sound level

The maximum sound level ( $L_{Amax}$ ) is the highest time-weighted sound level measured during a period. The time constant of the measure may either be fast (125 ms), slow (1 s) or impulsive (35 ms), and it is usual to identify the time constant in the notation – e.g.  $L_{AFmax}$  indicates that the maximum sound level was measured with the fast time-weighting. The longer the time constant over which the measurement is integrated, the greater the smoothing effect of the time-weighting, which gives a lower numeric value of the measurement.

## 2 Assessment method

### 2.1 Desk Study

Prior to the measurement of baseline noise levels in the vicinity of the works, a desk study was undertaken in order to assess the most likely affected residential properties and the most suitable locations where baseline noise measurements could be undertaken to represent noise levels at several locations.

The desk study was also used to identify areas where no further assessment is at this stage required. This includes areas where there are no residential properties in the vicinity, such as the northern limit of the proposed works at north of the A259, or North of the Arun View Public House on the east bank of the River and adjacent to the industrial areas of Littlehampton, which are remote from residential properties.

It is possible however that further assessments might be required under Environmental Health Legislation to ensure an appropriate level of control during construction works.

### 2.2 Survey

An environmental noise survey was undertaken in the Littlehampton area in November 2012.

The survey was undertaken using a Castle Pro-DX Vocis GA131M Sound Level Meter (serial number 0062925) with a Castle MKDXP Pre-amplifier (serial number 1026) and a Castle ½" microphone (serial number 5035). The meter was calibrated using a Castle GA607 Sound Level Calibrator (serial number 035748).

The meter and calibrator have been calibrated in an NPL accredited laboratory within the past year and the details are shown in Table 2.1.

Table 2.1 Noise Equipment Calibration

Equipment	Serial Number	NPL Calibration Certificate Number	NPL Calibration Certificate Reference	Date
Castle Vocis M Sound Level Meter	0062925	0062925/57985	S6055	31/05/12
Castle GA607 Acoustic Calibrator	035748	035748/57985	S6055	31/05/12

Noise measurements were taken in accordance with the methodology in British Standard 7445-1: 2003 '*Description and measurement of environmental noise Part 1 Guide to quantities and procedures*', with the microphone between 1.2 and 1.5m above the ground and at least 3.5m from any reflecting structure.

In order to gain sufficient data to assess the impacts of the scheme, baseline measurements were undertaken at the following measurement locations, all of which were agreed in writing prior to the survey with Graham Evans, Environmental Health Officer at Arun District Council:

- The Marina View Chalet developments on the West Bank of the Arun;
- The Arun View Public House Car Park in line with the Riverside Facade of the Pub;
- At the Northern end of the Riverside Walkway to the rear of residential development on River Road; and,
- At the Southern end of the Riverside Walkway opposite 46 Pier Road.

As works are proposed to be undertaken during weekday periods unless there is an urgent need to undertake works outside these hours, all baseline measurements were undertaken between the hours of 07:00 and 18:00.

## 2.3 Impact assessment criteria

The identification of the value or sensitivity of each noise sensitive receptor has been made according to the five point scale as shown in Table 2.2.

Table 2.2 Classification of the value or sensitivity of environmental resources

Value	Criteria
Very High	International Importance
High	National Importance
Medium	Regional/ County Importance
Low	District/ Parish Importance
Negligible	No Listed Importance

In addition to the above, the findings of an Institute of Acoustics / Institute of Environmental Management and Assessment Joint Working Party in 2002 presented a draft scale that can be used for the classification of magnitude of impact of changes in noise level. Although in draft, this is used for this assessment as it is still considered valid and has been accepted for use by the Local Authority. A subsequent update to this guidance has been presented, although not published in draft. This has moved away from supplying a classification in terms of changes in actual noise level, and introduces a scale to classify the consequence of any change and whether they are significant. This later guidance has not been followed here due to the lack of a scale of magnitude against which to relate predicted changes in noise level.

The classification set out by the Working Party is shown in Table 2.3.

Table 2.3 Impact Scale for Comparison of Future Noise against Existing Noise

Change in Noise Level dB(A)	Subjective Response	Significance
0	No change	No impact
0.1 to 2.9	Barely perceptible	Slight impact
3.0 to 4.9	Noticeable	Moderate impact
5.0 to 9.9	Up to a doubling or halving in loudness	Substantial impact
10.0 or more	More than a doubling or halving in loudness	Severe impact

The draft guidelines state that the assessor should set out assessment criteria specific to each assessment. However, the above criteria reflect key benchmarks of human response to changes in noise level. For example, a 3 dB change is generally taken to be the smallest change perceptible to the human ear and a 10 dB change is heard as a doubling or halving of the loudness of a source. The 5 dB category has been included as it provides a greater definition of the assessment of changes in noise level.

It can be seen that either of the above are as applicable as the other in the assessment of construction noise, but as the latter numerates the scale of the impacts, this impact scale has been employed.

The assessment of the magnitude and nature (positive or negative) of the potential effects on receptors has been made according to a seven point scale as presented in Table 2.4.

Table 2.4 Classification of the magnitude and nature of environmental effects

Magnitude	Definition
Major Negative	Impact with serious consequences and/or on a large area.
Moderate Negative	Impact with undesirable consequences.
Minor Negative	Discernible negative impact and/or on a small scale.
Negligible	No impact or no discernible impact.
Minor Positive	Discernible positive impact and/or on a small area.
Moderate Positive	Impact with favourable consequences.
Major Positive	Impact provide substantial gains and/or on a large area.

Evaluation of the significance of the potential effects on receptors is based on the value or sensitivity and magnitude of the potential effects using the criteria shown in Table 2.5.

Table 2.5 Assessment of significance of environmental effects and residual effects

Magnitude	Value/ Sensitivity			
	Very High	High	Medium	Low
Major Negative	Major adverse	Moderate adverse – Major adverse	Moderate adverse	Minor adverse – moderate adverse
Moderate Negative	Moderate adverse – Major adverse	Moderate adverse	Minor adverse – moderate adverse	Minor adverse
Minor Negative	Minor adverse – Moderate adverse	Minor adverse – moderate adverse	Minor adverse	Minor adverse
Negligible	No significant effect			
Minor Positive	Minor beneficial – moderate beneficial	Minor beneficial – moderate beneficial	Minor beneficial	Minor beneficial
Moderate Positive	Moderate beneficial – major beneficial	Moderate beneficial	Minor beneficial – moderate beneficial	Minor beneficial
Major Positive	Major beneficial	Moderate beneficial – major beneficial	Moderate beneficial	Minor beneficial – moderate beneficial

### 3 Legislative framework

The relevant legislation and guidance which cover the noise and vibration aspects of the proposed Scheme are as follows:

#### 3.1 Legislation

The Control of Pollution Act 1974 (CoPA), Sections 60 and 61 relate to noise and vibration from construction sites and although much of CoPA has been re-enacted and extended by the Environmental Protection Act 1990, they remain highly relevant

#### 3.2 Other guidance

#### 3.3 BS 5228-1: 2009 Code of practice for noise and vibration control on construction and open sites - Part 1 (Noise)

This code of practice provides guidance and recommendations on methods for the measurement of construction noise and assessing its impact on those exposed to it. It also makes reference to the legislative background to noise control on construction sites, and gives recommendations for basic methods of noise control.

Suitable methods are provided for the calculation of noise from construction activities, including basic information regarding noise levels from a range of construction equipment.

The standard provides guidance for the identification of the significance of noise levels from surface construction activity. Significance can be considered in relation to fixed limits for noise and vibration, or alternatively in considering the potential change in the ambient noise level with the construction noise.

A significance criterion is developed from noise measurements of existing ambient noise levels at the nearest sensitive receptors to the site. Sensitive receptors are considered to be residential housing; hotels and hostels; buildings in religious use; buildings in educational use and buildings in health and/or community use.

Measurements of the ambient noise level at the sensitive receptors are the basis of the significance criteria. The measured ambient noise level is rounded to the nearest 5dB(A). BS5228-1 provides a range of significance criteria depending on the measured noise level, as presented in Table 3.1.

Table 3.1 Threshold of Significant Effect from Construction Works at Dwellings

Assessment Category and Threshold Value Period ( $L_{Aeq}$ )	Threshold Value, in decibels (dB)		
	Category A <sup>A)</sup>	Category B <sup>B)</sup>	Category C <sup>C)</sup>
Night-time (2300-0700)	45	50	55
Evenings and Weekends	55	60	65
Daytime (0700-1900) and Saturdays (0700-1300)	65	70	75
<sup>A)</sup> Category A: Threshold values to use when ambient noise levels rounded to the nearest 5 dB are less than these values.			
<sup>B)</sup> Category B: Threshold values to use when ambient noise levels rounded to the nearest 5 dB are the same as category A values.			
<sup>C)</sup> Category C: Threshold values to use when ambient noise levels rounded to the nearest 5 dB are higher than category A values.			

Where the ambient noise level is greater than category C levels the ambient noise level shall be used as the significance criterion threshold.

The predictions of 'total noise' from construction, including the ambient noise level, are compared to the criteria. If the total noise level exceeds the appropriate category threshold value, then a significant effect is deemed to occur.

### 3.4 BS 5228-2: 2009 Code of practice for noise and vibration control on construction and open sites - Part 2 (Vibration)

BS 5228 2009, Part 2: Vibration provides guidance in relation to the effects of construction vibration upon the surroundings. Vibration, even of a very low magnitude, can be perceptible to people. Vibration nuisance is frequently associated with the assumption that, if vibration can be felt, then damage is inevitable. However, considerably greater levels of vibration are required to cause damage to buildings and structures. In any neighbourhood, some individuals will be more sensitive to vibration than others.

Guidance on human response and guide values for the cosmetic damage of buildings is provided in BS5228:2009-2, and reproduced in Tables 3.2 and Table 3.3.

Table 3.2 Guidance on effects of vibration levels (Human Response)

Vibration Level	Effect
0.14 mm/s	Vibration might be just perceptible in the most sensitive situations for most vibration frequencies associated with construction. At lower frequencies, people are less sensitive to vibration.
0.3 mm/s	Vibration might just be perceptible in residential environments.
1.0 mm/s	It is likely that vibration of this level in residential environments will cause complaint, but can be tolerated if prior warning and explanation has been given to residents.
10 mm/s	Vibration is likely to be intolerable for any more than a very brief exposure of this level.

Table 3.3 Transient vibration guide values for cosmetic damage to buildings

Type of Building	Peak component of particle velocity in frequency range of predominant pulse	
	4Hz to 15Hz	15Hz and above
Reinforced or Framed structures Industrial and heavy commercial buildings	50 mm/s at 4Hz and above	50mm/s at 4Hz and above
Unreinforced or light framed buildings Residential or light commercial buildings	15 mm/s at 4Hz increasing to 20mm/s at 15 Hz	20 mm/s at 15Hz increasing to 50mm/s at 40Hz and above

### 3.5 Other Guidance

1963 Wilson Report, first suggested a figure of 75dB  $L_{Aeq}$  as an acceptable level of noise from construction or demolition sites when measured at the external façade of an occupied building over the normal working day.

The Department of Environment Advisory Leaflet 72 '*Noise control on building sites*' reiterated the guidance suggested by Wilson. It set daytime limits (7.00am to 7.00pm) of 75dB(A) for urban areas near to main roads or in heavy industrial areas and 70dB(A) for rural, urban, and suburban area away from main traffic routes.

'Guidelines for Noise Impact Assessment', produced by a joint working party of the Institute of Acoustics and the Institute of Environmental Management gives guidance on the impact significance of construction.

The assessment of acoustics is by its very nature a technically complex subject. As a result a short introduction to noise has been provided above, whilst a glossary of acoustic terminology is attached as Annex 1.

### 3.6 Protected Sites/ Features

The construction of the flood protection scheme will not directly impact upon any sites of specific protection within Littlehampton.

## 4 Environmental baseline

### 4.1 Overview

The environmental noise survey was undertaken in Littlehampton on 17<sup>th</sup> November 2012

Noise measurements were taken in accordance with the methodology in British Standard 7445-1: 2003 '*Description and measurement of environmental noise Part 1 Guide to quantities and procedures*', with the microphone between 1.2 and 1.5m above the ground and at least 3.5m from any reflecting structure.

Weather conditions during the survey were acceptable for the measurement of environmental noise, with clear weather conditions and wind speeds below 3m/s at all times.

### 4.2 Receptors

The receptors used for the environmental noise baseline survey were as follows:

- The Marina View Chalet developments on the West Bank of the Arun;
- The Arun View Public House Car Park in line with the Riverside Facade of the Pub;
- At the Northern end of the Riverside Walkway to the rear of residential development on River Road; and,
- At the Southern end of the Riverside Walkway opposite 46 Pier Road.

These locations are representative of the sensitive receptors in the proposed working areas. As works are proposed to be undertaken during weekday periods unless there is an urgent need to undertake works outside these hours, all baseline measurements were undertaken between the hours of 07:00 and 18:00.

The summary of the surveys are shown in Table 4.1.

Table 4.1 Summary of existing noise levels at chosen monitoring locations

Location	Average L <sub>Aeq</sub> , dB	Average L <sub>A10</sub> , dB	Average L <sub>A90</sub> , dB	L <sub>AMax</sub> , dB
Marina View Chalet Development	57.8	57.2	52.7	82.0
Arun View Public House	58.6	59.1	53.8	82.7
Northern End of Riverside Walkway to the rear of 37 River Road	53.3	54.9	48.4	74.6
Southern End of Riverside Walkway opposite 46 Pier Road	58.7	61.8	46.1	82.2

Full measurement results are attached to this assessment in Annex 2.

## 5 Impact Assessment

In order to address the potential severity of the impacts of the proposed development it is necessary to consider the calculated noise levels from the works without the benefit of mitigation.



The level and nature of noise generated by construction activities would usually be expected to be greater than the existing background noise levels. The works are therefore likely to cause disturbance and disruption to local residents. Disruption due to construction is however generally a localised phenomenon and temporary in nature.

The activities considered in calculating the likely noise levels from the three working areas are given in the tables below.

Table 5.1 Plant Complement for Piling Works – Reach 1 & 2

Plant Description	Plant Information		
	BS5228 Ref.	Sound Power Level $L_{WA}$ dB	On Time , %
BSP CX110 Hammer Rig	N/A – Manufacturer's Data	126.0	40%
Tracked mobile crane 240 kW (105t)	C4.52	103.0	20%
PVE 40M Hydraulic Piling Vibrator	N/A – Manufacturer's Data	113.0	40%

Table 5.2 Plant Complement for Earthworks Reach 2

Plant Description	Plant Information		
	BS5228 Ref.	Sound Power Level $L_{WA}$ dB	On Time , %
Pulveriser mounted on excavator (30t) 147 kW	C1.4	104.0	30%
Road lorry (full) 270 kW 39 t	C6.21	108.0	20%
Mobile telescopic crane 280 kW (100t)	C4.41	99.0	20%
Tracked excavator (25t) 125 kW	C2.19	105.0	30%
Vibratory roller 98 kW 8.9 t	C5.20	103.0	30%

Table 5.3 Plant Complement for Concreting Reach 2

Plant Description	Plant Information		
	BS5228 Ref.	Sound Power Level $L_{WA}$ dB	On Time , %
Concrete mixer truck	C4.27	107.0	40%
Hand-held circular saw (petrol-cutting concrete blocks) 3.9kg	C4.72	107.0	20%
Poker vibrator 2.2 kW	C4.34	97.0	10%
Tracked excavator (25t) 125 kW	C2.19	105.0	30%

Table 5.4 Plant Complement for Vibro Piling - Reaches 3 &amp; 4

Plant Description	Plant Information		
	BS5228 Ref.	Sound Power Level $L_{WA}$ dB	On Time , %
Mobile telescopic crane 315 kW (80t)	C4.39	105.0	20%
PVE 40M Hydraulic Piling Vibrator	N/A – Manufacturer's Data	113.0	40%

Table 5.5 Plant Complement for Hammer Piling - Reaches 3 &amp; 4

Plant Description	Plant Information		
	BS5228 Ref.	Sound Power Level $L_{WA}$ dB	On Time , %
Mobile telescopic crane 315 kW (80t)	C4.39	105.0	20%
SL30DA Hammer Rig	N/A – Manufacturer's Data	106.0	40%

Table 5.6 Plant Complement for Earthworks - Reaches 3 &amp; 4

Plant Description	Plant Information		
	BS5228 Ref.	Sound Power Level $L_{WA}$ dB	On Time , %
Mobile telescopic crane 315 kW (80t)	C4.39	105.0	30%
Vibratory roller 12 1.5 t	C5.28	105.0	30%

Table 5.7 Plant Complement for Concreting - Reaches 3, 4 &amp; 5

Plant Description	Plant Information		
	BS5228 Ref.	Sound Power Level $L_{WA}$ dB	On Time , %
Mini tracked excavator 30 5 t	C4.68	93.0	30%
Dumper 32 kW (3t)	C4.9	105.0	20%
Concrete pump + cement mixer truck (discharging) 223 kW (8t/350bar)	C4.24	95.0	50%

Table 5.8 Plant Complement for Piling Reach 5

Plant Description	Plant Information		
	BS5228 Ref.	Sound Power Level $L_{WA}$ dB	On Time , %
Mobile telescopic crane 315 kW (80t)	C4.39	105.0	30%
PVE 40M Hydraulic Piling Vibrator	N/A – Manufacturer's Data	113.0	40%
SL30DA Hammer Rig	N/A – Manufacturer's Data	106.0	40%

Table 5.9 Plant Complement for Piling Reach 6

Plant Description	Plant Information		
	BS5228 Ref.	Sound Power Level $L_{WA}$ dB	On Time , %
Tracked excavator (25t) 125 kW	C2.19	105.0	30%
SL30DA Hammer Rig	N/A – Manufacturer's Data	106.0	40%

Table 5.10 Plant Complement for Rock Revetment Reach 6

Plant Description	Plant Information		
	BS5228 Ref.	Sound Power Level $L_{WA}$ dB	On Time , %
Tracked excavator (25t) 125 kW	C2.19	105.0	40%
6t Dumper	C4.6	107.0	30%
Tractor (towing water bowser)	C6.30	111.0	20%

## 5.1 Construction impacts – Noise on Land

The calculation methodologies set out in BS 5228: Part 1: 2009 have been used to estimate the worst-case noise level at the nearest sensitive receptors. The calculations have been undertaken based on the assumed plant complements, and assuming the construction works will occur at the closest points to each noise sensitive receptor at all times. The distances used in the calculations are presented in Table 5.11.

Table 5.11 Closest Approach Distances of Construction Works to Sensitive Receptors

Receptor	Closest Approach of Construction Works (m)
Reach 1 (Nelson Hotel)	15.0
Reach 2 (Pier Road/Mussel Row)	10.0
Reach 3 (Netley Court)	5.0
Reach 4 (West of River Road/ Britannia Quay)	5.0
Reach 5 (Receptors on Terminus Road)	30.0
Reach 6 (Marina Holiday Lodges)	95.0

Given the above distances, the calculated impacts at the assessment locations are as presented in Table 5.12. These calculated levels are reported as free-field levels; facade levels in these vicinities would be 2.5 to 3dB higher than those reported in Table 5.12. The predictions are based on the core working day, which is assumed to be 8.00am to 6.00pm.

Table 5.12 Calculated Worst Case Noise Levels of Construction Works at Sensitive Receptors

Phases of Operation	Receptors					
	1. Reach 1 (Nelson Hotel)	2. Reach 2 (Pier Road/ Mussel Row)	3. Reach 3 (Netley Court)	4. Reach 4 (West of River Road/ Britannia Quay)	5. Reach 5 (Arun View PH)	6. Reach 6 (Marina Holiday Lodges)
Reach 1/2 Piling	90.0	93.0	-	-	-	-
Reach 2 Earthworks	68.0	74.0	-	-	-	-
Reach 2 Concreting	67.4	73.5	-	-	-	-
Reach 3/4 Vibro Piling	-	-	86.4	86.4	-	-
Reach 3/4 Hammer Piling	-	-	80.5	80.5	-	-
Reach 3/4 Backfill	-	-	79.3	79.3	-	-
Reach 3/4/5 Final Construction	-	-	75.9	75.9	60.4	-
Reach 6 Piling	-	-	-	-	-	54.7
Reach 6 Rock Revetment	-	-	-	-	-	57.3

The calculated noise levels are then compared with the thresholds for construction noise from Annex E.3.2 of BS5228:2009-1, and repeated in Table 3.1 above to assess the absolute impact against the thresholds.

The significance of the works have then been considered using the methods detailed in Table 2.3 above, and are detailed in Table 5.13 below when compared with the measured ambient noise levels.

Table 5.13 Increase in Noise Levels as a result of Construction Works and Impact Significance

Reach	Element of Construction	Increase over Ambient $L_{Aeq}$	Sensitivity of Receptor	Impact Magnitude	Impact Significance
Reach 1	Piling	30	Low	Major Negative	Minor Averse – Moderate Averse
	Earthworks/ Backfill	8	Low		
	Concreting	7	Low		
Reach 2	Piling	32	Low		
	Earthworks/ Backfill	14	Low		
	Concreting	13	Low		
Reach 3	Vibro-Piling	31	Low		
	Hammer Piling	26	Low		
	Earthworks/ Backfill	24	Low		
	Final Construction	21	Low		
Reach 4	Vibro-Piling	31	Low		
	Hammer Piling	26	Low		
	Earthworks/ Backfill	24	Low		
	Final Construction	21	Low		
Reach 5	Final Construction	0	Low	Negligible	No Significant Effect
Reach 6	Piling	-5	Low		
	Rock Revetment	-3	Low		

When considering the threshold values from Annex E.3.2 from BS5228:2009-1, the impacts would be as reported in Table 5.14.

Table 5.14 Increase in Noise Levels as a result of Construction Works and Impact Significance, BS5228:2009-1 Threshold Annex E.3.2

Reach	Element of Construction	Increase over Annex E.3.2 Threshold Level	Sensitivity of Receptor	Impact Magnitude	Impact Significance
Reach 1	Piling	25	Low	Major Negative	Minor Averse – Moderate Averse
	Earthworks/ Backfill	4	Low		
	Concreting	3	Low		
Reach 2	Piling	28	Low		
	Earthworks/ Backfill	9	Low		
	Concreting	8	Low		
Reach 3	Vibro -Piling	21	Low		
	Hammer Piling	16	Low		
	Earthworks/ Backfill	14	Low		
	Final Construction	11	Low		
Reach 4	Vibro-Piling	21	Low		
	Hammer Piling	16	Low		
	Earthworks/ Backfill	14	Low		
	Final Construction	11	Low		
Reach 5	Final Construction	-5	Low	Negligible	No Significant Effect
Reach 6	Piling	-10	Low		
	Rock Revetment	-8	Low		

Irrespective of the method of assessment chosen, therefore, it can be seen that the impact significance remains the same.

## 5.2 Construction impacts – Marine Noise & Vibration

In addition to impacts on land, it is important to consider the impacts upon the marine environment as well, as the Arun is an important river for various species. Discussions held with the fisheries experts in the Environment Agency have revealed that they concur with the research undertaken that there is no discernible effect upon fisheries from Vibro-piling. As a result they are of the view that there is no constraint in terms of the majority of the piling works upon the fish stocks in the River.

There is however the potential for Hammer Piling to be required in order to drive piles to refusal, and if this is the case, discussions with the Environment Agency specialists suggest that there is the potential for significant effects upon certain species, namely Sea Trout and Elvers. This being the case it is clear that mitigation would be required.

### 5.3 Construction impacts – Vibration

Piling operations are also likely to give rise to vibration. Given that piling operations will take place within up to 5m of residential property in some reaches it is likely that this will cause some degree of impact, although it is proposed that resonant-free vibrators are used wherever possible. These have been successfully used in similar circumstances in close proximity to residential property and other sensitive structures. We have made calculations using the methods contained within BS5228:2009-2 for vibratory piling, to determine the level of impact on buildings and residents, using a 50% probability of the figures noted being exceeded. The results are presented in full in Appendix D and summarised in Table 5.15.

It should be noted that given the method of transfer, vibro-piling generates higher levels of vibration in the surrounding environment than does hammer piling, which is only proposed to be used in the last few metres of piling driving to design depth. As a result Table 5.15 reports the impacts from vibro-piling, which are considered to be the worst case impacts in terms of vibration generation.

Table 5.15 Summary of Vibration Impact Significance from construction works

Reach	Calculated Vibration Level PPV (mm/s)	Impact on Buildings (BS5228:2009-2)	Impact on Residents (BS5228:2009-2)
Reach 1	1.2 mm/s	No Impact	Above a level likely to cause complaint, but can be tolerated if prior warning and explanation has been given, but lower than an intolerable level
Reach 2	1.2 mm/s	No Impact	
Reach 3	7.4 mm/s	No Impact	
Reach 4	7.4 mm/s	No Impact	
Reach 5	No Piling Activities	No Impact	No perceptible impacts
Reach 6	0.1 mm/s	No Impact	Vibration might just be perceptible

For Reaches 3 and 4 if the majority of the piling works, and those close to residential property, will be undertaken using Giken or press piling techniques, vibration impacts are unlikely to occur. There is a possibility that hammer piling may be required where Vibro-piling is used in order to drive the piles to refusal, but the calculations indicate that vibration levels generated for percussive piling will be lower than those noted for Vibro-piling in all circumstances.

## 6 Mitigation

It is inevitable with many projects that there will be some disturbance caused to those people living nearby during construction. However, as stated previously, disruption due to construction is generally a localised phenomenon and temporary in nature. Several safeguards exist to minimise the effects of noise and vibration during the construction, including:

- Restriction of working hours to 8.00am to 6.00pm Mondays to Fridays, 8.00am to 1.00pm Saturdays and no working on Sundays or Public Holidays, in line with the recommendation from Arun District Council
- Programming and phasing the works over a number of stages to restrict impacts within any one area to the minimum time, and to minimise works within Reaches 1 and 2 during the main tourist season

- Submission of a more detailed application under Section 61 of Part III of The Control of Pollution Act 1974 to Arun District Council to detail the construction operations and their impacts in terms of the noise and vibration impacts
- The adoption of Best Practicable Means as defined in the Control of Pollution Act 1974, which is usually the most effective means of controlling noise from construction sites. This generally entails the employment of good site practice to minimise the noise and vibration impacts from the works
- If available using shielded piling hammers, which will reduce noise levels generated from hammer piling by in the order of 10dB
- Using screening around piling equipment and maintain plant in good operational condition with all engine covers and noise control measures as provided in place
- Keeping local residents and property owners fully informed about the nature and timing of the works, including compound locations and traffic controls, via such means as newsletters
- Adoption of Considerate Contractors Scheme and having a representative available on site during working hours to answer queries or address any concerns expressed
- Careful selection of equipment, for example any compressors brought to site will be super-silenced or sound reduced models fitted with acoustic enclosures or any pneumatic tools will be fitted with silencers or mufflers wherever practicable
- Careful consideration will be made of the site layout in Reaches 1 and 2 in order that any noise impact at nearby sensitive properties is minimised. Where possible this will include the minimisation of vehicle reversing, the elimination of vehicle waiting outside of residential property, and the orientation of the site layout to ensure that the noisiest activities are either located farthest away from residential property, or are shielded in part from the residential properties by other uses within the site (such as site offices)
- Localised use of hoardings and portable barriers will be erected by agreement to shield particularly noisy activities along the areas of Reaches 1 and 2 close to residential property and where stationary generators, concrete pumps and concrete breaking activities are required. Hoardings and portable barriers will not be effective against noise from vibro-piling works at the early stage of insertion of each pile given the potential height of the noise sources. It may be effective against hammer piling on the site where this is being used in the last metre or so in order to drive the sheet piles to refusal, but will be less effective on King Piles where these will have to be hammer driven for a much greater depth.
- All plant and equipment will be properly maintained and operated in accordance with manufacturers' recommendations and in such a manner as to avoid causing excessive noise
- Equipment will be shut down when not in use for a period longer than 5 minutes
- No vehicles will wait or queue on public highways with engines running;
- Deliveries will be restricted to daytime hours, during the working hours of the sites and will be routed so as to minimise disturbance to local residents; care will be taken when unloading deliveries and vehicles will be prohibited from waiting on site with their engines running
- Where elevated levels of vibration are predicted to occur, and vibro- or percussion piling techniques are to be employed, pre construction condition surveys will be undertaken to ascertain the stability of the structure and its potential resistance to vibration. If the property is shown to be susceptible, alternative piling methods should be employed where ground conditions permit, and in any case, regular vibration monitoring shall be undertaken at or near



the foundations of sensitive buildings to ensure that adequate levels of control are being employed.

In addition, we will undertake regular noise monitoring on a four-weekly basis to ensure compliance with the levels agreed by Arun District Council.

All of the above should be included in the Environmental Action Plan and should be complied with for the duration of the site works. These will help to control the noise levels produced by the construction works on the site, but at best will reduce noise impacts from the construction works by 5dB.

With respect to the potential for unavoidable impact piling, the Environment Agency have advised that such work will be acceptable in daylight hours during the winter, (Nov – March) since the vast majority of Sea Trout move at night.

With regard to Elvers, which are more vulnerable and will start moving up the channel in the spring when the water reaches around 10 deg C (normally around April), water temperature should be monitored, and if this temperature is exceeded, mitigation would be needed.

This could include working at low tide for Reach 4, cushions on top or baffles around the piles. Similar mitigation will also be required if the contractor starts earlier than November and discovers that impact hammering is required in some places.

Further measures that will be considered to mitigate the impacts of noise for both human and marine receptors include slow start techniques which minimise the initial pulse from vibration operations.

## 7 Residual effects

The restriction of construction activities to avoid sensitive times of the year for tourists and ecological interests, and restriction of the working days and hours for residents and ecological interests, coupled with application of further measures as listed above, will help to avoid adverse impacts or reduce noise levels and nuisance for all sensitive receptors.

It is envisaged that there will be no residual impacts on fish. Neither press nor vibro-piling will result in any adverse impacts during any time of the year. Any remaining risk as result of a need to use percussion piling methods outside the November to March window will be mitigated by the application of further measures such as water temperature monitoring, and further measures to be agreed with Environmental Agency specialists at the time such as the use of cushions or baffles or by adjustment of the working methods under ecological supervision to ensure no significant impact on fish behaviour or well-being.

It is estimated that the mitigation measures will reduce noise levels by up to 5dBA for residential receptors. This will not be sufficient to reduce the significance of impacts affecting the closest residential receptors. The closest residents could be affected by impacts of Minor to Moderate significance, particularly where percussion or vibro-piling is used.

Where piling occurs in Reaches 3 and 4, there is the potential for Major vibration impacts, which could be mitigated completely by press piling techniques if these techniques are feasible. Noise impacts for the remaining works will be elevated over existing noise levels but will be temporary in nature, such that each residential receptor may only be exposed to elevated noise levels for periods from a few days to a few weeks at an individual.

Coupled with the short duration of the works, good site practice and advance and continuing communication through the project with residents, nuisance will be reduced to a minimum.

## Annex 1

### Glossary of Acoustic Terminology

#### A-weighting

This is a measure of the overall level of sound across the audible spectrum with a frequency weighting (i.e. 'A' weighting) to compensate for the varying sensitivity of the human ear to sound at different frequencies.

#### dB

Abbreviation of decibel.

#### dB(A)

Abbreviation of A-weighted decibel.

#### Decibel

The scale on which sound pressure level is expressed. In air it is defined as 20 times the logarithm of the ratio between the root-mean-square pressure of the sound field and a reference pressure ( $2 \times 10^{-5}$  Pa).

#### $D_{nT}$ or $D_{nT,w}$

Standardised Level Difference,  $D_{nT}$ , (dB) - This is the level difference between rooms standardised on the logarithmic ratio of the receiving room reverberation time to a reference reverberation time (for dwellings of 0.5s).

The receiving room reverberation time can be measured quickly and accurately on site using an impulsive sound source and any Type 1 sound level meter equipped with basic building acoustics functions. This makes the standardised level difference relatively easy to determine on site and the single number rating of this quantity (weighted standardised level difference,  $D_{nT,w}$ ) is used to express performance requirements in the Building Regulations Approved Document Part E.

#### $D_{nT,w} + C_{tr}$

The weighted standardised level difference, but with the addition of the low frequency adaption term ( $C_{tr}$ ) which better expresses the in-situ sound insulation performance to noise with a strong low frequency content, such as road traffic noise or music.

#### Equivalent Continuous Sound Pressure Level

The Equivalent Continuous Sound Pressure Level is the notional steady sound level which, over a stated period of time, would contain the same amount of acoustical energy as the A-weighted fluctuating sound measured over that period.

## **L<sub>10</sub> or L<sub>A10</sub>**

Acoustic nomenclature indicating that the value is exceeded for 10% of the period of interest. See Appendix 5.1 for an overview of statistical noise descriptors. This index, evaluated over the period 06.00hrs to 24.00hrs, is often used to describe road traffic noise. See Appendix K1 for an overview of statistical noise descriptors.

## **L<sub>90</sub> or L<sub>A90</sub>**

Acoustic nomenclature indicating that the value is exceeded for 90% of the period of interest. See Appendix 5.1 for an overview of statistical noise descriptors. This index is taken to be a good indicator of the 'background' noise level remaining at a location in the absence of any readily identifiable sources.

## **L<sub>eq</sub> or L<sub>Aeq</sub>**

Acoustic nomenclature indicating that a value is expressed in terms of the Equivalent Continuous Sound Pressure Level. See Appendix 5.1 for an overview of statistical noise descriptors.

## **Reverberation Time**

Reverberation time is the length of time taken for the reverberant sound energy within a room to reduce by 60dB when the source is stopped abruptly. Reverberation time is frequency dependant and is a function of the room surface absorption coefficients and the volume of the room. Often reverberation time is measured as the time taken for the sound energy to decay by 30dB and extrapolated from this, as it can be impractical to generate a reverberant sound field 65dB or more above the room background noise level.

## **RT**

Abbreviation of Reverberation Time.

## **R<sub>w</sub> (dB)**

Sound Reduction Index, R<sub>w</sub> (dB) - At the design stage a method of estimating the sound insulation performance of a building construction from its constituent elements is necessary.

The sound reduction index provides a quantity for expressing the sound insulation performance of a building element independently of the situation in which it is to be installed. This is normally done by measuring the performance of a sample of the building element in a laboratory where it is mounted in such a fashion that flanking transmission is negligible. The test procedure for the laboratory measurement of the sound reduction index of a material is given in EN ISO 140-3.

It is common for manufactures of building materials to state the performance of their products in terms of the sound reduction index R<sub>w</sub>. Whilst these values can be compared in a catalogue to evaluate the relative performance of materials, the R<sub>w</sub> cannot be compared directly to performance criteria expressed in terms of the weighed standardised level difference D<sub>nT,w</sub>, or the apparent sound reduction index R'<sub>w</sub> despite these quantities all having common units (dB).

## Annex 2

### Full Noise Monitoring Results

Please see over for full survey report sheets for each of the following monitoring locations:

- The Marina View Chalet developments on the West Bank of the Arun;
- The Arun View Public House Car Park in line with the Riverside Facade of the Pub;
- At the Northern end of the Riverside Walkway to the rear of residential development on River Road; and,
- At the Southern end of the Riverside Walkway opposite 46 Pier Road.

## Appendix A - Excavation Noise Calculations



### BS5228 (2009) Stationary Plant Sound Power Level Calculation (F.2.3)

Project	Littlehampton Tidal Defence Scheme	Date	31-Dec-2012
Construction Activity	Phase 1: Reach 1/2 Piling	By	Ian Stanworth
Sensitive Receiver	1. Reach 1 (Nelson Hotel)	Checked	Louise Hill

Distance to receiver:	15 metres	% Soft Ground to Receptor:	0.0%	Reflection:	FREE FIELD
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		1	2	3	4	5	6	7	8
Activity Description		BSP Shrouded Hammer Rig	Lifting	PVE 40M Hydraulic Piling Vibrator	-	-	-	-	-
Plant Description		CX110 Unshrouded Rig	Tracked mobile crane 240 kW (105t)	Hydraulic Piling Vibrator	-	-	-	-	-
BS5228 Reference (Part 1 2009)		Tbl Other Ref 1	Tbl C.4. Ref 52	Tbl Other Ref 2	-	-	-	-	-
Quantity		1	1	1	0	0	0	0	0
Sound Power Level $L_{WA}$	$dB(A)$	129.0	103.0	113.0	0.0	0.0	0.0	0.0	0.0
Ave. Percentage On-Time	%	40%	20%	40%	0%	0%	0%	0%	0%
Ave. On-Time Correction	$dB(A)$	-4.0	-7.0	-4.0	0.0	0.0	0.0	0.0	0.0
Corrected $L_{WA}$	$dB(A)$	125.0	96.0	109.0	0.0	0.0	0.0	0.0	0.0
<b>Corrections</b>									
Source-Receiver Distance	$m$	15	15	15	15	15	15	15	15
Percentage Soft Ground	%	0%	0%	0%	0%	0%	0%	0%	0%
Distance Correction (Hard)	$dB(A)$	-31.5	-31.5	-31.5	-31.5	-31.5	-31.5	-31.5	-31.5
Soft Ground Correction	$dB(A)$	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Screening	None/Partial/Full	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE
Screening Correction	$dB(A)$	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Reflection Correction	$dB(A)$	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Shift Duration, T	Hrs	10	10	10	10	10	10	10	10
Duration of Activity	Hrs	8	8	8	0	0	0	0	0
% Assessment Period	%	80%	80%	80%	0%	0%	0%	0%	0%
Correction to $L_{Aeq}$	$dB(A)$	-1.0	-1.0	-1.0	0.0	0.0	0.0	0.0	0.0
<b>Resultant Noise Level</b>									
Activity $L_{Aeq,T}$	$dB(A)$	92.5	63.5	76.5	0.0	0.0	0.0	0.0	0.0

Total $L_{Aeq,T}$	$dB(A)$	92.6
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Project	Littlehampton Tidal Defence Scheme	Date	31-Dec-2012
Construction Activity	Phase 1: Reach 1/2 Piling	By	Ian Stanworth
Sensitive Receiver	2. Reach 2 (Pier Road/Mussel Row)	Checked	Louise Hill

Distance to receiver:	10 metres	% Soft Ground to Receptor:	0.0%	Reflection:	FREE FIELD
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		1	2	3	4	5	6	7	8
Activity Description		BSP Shrouded Hammer Rig	Lifting	PVE 40M Hydraulic Piling Vibrator	-	-	-	-	-
Plant Description		CX110 Unshrouded Rig	Tracked mobile crane 240 kW (105t)	Hydraulic Piling Vibrator	-	-	-	-	-
BS5228 Reference (Part 1 2009)		Tbl Other Ref 1	Tbl C.4. Ref 52	Tbl Other Ref 2	-	-	-	-	-
Quantity		1	1	1	0	0	0	0	0
Sound Power Level $L_{WA}$	$dB(A)$	129.0	103.0	113.0	0.0	0.0	0.0	0.0	0.0
Ave. Percentage On-Time	%	40.0%	20.0%	40.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Ave. On-Time Correction	$dB(A)$	-4.0	-7.0	-4.0	0.0	0.0	0.0	0.0	0.0
Corrected $L_{WA}$	$dB(A)$	125.0	96.0	109.0	0.0	0.0	0.0	0.0	0.0
<b>Corrections</b>									
Source-Receiver Distance	$m$	10	10	10	10	10	10	10	10
Percentage Soft Ground	%	0%	0%	0%	0%	0%	0%	0%	0%
Distance Correction	$dB(A)$	-28.0	-28.0	-28.0	-28.0	-28.0	-28.0	-28.0	-28.0
Soft Ground Correction	$dB(A)$	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Screening	None/Partial/Full	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE
Screening Correction	$dB(A)$	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Reflection Correction	$dB(A)$	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Shift Duration, T	Hrs	10	10	10	10	10	10	10	10
Duration of Activity	Hrs	8	8	8	0	0	0	0	0
% Assessment Period	%	80.0%	80.0%	80.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Correction to $L_{Aeq}$	$dB(A)$	-1.0	-1.0	-1.0	0.0	0.0	0.0	0.0	0.0
<b>Resultant Noise Level</b>									
Activity $L_{Aeq,T}$	$dB(A)$	96.1	67.0	80.1	0.0	0.0	0.0	0.0	0.0

Total $L_{Aeq,T}$	$dB(A)$	96.2
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## Appendix A - Excavation Noise Calculations



### BS5228 (2009) Stationary Plant Sound Power Level Calculation (F.2.3)

Project	Littlehampton Tidal Defence Scheme	Date	31-Dec-2012
Construction Activity	Phase 1: Reach 1/2 Piling	By	Ian Stanworth
Sensitive Receiver	3. Reach 3 (Netley Court)	Checked	Louise Hill

Distance to receiver:	0	metres	% Soft Ground to Receptor:	0.0%	Reflection:	FREE FIELD
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		1	2	3	4	5	6	7	8
Activity Description		BSP Shrouded Hammer Rig	Lifting	PVE 40M Hydraulic Piling Vibrator	-	-	-	-	-
Plant Description		CX110 Unshrouded Rig	Tracked mobile crane 240 kW (105t)	Hydraulic Piling Vibrator	-	-	-	-	-
BS5228 Reference (Part 1 2009)		Tbl Other Ref 1	Tbl C.4, Ref 52	Tbl Other Ref 2	-	-	-	-	-
Quantity		1	1	1	0	0	0	0	0
Sound Power Level $L_{WA}$	$dB(A)$	129.0	103.0	113.0	0.0	0.0	0.0	0.0	0.0
Ave. Percentage On-Time	%	40.0%	20.0%	40.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Ave. On-Time Correction	$dB(A)$	-4.0	-7.0	-4.0	0.0	0.0	0.0	0.0	0.0
Corrected $L_{WA}$	$dB(A)$	125.0	96.0	109.0	0.0	0.0	0.0	0.0	0.0
<b>Corrections</b>									
Source-Receiver Distance	$m$	0	0	0	0	0	0	0	0
Percentage Soft Ground	%	0%	0%	0%	0%	0%	0%	0%	0%
Distance Correction	$dB(A)$	#NUM!	#NUM!	#NUM!	#NUM!	#NUM!	#NUM!	#NUM!	#NUM!
Soft Ground Correction	$dB(A)$	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Screening	None/Partial/Full	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE
Screening Correction	$dB(A)$	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Reflection Correction	$dB(A)$	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Shift Duration, T	Hrs	10	10	10	10	10	10	10	10
Duration of Activity	Hrs	8	8	8	0	0	0	0	0
% Assessment Period	%	80.0%	80.0%	80.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Correction to $L_{Aeq}$	$dB(A)$	-1.0	-1.0	-1.0	0.0	0.0	0.0	0.0	0.0
<b>Resultant Noise Level</b>									
Activity $L_{Aeq,T}$	$dB(A)$	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Total $L_{Aeq,T}$	$dB(A)$	0.0
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Project	Littlehampton Tidal Defence Scheme	Date	31-Dec-2012
Construction Activity	Phase 1: Reach 1/2 Piling	By	Ian Stanworth
Sensitive Receiver	4. Reach 4 (West of River Road/ Britannia Quay)	Checked	Louise Hill

Distance to receiver:	0	metres	% Soft Ground to Receptor:	0.0%	Reflection:	FREE FIELD
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		1	2	3	4	5	6	7	8
Activity Description		BSP Shrouded Hammer Rig	Lifting	PVE 40M Hydraulic Piling Vibrator	-	-	-	-	-
Plant Description		CX110 Unshrouded Rig	Tracked mobile crane 240 kW (105t)	Hydraulic Piling Vibrator	-	-	-	-	-
BS5228 Reference (Part 1 2009)		Tbl Other Ref 1	Tbl C.4, Ref 52	Tbl Other Ref 2	-	-	-	-	-
Quantity		1	1	1	0	0	0	0	0
Sound Power Level $L_{WA}$	$dB(A)$	129.0	103.0	113.0	0.0	0.0	0.0	0.0	0.0
Ave. Percentage On-Time	%	40.0%	20.0%	40.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Ave. On-Time Correction	$dB(A)$	-4.0	-7.0	-4.0	0.0	0.0	0.0	0.0	0.0
Corrected $L_{WA}$	$dB(A)$	125.0	96.0	109.0	0.0	0.0	0.0	0.0	0.0
<b>Corrections</b>									
Source-Receiver Distance	$m$	0	0	0	0	0	0	0	0
Percentage Soft Ground	%	0%	0%	0%	0%	0%	0%	0%	0%
Distance Correction	$dB(A)$	#NUM!	#NUM!	#NUM!	#NUM!	#NUM!	#NUM!	#NUM!	#NUM!
Soft Ground Correction	$dB(A)$	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Screening	None/Partial/Full	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE
Screening Correction	$dB(A)$	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Reflection Correction	$dB(A)$	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Shift Duration, T	Hrs	10	10	10	10	10	10	10	10
Duration of Activity	Hrs	8	8	8	0	0	0	0	0
% Assessment Period	%	80.0%	80.0%	80.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Correction to $L_{Aeq}$	$dB(A)$	-1.0	-1.0	-1.0	0.0	0.0	0.0	0.0	0.0
<b>Resultant Noise Level</b>									
Activity $L_{Aeq,T}$	$dB(A)$	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Total $L_{Aeq,T}$	$dB(A)$	0.0
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## Appendix A - Excavation Noise Calculations



### BS5228 (2009) Stationary Plant Sound Power Level Calculation (F.2.3)

Project	Littlehampton Tidal Defence Scheme	Date	31-Dec-2012
Construction Activity	Phase 1: Reach 1/2 Piling	By	Ian Stanworth
Sensitive Receiver	5. Reach 5 (Arun View PH)	Checked	Louise Hill

Distance to receiver:	0	metres	% Soft Ground to Receptor:	0.0%	Reflection:	FREE FIELD
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		1	2	3	4	5	6	7	8
Activity Description		BSP Shrouded Hammer Rig	Lifting	PVE 40M Hydraulic Piling Vibrator	-	-	-	-	-
Plant Description		CX110 Unshrouded Rig	Tracked mobile crane 240 kW (105t)	Hydraulic Piling Vibrator	-	-	-	-	-
BS5228 Reference (Part 1 2009)		Tbl Other Ref 1	Tbl C.4, Ref 52	Tbl Other Ref 2	-	-	-	-	-
Quantity		1	1	1	0	0	0	0	0
Sound Power Level $L_{WA}$	$dB(A)$	129.0	103.0	113.0	0.0	0.0	0.0	0.0	0.0
Ave. Percentage On-Time	%	40.0%	20.0%	40.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Ave. On-Time Correction	$dB(A)$	-4.0	-7.0	-4.0	0.0	0.0	0.0	0.0	0.0
Corrected $L_{WA}$	$dB(A)$	125.0	96.0	109.0	0.0	0.0	0.0	0.0	0.0
<b>Corrections</b>									
Source-Receiver Distance	$m$	0	0	0	0	0	0	0	0
Percentage Soft Ground	%	0%	0%	0%	0%	0%	0%	0%	0%
Distance Correction	$dB(A)$	#NUM!	#NUM!	#NUM!	#NUM!	#NUM!	#NUM!	#NUM!	#NUM!
Soft Ground Correction	$dB(A)$	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Screening	None/Partial/Full	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE
Screening Correction	$dB(A)$	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Reflection Correction	$dB(A)$	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Shift Duration, T	Hrs	10	10	10	10	10	10	10	10
Duration of Activity	Hrs	8	8	8	0	0	0	0	0
% Assessment Period	%	80.0%	80.0%	80.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Correction to $L_{Aeq}$	$dB(A)$	-1.0	-1.0	-1.0	0.0	0.0	0.0	0.0	0.0
<b>Resultant Noise Level</b>									
Activity $L_{Aeq,T}$	$dB(A)$	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Total $L_{Aeq,T}$	$dB(A)$	0.0
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Project	Littlehampton Tidal Defence Scheme	Date	31-Dec-2012
Construction Activity	Phase 1: Reach 1/2 Piling	By	Ian Stanworth
Sensitive Receiver	6. Reach 6 (Marina Holiday Lodges)	Checked	Louise Hill

Distance to receiver:	0	metres	% Soft Ground to Receptor:	0.0%	Reflection:	FREE FIELD
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		1	2	3	4	5	6	7	8
Activity Description		BSP Shrouded Hammer Rig	Lifting	PVE 40M Hydraulic Piling Vibrator	-	-	-	-	-
Plant Description		CX110 Unshrouded Rig	Tracked mobile crane 240 kW (105t)	Hydraulic Piling Vibrator	-	-	-	-	-
BS5228 Reference (Part 1 2009)		Tbl Other Ref 1	Tbl C.4, Ref 52	Tbl Other Ref 2	-	-	-	-	-
Quantity		1	1	1	0	0	0	0	0
Sound Power Level $L_{WA}$	$dB(A)$	129.0	103.0	113.0	0.0	0.0	0.0	0.0	0.0
Ave. Percentage On-Time	%	40.0%	20.0%	40.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Ave. On-Time Correction	$dB(A)$	-4.0	-7.0	-4.0	0.0	0.0	0.0	0.0	0.0
Corrected $L_{WA}$	$dB(A)$	125.0	96.0	109.0	0.0	0.0	0.0	0.0	0.0
<b>Corrections</b>									
Source-Receiver Distance	$m$	0	0	0	0	0	0	0	0
Percentage Soft Ground	%	0%	0%	0%	0%	0%	0%	0%	0%
Distance Correction	$dB(A)$	#NUM!	#NUM!	#NUM!	#NUM!	#NUM!	#NUM!	#NUM!	#NUM!
Soft Ground Correction	$dB(A)$	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Screening	None/Partial/Full	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE
Screening Correction	$dB(A)$	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Reflection Correction	$dB(A)$	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Shift Duration, T	Hrs	10	10	10	10	10	10	10	10
Duration of Activity	Hrs	8	8	8	0	0	0	0	0
% Assessment Period	%	80.0%	80.0%	80.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Correction to $L_{Aeq}$	$dB(A)$	-1.0	-1.0	-1.0	0.0	0.0	0.0	0.0	0.0
<b>Resultant Noise Level</b>									
Activity $L_{Aeq,T}$	$dB(A)$	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Total $L_{Aeq,T}$	$dB(A)$	0.0
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## Appendix A - Excavation Noise Calculations



### BS5228 (2009) Stationary Plant Sound Power Level Calculation (F.2.3)

Project	Littlehampton Tidal Defence Scheme	Date	31-Dec-2012
Construction Activity	Phase 1: Reach 1/2 Piling	By	Ian Stanworth
Sensitive Receiver	7. At 50m	Checked	Louise Hill

Distance to receiver:	50	metres	% Soft Ground to Receptor:	0.0%	Reflection:	FREE FIELD
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		1	2	3	4	5	6	7	8
Activity Description		BSP Shrouded Hammer Rig	Lifting	PVE 40M Hydraulic Piling Vibrator	-	-	-	-	-
Plant Description		CX110 Unshrouded Rig	Tracked mobile crane 240 kW (105t)	Hydraulic Piling Vibrator	-	-	-	-	-
BS5228 Reference (Part 1 2009)		Tbl Other Ref 1	Tbl C.4, Ref 52	Tbl Other Ref 2	-	-	-	-	-
Quantity		1	1	1	0	0	0	0	0
Sound Power Level $L_{WA}$	$dB(A)$	129.0	103.0	113.0	0.0	0.0	0.0	0.0	0.0
Ave. Percentage On-Time	%	40.0%	20.0%	40.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Ave. On-Time Correction	$dB(A)$	-4.0	-7.0	-4.0	0.0	0.0	0.0	0.0	0.0
Corrected $L_{WA}$	$dB(A)$	125.0	96.0	109.0	0.0	0.0	0.0	0.0	0.0
<b>Corrections</b>									
Source-Receiver Distance	$m$	50	50	50	50	50	50	50	50
Percentage Soft Ground	%	0%	0%	0%	0%	0%	0%	0%	0%
Distance Correction	$dB(A)$	-42.0	-42.0	-42.0	-42.0	-42.0	-42.0	-42.0	-42.0
Soft Ground Correction	$dB(A)$	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Screening	None/Partial/Full	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE
Screening Correction	$dB(A)$	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Reflection Correction	$dB(A)$	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Shift Duration, T	Hrs	10	10	10	10	10	10	10	10
Duration of Activity	Hrs	8	8	8	0	0	0	0	0
% Assessment Period	%	80.0%	80.0%	80.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Correction to $L_{Aeq}$	$dB(A)$	-1.0	-1.0	-1.0	0.0	0.0	0.0	0.0	0.0
<b>Resultant Noise Level</b>									
Activity $L_{Aeq,T}$	$dB(A)$	82.1	53.1	66.1	0.0	0.0	0.0	0.0	0.0

Total $L_{Aeq,T}$	$dB(A)$	82.2
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Project	Littlehampton Tidal Defence Scheme	Date	31-Dec-2012
Construction Activity	Littlehampton Tidal Defence Scheme	By	Ian Stanworth
Sensitive Receiver	8. At 100m	Checked	Louise Hill

Distance to receiver:	100	metres	% Soft Ground to Receptor:	0.0%	Reflection:	FREE FIELD
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		1	2	3	4	5	6	7	8
Activity Description		BSP Shrouded Hammer Rig	Lifting	PVE 40M Hydraulic Piling Vibrator	-	-	-	-	-
Plant Description		CX110 Unshrouded Rig	Tracked mobile crane 240 kW (105t)	Hydraulic Piling Vibrator	-	-	-	-	-
BS5228 Reference (Part 1 2009)		Tbl Other Ref 1	Tbl C.4, Ref 52	Tbl Other Ref 2	-	-	-	-	-
Quantity		1	1	1	0	0	0	0	0
Sound Power Level $L_{WA}$	$dB(A)$	129.0	103.0	113.0	0.0	0.0	0.0	0.0	0.0
Ave. Percentage On-Time	%	40.0%	20.0%	40.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Ave. On-Time Correction	$dB(A)$	-4.0	-7.0	-4.0	0.0	0.0	0.0	0.0	0.0
Corrected $L_{WA}$	$dB(A)$	125.0	96.0	109.0	0.0	0.0	0.0	0.0	0.0
<b>Corrections</b>									
Source-Receiver Distance	$m$	100	100	100	100	100	100	100	100
Percentage Soft Ground	%	0%	0%	0%	0%	0%	0%	0%	0%
Distance Correction	$dB(A)$	-48.0	-48.0	-48.0	-48.0	-48.0	-48.0	-48.0	-48.0
Soft Ground Correction	$dB(A)$	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Screening	None/Partial/Full	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE
Screening Correction	$dB(A)$	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Reflection Correction	$dB(A)$	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Shift Duration, T	Hrs	10	10	10	10	10	10	10	10
Duration of Activity	Hrs	8	8	8	0	0	0	0	0
% Assessment Period	%	80.0%	80.0%	80.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Correction to $L_{Aeq}$	$dB(A)$	-1.0	-1.0	-1.0	0.0	0.0	0.0	0.0	0.0
<b>Resultant Noise Level</b>									
Activity $L_{Aeq,T}$	$dB(A)$	76.1	47.0	60.1	0.0	0.0	0.0	0.0	0.0

Total $L_{Aeq,T}$	$dB(A)$	76.2
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## Appendix A - Excavation Noise Calculations



### BS5228 (2009) Stationary Plant Sound Power Level Calculation (F.2.3)

Project	Littlehampton Tidal Defence Scheme	Date	31-Dec-2012
Construction Activity	Littlehampton Tidal Defence Scheme	By	Ian Stanworth
Sensitive Receiver	9. At 150m	Checked	Louise Hill

Distance to receiver:	150	metres	% Soft Ground to Receptor:	0.0%	Reflection: FREE FIELD
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		1	2	3	4	5	6	7	8
Activity Description		BSP Shrouded Hammer Rig	Lifting	PVE 40M Hydraulic Piling Vibrator	-	-	-	-	-
Plant Description		CX110 Unshrouded Rig	Tracked mobile crane 240 kW (105t)	Hydraulic Piling Vibrator	-	-	-	-	-
BS5228 Reference (Part 1 2009)		Tbl Other Ref 1	Tbl C.4, Ref 52	Tbl Other Ref 2	-	-	-	-	-
Quantity		1	1	1	0	0	0	0	0
Sound Power Level $L_{WA}$	$dB(A)$	129.0	103.0	113.0	0.0	0.0	0.0	0.0	0.0
Ave. Percentage On-Time	%	40.0%	20.0%	40.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Ave. On-Time Correction	$dB(A)$	-4.0	-7.0	-4.0	0.0	0.0	0.0	0.0	0.0
Corrected $L_{WA}$	$dB(A)$	125.0	96.0	109.0	0.0	0.0	0.0	0.0	0.0
<b>Corrections</b>									
Source-Receiver Distance	$m$	150	150	150	150	150	150	150	150
Percentage Soft Ground	%	0%	0%	0%	0%	0%	0%	0%	0%
Distance Correction	$dB(A)$	-51.5	-51.5	-51.5	-51.5	-51.5	-51.5	-51.5	-51.5
Soft Ground Correction	$dB(A)$	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Screening	None/Partial/Full	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE
Screening Correction	$dB(A)$	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Reflection Correction	$dB(A)$	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Shift Duration, T	Hrs	10	10	10	10	10	10	10	10
Duration of Activity	Hrs	8	8	8	0	0	0	0	0
% Assessment Period	%	80.0%	80.0%	80.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Correction to $L_{Aeq}$	$dB(A)$	-1.0	-1.0	-1.0	0.0	0.0	0.0	0.0	0.0
<b>Resultant Noise Level</b>									
Activity $L_{Aeq,T}$	$dB(A)$	72.5	43.5	56.5	0.0	0.0	0.0	0.0	0.0

Total $L_{Aeq,T}$	$dB(A)$	72.6
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Project	Littlehampton Tidal Defence Scheme	Date	31-Dec-2012
Construction Activity	Littlehampton Tidal Defence Scheme	By	Ian Stanworth
Sensitive Receiver	10. At 200m	Checked	Louise Hill

Distance to receiver:	200	metres	% Soft Ground to Receptor:	0.0%	Reflection: FREE FIELD
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		1	2	3	4	5	6	7	8
Activity Description		BSP Shrouded Hammer Rig	Lifting	PVE 40M Hydraulic Piling Vibrator	-	-	-	-	-
Plant Description		CX110 Unshrouded Rig	Tracked mobile crane 240 kW (105t)	Hydraulic Piling Vibrator	-	-	-	-	-
BS5228 Reference (Part 1 2009)		Tbl Other Ref 1	Tbl C.4, Ref 52	Tbl Other Ref 2	-	-	-	-	-
Quantity		1	1	1	0	0	0	0	0
Sound Power Level $L_{WA}$	$dB(A)$	129.0	103.0	113.0	0.0	0.0	0.0	0.0	0.0
Ave. Percentage On-Time	%	40.0%	20.0%	40.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Ave. On-Time Correction	$dB(A)$	-4.0	-7.0	-4.0	0.0	0.0	0.0	0.0	0.0
Corrected $L_{WA}$	$dB(A)$	125.0	96.0	109.0	0.0	0.0	0.0	0.0	0.0
<b>Corrections</b>									
Source-Receiver Distance	$m$	200	200	200	200	200	200	200	200
Percentage Soft Ground	%	0%	0%	0%	0%	0%	0%	0%	0%
Distance Correction	$dB(A)$	-54.0	-54.0	-54.0	-54.0	-54.0	-54.0	-54.0	-54.0
Soft Ground Correction	$dB(A)$	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Screening	None/Partial/Full	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE
Screening Correction	$dB(A)$	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Reflection Correction	$dB(A)$	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Shift Duration, T	Hrs	10	10	10	10	10	10	10	10
Duration of Activity	Hrs	8	8	8	0	0	0	0	0
% Assessment Period	%	80.0%	80.0%	80.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Correction to $L_{Aeq}$	$dB(A)$	-1.0	-1.0	-1.0	0.0	0.0	0.0	0.0	0.0
<b>Resultant Noise Level</b>									
Activity $L_{Aeq,T}$	$dB(A)$	70.0	41.0	54.0	0.0	0.0	0.0	0.0	0.0

Total $L_{Aeq,T}$	$dB(A)$	70.1
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## Appendix A - Excavation Noise Calculations



### BS5228 (2009) Stationary Plant Sound Power Level Calculation (F.2.3)

Project	Littlehampton Tidal Defence Scheme	Date	31-Dec-2012
Construction Activity	Littlehampton Tidal Defence Scheme	By	Ian Stanworth
Sensitive Receiver	11. At 250m	Checked	Louise Hill

Distance to receiver:	250	metres	% Soft Ground to Receptor:	0.0%	Reflection: FREE FIELD
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		1	2	3	4	5	6	7	8
Activity Description		BSP Shrouded Hammer Rig	Lifting	PVE 40M Hydraulic Piling Vibrator	-	-	-	-	-
Plant Description		CX110 Unshrouded Rig	Tracked mobile crane 240 kW (105t)	Hydraulic Piling Vibrator	-	-	-	-	-
BS5228 Reference (Part 1 2009)		Tbl Other Ref 1	Tbl C.4, Ref 52	Tbl Other Ref 2	-	-	-	-	-
Quantity		1	1	1	0	0	0	0	0
Sound Power Level $L_{WA}$	$dB(A)$	129.0	103.0	113.0	0.0	0.0	0.0	0.0	0.0
Ave. Percentage On-Time	%	40.0%	20.0%	40.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Ave. On-Time Correction	$dB(A)$	-4.0	-7.0	-4.0	0.0	0.0	0.0	0.0	0.0
Corrected $L_{WA}$	$dB(A)$	125.0	96.0	109.0	0.0	0.0	0.0	0.0	0.0
<b>Corrections</b>									
Source-Receiver Distance	$m$	250	250	250	250	250	250	250	250
Percentage Soft Ground	%	0%	0%	0%	0%	0%	0%	0%	0%
Distance Correction	$dB(A)$	-56.0	-56.0	-56.0	-56.0	-56.0	-56.0	-56.0	-56.0
Soft Ground Correction	$dB(A)$	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Screening	None/Partial/Full	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE
Screening Correction	$dB(A)$	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Reflection Correction	$dB(A)$	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Shift Duration, T	Hrs	10	10	10	10	10	10	10	10
Duration of Activity	Hrs	8	8	8	0	0	0	0	0
% Assessment Period	%	80.0%	80.0%	80.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Correction to $L_{Aeq}$	$dB(A)$	-1.0	-1.0	-1.0	0.0	0.0	0.0	0.0	0.0
<b>Resultant Noise Level</b>									
Activity $L_{Aeq,T}$	$dB(A)$	68.1	39.1	52.1	0.0	0.0	0.0	0.0	0.0

Total $L_{Aeq,T}$	$dB(A)$	68.2
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Project	Littlehampton Tidal Defence Scheme	Date	31-Dec-2012
Construction Activity	Littlehampton Tidal Defence Scheme	By	Ian Stanworth
Sensitive Receiver	12. At 300m	Checked	Louise Hill

Distance to receiver:	300	metres	% Soft Ground to Receptor:	0.0%	Reflection: FREE FIELD
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		1	2	3	4	5	6	7	8
Activity Description		BSP Shrouded Hammer Rig	Lifting	PVE 40M Hydraulic Piling Vibrator	-	-	-	-	-
Plant Description		CX110 Unshrouded Rig	Tracked mobile crane 240 kW (105t)	Hydraulic Piling Vibrator	-	-	-	-	-
BS5228 Reference (Part 1 2009)		Tbl Other Ref 1	Tbl C.4, Ref 52	Tbl Other Ref 2	-	-	-	-	-
Quantity		1	1	1	0	0	0	0	0
Sound Power Level $L_{WA}$	$dB(A)$	129.0	103.0	113.0	0.0	0.0	0.0	0.0	0.0
Ave. Percentage On-Time	%	40.0%	20.0%	40.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Ave. On-Time Correction	$dB(A)$	-4.0	-7.0	-4.0	0.0	0.0	0.0	0.0	0.0
Corrected $L_{WA}$	$dB(A)$	125.0	96.0	109.0	0.0	0.0	0.0	0.0	0.0
<b>Corrections</b>									
Source-Receiver Distance	$m$	300	300	300	300	300	300	300	300
Percentage Soft Ground	%	0%	0%	0%	0%	0%	0%	0%	0%
Distance Correction	$dB(A)$	-57.5	-57.5	-57.5	-57.5	-57.5	-57.5	-57.5	-57.5
Soft Ground Correction	$dB(A)$	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Screening	None/Partial/Full	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE
Screening Correction	$dB(A)$	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Reflection Correction	$dB(A)$	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Shift Duration, T	Hrs	10	10	10	10	10	10	10	10
Duration of Activity	Hrs	8	8	8	0	0	0	0	0
% Assessment Period	%	80.0%	80.0%	80.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Correction to $L_{Aeq}$	$dB(A)$	-1.0	-1.0	-1.0	0.0	0.0	0.0	0.0	0.0
<b>Resultant Noise Level</b>									
Activity $L_{Aeq,T}$	$dB(A)$	66.5	37.5	50.5	0.0	0.0	0.0	0.0	0.0

Total $L_{Aeq,T}$	$dB(A)$	66.6
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# Appendix E – Archaeology (Heritage Statement)

This appendix contains two reports.

The first is a copy of the Cultural Heritage Appraisal undertaken in 2009/2010, during preparation of the Scoping Report, and the second is an update report undertaken in 2012/13, during preparation of the Environmental Statement.

A full gazetteer of archaeological and heritage sites is included in the update report, together with details of the assessment methods used during the assessment.

Note that the figures that accompany these reports have not been reproduced here as they are provided in Volume Two, the main text of the Environmental Statement, as follows:

- Figure 6.1 – Designated Cultural Heritage Assets - NORTH
- Figure 6.2 – Designated Cultural Heritage Assets - SOUTH
- Figure 6.3 – Non-Designated Cultural Heritage Assets - NORTH
- Figure 6.4 – Non-Designated Cultural Heritage Assets - SOUTH
- Figure 6.5 – Rapid Coastal Zone Assessment Data
- Figure 6.6 – Historic Landscape Character Data
- Figure 6.7 – Archaeological Sensitivity Plan
- Figure 6.8 – Ground Investigation Results and Known Archaeology
- Figure 6.9 – Ordnance Survey West Sussex Sheets LXIII/13, 1:2500, 1876 – Reach 6

## **Environment Agency**

Littlehampton Arun Tidal Defences (East Bank)

Cultural Heritage Appraisal

November 2010

**Halcrow Group Limited**

## **Environment Agency**

Littlehampton Arun Tidal Defences (East Bank)

Cultural Heritage Appraisal

November 2010

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# Environment Agency

## Littlehampton Arun Tidal Defences (East Bank) Cultural Heritage Appraisal

### Contents Amendment Record

This report has been issued and amended as follows:

Issue	Revision	Description	Date	Approved by
1	1	Draft for internal review	4 <sup>th</sup> December 2009	JG/EJW
1	2	Revised draft after internal review	11 <sup>th</sup> December 2009	JG/EJW
1	3	Revised submission following client comments	18 <sup>th</sup> January 2010	JG/EJW
1	4	Revised submission following Local Planning Authority comments	24 <sup>th</sup> February 2010	JG/EJW
1	5	Revised submission following responses to the Scoping Consultation Document	November 2010	EJW

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# 1 Introduction

Halcrow Group Ltd (Halcrow) has been commissioned by the Environment Agency to provide engineering and environmental consultancy for the proposed renewal and enhancement of the tidal walls along the lower reaches of the River Arun (East Bank) at Littlehampton, West Sussex ('the proposed scheme').

This report appraises the cultural heritage (archaeology, built heritage and historic townscape or landscape) resource along the line of the proposed enhancement, and identifies constraints, issues and opportunities relating to this resource.

Section 2 outlines the methodology for this report; Section 3 describes the baseline and Section 4 the issues, constraints and opportunities relating to the cultural heritage resource.

## 2 Methodology

To appraise the cultural heritage resource for the River Arun in this report, primary data was acquired from the following sources:

- The National Monuments Record (NMR) for the most recent listed building data, and;
- The West Sussex County Council (WSCC) Historic Environment Record (HER) for archaeological sites and monuments data and urban historic character data.

The datasets were acquired for an area which incorporated the proposed extent of the scheme, and a 300m buffer area projecting outwards from the edge of this boundary. This study area incorporated the western portion of the town of Littlehampton, the River Arun and an area on the west bank of the river. The site includes the revetment in between the River Arun and the railway line in the north, and follows the east bank of the river to East Pier at the southern end.

The data has been reproduced on two Indicative Heritage Plans (Appendix 1). The WSCC HER and NMR reference numbers are presented in brackets after the monument/ building name when reproduced below.

An Archaeological Sensitivity Plan (Figure 3, Appendix 1) has been produced based on the West Sussex Extensive Urban Survey that has been undertaken by WSCC. The zones of sensitivity have been reproduced from the areas of the town covered by the survey. No archaeological sensitivity data has been reproduced for those areas not covered by the survey. Archaeological sensitivity can only be determined by detailed archaeological assessment.

The location and nature of statutory designations for the wider area has been established through viewing data on the MAGIC website ([www.magic.gov.uk](http://www.magic.gov.uk)).

Additional information on the nature of archaeology and heritage in Littlehampton has been retrieved from online resources, which include:

- [www.shorchamfort.co.uk](http://www.shorchamfort.co.uk)
- [www.palmerstonforts.gov.uk](http://www.palmerstonforts.gov.uk)
- [www.romansinsussex.co.uk](http://www.romansinsussex.co.uk)

Contact was made with the Littlehampton Museum and Town Council to see if there were any useful resources that could be obtained to aid the study.

This appraisal is not an archaeological desk-based assessment as defined by the Institute for Archaeologists (IfA) standards and guidance documentation. For instance, this report has not utilised the full range of documentary, cartographic, photographic and published/ unpublished sources as required by the IfA guidance. In addition, this report does not include an impact assessment on the cultural heritage resource, but merely highlights the possible issues associated with implementing the proposed scheme.

## **3 Baseline Environment**

### **3.1 *Introduction***

This section lays out the known cultural heritage resource within the site and study area. The potential (as yet unknown) resource is explored in Section 4.

The designated and non-designated sites and monuments below are reproduced on supporting drawings (Figures 1-3).

### **3.2 *Historic Environment Overview***

'Littlehampton was a village in the medieval period, with the main port of the River Arun located upstream at Arundel. The first evidence of significant maritime activity at Littlehampton itself dates from the mid-16<sup>th</sup> century, but it remained a village until the late 18<sup>th</sup> century, when both the port and the seaside resort began to develop. Few buildings survive from before the 18<sup>th</sup> century, and nothing appears to pre-date 1500. Evidence of the emerging port survives in the form of late 18<sup>th</sup> century houses in Surrey Street and early 19<sup>th</sup> century houses and warehouses in River Road. The early resort at Beach Town is represented by large terraced lodging houses in South Terrace and Norfolk Place, and, to the rear, small terraced houses in Western Road, of c.1790-1825. A key survival of the 19<sup>th</sup> century is the fort of 1854. Although there has been some exploration of the archaeology of the emergent port and resort, and the prehistoric and Romano-British occupation in the area, the potential of archaeological evidence for the pre-18<sup>th</sup>-century village has yet to be realized.' (Statement of Historic Urban Character, WSCC)

### **3.3 *Statutory and non-statutory designations***

There are no scheduled monuments, listed buildings, registered battlefields, registered historic parks and gardens or world heritage sites within the site boundary.

A scheduled monument – Littlehampton Fort (MWS 3361) – is located in the wider study area at the southern end of the scheme, on the west side of the harbour mouth on what is now Littlehampton golf course. The monument, which comprises earthworks and upstanding stone walls, is currently heavily vegetated and derelict (although there are agreements in place with the Golf Club, English Heritage and West Sussex County Council coastal ranger for volunteer parties progressively to reduce the ivy in anticipation of consolidation measures).

The proposed scheme runs through a portion of the River Road Conservation Area, which is located approximately halfway along the scheme. The proposed scheme runs through the western side of the Conservation Area, which includes a large stretch of the river frontage. The majority of the designated area lies to the east of the site, however, incorporating what appears to be mostly a residential area.

Two further Conservation Areas; East Street and the Seafront, lie at the eastern edges of the study area (approximately 300m to the east of the site).

There are no listed buildings within the boundaries of the proposed scheme. The majority of these designations are located in a cluster outside of the site boundary, and are within and near to a portion of the River Road Conservation Area.

Within, and adjacent to, the River Road Conservation Area the following Grade II listed buildings are present:

- No. 12 River Road (297487);
- No. 10 River Road (297486);
- No. 7 and 8 River Road (297485);
- No. 1 River Road (297483);
- No. 4 and 5 River Road (297484);
- No. 61 Surrey Street, 'The Cairo Club' (297510);
- No. 59 Surrey Street, 'Old Quay House' (297509);
- Nos. 31-37 Surrey Street, 'Floyd's Corner' (297508);
- No. 34 Surrey Street (297507);
- No. 32 Surrey Street, 'The White Hart Public House' (297506);
- Nos. 20-24 Surrey Street (297505);
- A garden wall (297450) fronting Avon House on Avon Road;
- St Catherine's Presbytery (416340) on Beach Road;
- St Catherine's Roman Catholic Church (297452) on Beach Road, and;
- A war memorial on Beach Road (297451).

Within the River Road Conservation Area, there are two non-listed but locally important buildings, which are rare local survivals of post-medieval buildings on the east bank of the river, and form part of the tidal walls:

- No. 47 River Road (an early riverside flint and brick warehouse) and;
- An adjoining (no. 47) warehouse of mid-19<sup>th</sup> century date

### **3.4**

#### ***Non-designated monuments and other receptors***

The following archaeological monuments and find spots (listed from north to south along the course of the proposed scheme) lie within or adjacent to the site boundary:

- The line of WWII perimeter defences (MWS 8184);
- The site of WWII anti-tank cylinders on the quayside (MWS 8298);
- The former site of a swing bridge (MWS 5736);
- Buried archaeology associated with an old wharf building on River Road (MWS 7055);
- A harbour with saw mill (MWS 3107);

- The site of a windmill (MWS 3115) now no longer extant and within an amusement arcade. This monument might still have archaeological remains below ground level;
- The site of a gun battery (MWS 3114) dating to 1759 and dismantled in 1830's when it was replaced by the battery on the west side of the river (Littlehampton Fort SM), and;
- Roman coins findspot (MWS 3088) have been found just to the east of East Pier in the foreshore area.

The remaining historic buildings, archaeological monuments and findspots in the study area east of the river give an indication of the multi-period human occupation and activity in Littlehampton. From north to south, these receptors are:

- A sherd of Neolithic (prehistoric) pottery (MWS 3119);
- Iron Age (prehistoric) settlement (MWS 3899) excavated in advance of ring road construction. This was accompanied by a spread of occupation debris (MWS 3900) from the same period;
- Part of a Neolithic (prehistoric) axe (MWS 3474);
- Upstanding 1860's brewery building (MSW 3112);
- The site of a malthouse (MSW 6571);
- Prehistoric axe (MSW 2097);
- The later medieval village of Littlehampton (MSW 5799);
- Roman coin find spot (MSW 5734);
- Floyds Corner (MSW 4374) is an area of 18<sup>th</sup> and 19<sup>th</sup> century development that has been superseded but buried remains survive;
- A bronze coin findspot (MSW 3098);
- A prehistoric saddle quern find spot (MSW 3196);
- A Roman coin find spot (MSW 3087) and;
- The timber groynes along the beach front are not included in the HER data, but may have some historic value, as they are likely to date from the mid to late 19<sup>th</sup> century onwards.

Within the study area to the west of the River Arun the following buildings, monuments and find spots are recorded:

- A series (three) of flint and brick-built workshops (MSW 6574) dating to the first half of the 19<sup>th</sup> century;
- The site of the Climping Shipyard (MSW 3108), a former boat building and repair yard;
- Two rifle ranges (MSW 8297) have been located on late 19<sup>th</sup> century Ordnance Survey mapping;
- The site of the town gasworks (MWS 3109) constructed in the mid-19<sup>th</sup> century which is now inactive but the buildings remain;
- The site of a marker post of unknown date (MWS 8296);

- The harbour entrance at Littlehampton (MSW 3106) was cut in the early 18<sup>th</sup> century and has seen few changes since then, although the East Pier has been replaced several times, and;
- WWII Defence Work (MSW 7563) on the west side of Littlehampton Harbour.

### 3.5

#### ***Littlehampton Extensive Urban Survey***

West Sussex has been subject to an Extensive Urban Survey (EUS) which has characterised urban areas through historic assessment of their form. The process includes the establishment of time-depth, through study of historic mapping, archaeology and the present historic and modern built resource. These historic character areas are reproduced as polygons within a GIS dataset, and the resulting data informs archaeological potential, historic environment value (HEV) and links in to local research questions.

The HEV is based on a five point scale established by WSCC, with 1 being the lowest and 5 the highest value. This is based on an assessment of:

- Townscape rarity;
- Time-depth or antiquity;
- Completeness;
- Visibility, and;
- Historic association.

The proposed scheme passes through four historic urban character (HUCA) types within Littlehampton (Figure 3). These are, from north to south:

- The Station (05);
- River Road (04);
- New Road (06) and;
- Seafront (09).

The Station HUCA (5) comprises the railway station, wharves and associated development on the north west side of Littlehampton. The area had a wharf in the early 19<sup>th</sup> century but development largely commenced in the 1860's when the railway was constructed. The station building itself has been replaced by modern residential development. Most of this area lies outside the pre-1863 (pre-railway) town limits, and archaeological intervention has not revealed significant archaeology, therefore the HEV has been put at 1.

The River Road HUCA (4) lies to the south of the historic pre-1700 core of Littlehampton. "The south-eastern part of River Road and the north part of Pier Road probably originate as medieval river walls, and the area west of this certainly appears to have been reclaimed after 1700, possibly excepting a modest earlier quay or landing place. Wharves were developed in the 18<sup>th</sup> century and, especially, the early 19<sup>th</sup> century, with Surrey Street extended towards the river frontage and built up. Today the area is partly commercial and partly residential, with many of the river frontage wharves being replaced since 2001 by blocks of flats.

Excavations at Floyd's Corner, Pier Road in 1993 and at Baltic Wharf in 2001 confirmed the absence of medieval archaeology, and reclamation of

land in the river front area by or in the late 18th century. Combined with the fact that any earlier landing place may have been no more than a hard, and that the part of the HUCA north of River Road lies largely outside the extent of the pre-1800 town, it is likely that the archaeological potential of the HUCA is limited.

The surviving 18th-century and later historic buildings, and the archaeological potential give this HUCA an HEV of 2.' (Statement of Historic Urban Character, WSCC).

The New Road HUCA (6) 'lies almost entirely outside the pre-1840 town, and predominantly comprises late 19th-century suburbs lying to the south of the High Street, between earlier Pier Road (on the west) and Bayford Road (on the east): the suburb was based on the grid of late 19th-century New Road, Clifton Road and Bayford Road. The area is largely residential, with the important exception of a saw mill and timber yard between the north end of Clifton Road and Pier Road: this was one of the first developments in the HUCA, being established by 1876.

The location of this suburb almost entirely outside the pre-1840 extent of the town, coupled with the subsequent density of building, means that the archaeological potential of this HUCA is limited.

The lack of historic buildings combined with the archaeological potential gives this HUCA an Historic Environment Value (HEV) of 1'. (Statement of Historic Urban Character, WSCC)

The Seafront HUCA (9) 'comprises the beach and the area to the north, which combines the open recreational grass area of the Green, the beach, leisure facilities and a small amusement park. The area began to be used as the resort seafront in the late 18th century, and attracted the Beach Coffee House of c.1775 (later the Beach Hotel: the site is now occupied by Beach Crescent, built 1995), and was in part land reclaimed from the shingle spit and river mouth prior to the establishment of the current harbour entrance in the 1730s.

There are no listed buildings. The earliest manmade feature of interest is the remains of a battery of seven guns (MWS 3114), built immediately on the east side of the harbour mouth in 1759-60. Later occupied by the coastguard the remaining earthwork is now part of the amusement park. No early resort buildings survive, with the oldest such remains comprising the 1912 Shelter Hall, now much modified as the Windmill theatre.

Excavation on the site of the 18th-century Beach Hotel in 1995 found no significant archaeology, confirming that the archaeological potential of this HUCA is likely to be limited.

The Seafront HUCA has seen considerable redevelopment in the 20th century, especially with successive redevelopment of the former battery and coastguard area on the west side of the Green, and gradual erosion of the extent of the Green through building and car parks. Although the Historic Environment Value is modest, the vulnerability of the HUCA is medium, as further encroachment on to the Green – a key feature of the seafront area since the late 18th century – is a significant threat.' The overall HER value of this area is 1 (Statement of Historic Urban Character, WSCC).

## **4 Constraints and Challenges**

### **4.1**

#### ***Proposed Scheme***

At time of writing, the detailed design of the proposed scheme is not available. However, the scheme aims to enhance the flood protection of Littlehampton through the renewal and strengthening of the existing tidal walls along the lower reaches of the River Arun. Predominantly, the enhancement works will take place along the line of the existing defences and will comprise new vertical structures along sections of the river wall. Sheet-piling might be utilised along selected lengths of the river, in some cases replacing existing flood walls, and in others possibly through the centre of existing flood embankments. Existing earthen embankments will likely be raised.

The cultural heritage resource includes buried and extant archaeology, built heritage and historic landscapes. Any of these elements can be adversely affected by development, through construction-related impacts or from the location, design or size of a particular scheme. For instance, buried archaeology can be negatively affected by removal of soil horizons through machine excavation, de-watering through changes in groundwater regimes, compression by plant activity and piling/ sheeting. Built heritage can be affected either physically through demolition or construction-related vibration, or have settings affected. All development schemes, from transport infrastructure, land development or flood management or managed realignment, has the potential to change historic landscapes through the physical erosion of landscape elements or overall signatures.

Given the nature of these enhancements, the nature of the construction work has the potential to adversely affect buried archaeological structures and deposits, as well as the physical structure and historic setting of historic buildings (listed or otherwise). However, the HUCA data suggests that on the land on the east side of the river there is a low potential for the presence of archaeological deposits.

### **4.2**

#### ***National and Local policies regarding the Historic Environment***

The following are a list of the policies relevant to this study which may have relevance to the archaeological and built heritage issues relating to the scheme as set out below (Section 4.3). (Note that this was correct at the time of writing but will require update as the scheme progresses. NPP 15 and 16 have been superseded by PPS5. The Local Development Framework for Littlehampton is also currently being revised by Arun District Council in accordance with recently revised national policy in accordance with the timetable set out in the Local Development Scheme.)

##### **National Planning Policy and Planning Guidance**

#### **4.2.1**

##### **National Planning Policy Guidance 16: Archaeology and Planning**

The importance of archaeology in the planning process is detailed in PPG16. The underlying principle is that archaeological remains should be



seen as a finite and non-renewable resource and should be regarded as a part of the environment to be protected and managed. The primary objective is to secure the best possible treatment of the archaeological heritage.

Where nationally important archaeological remains, whether scheduled or not, and their settings are affected by a proposed development there should be a presumption in favour of their physical preservation. If physical preservation in-situ is not feasible, an archaeological excavation for the purposes of 'preservation by record' may be an acceptable alternative. From an archaeological point of view, this should be regarded as a second best option.

#### 4.2.2 National Planning Policy Guidance 15: Planning and Historic Environment

PPG15 recognises that the listed buildings, conservation areas and other historic sites, which together form some of the individual elements of the historic environment, are a unique and irreplaceable record that contributes to our understanding of both the present and the past.

In any development control decision, planning authorities are required to fully take account of and mitigate the possibility of unnecessary erosion or damage to this resource. PPG15 ensures that protection should be given not only to the assets themselves but also to the settings, which contribute to their character.

#### 4.2.3 The Ancient Monument and Ancient Areas Act 1979

This is national policy which governs the nature and treatment of statutorily designated sites and monuments. This feeds through into all local policies.

#### Listed Buildings and Conservation Areas Act 1990

This national policy establishes the framework for national and local authorities for protection of historic buildings and areas through the implementation of statutory protection.

### **Local Legislation and Planning Guidance**

#### **Arun District Council Local Plan (Adopted September 2003)**

#### 4.2.4 Policy Area 16 Ancient Monument and Sites of National Archaeological Importance

'There will be a presumption in favour of the preservation of scheduled and other nationally important monuments and archaeological remains. Development which adversely affects their sites or settings will not be permitted'

#### 4.2.5 Policy Area 17 Sites of Archaeological Importance

Permission will not be granted for development that would be harmful to the significant archaeological interest of a site. Where the presence of archaeological remains is known or suspected:

- (i) the applicant must arrange for archaeological assessment of the site to be carried out before the planning application is determined;
- (ii) where the assessment shows that the physical preservation of remains in situ is not justified, conditions may be attached to any permission granted that development will not take place until provision has been made by the

developer for a programme of archaeological investigation and recording. The programme will be carried out prior to the commencement of the development;  
and

(iii) whenever practicable, opportunities should be taken for the enhancement and interpretation of archaeological remains left in situ.

#### 4.2.6 Policy DEV 11 Setting of listed buildings

‘Proposals which adversely affect the setting of a Listed Building, or group of Listed Buildings, will be resisted. Where the principle of development in the grounds of, or near to Listed Buildings is acceptable, it should be sensitively designed and constructed of appropriate materials to ensure that the special qualities of the older buildings remain unimpaired. Where relevant, appropriate space about the building or buildings must be retained. Proposals for more distant buildings and tall structures, including pylons and masts, will be carefully assessed in respect of their effect on the settings of Listed Buildings.’

#### 4.2.7 Policy Area 2 Conservation Areas

‘Planning permission will be granted for development which preserves or enhances the character or appearance of a Conservation Area or its setting.’

The policy towards Conservation Areas is further detailed in the Arun District Council Supplementary Planning Guidance (Arun DC, October 2000).

#### 4.2.8

A Supplementary Planning Guidance (SPG) for Archaeology has been produced by Arun District Council which provides additional planning advice concerning archaeology. This represents a material, though non-statutory, consideration for the local planning authority when considering applications.

### 4.3 ***Constraints and Issues***

The line of the proposed scheme runs through the River Road Conservation Area, which is a statutory designation. The detailed design of the new or enhanced tidal walls in this section of the scheme will have to take into account the policies towards development in Conservation Areas. There are regulations governing the nature of new development in Conservation Areas which concern the size and nature of the development, including the materials used.

The construction of new or renewed tidal walls within the River Road Conservation Area is likely to require Conservation Area Consent (CAC).

Although not on the line of the proposed scheme, Littlehampton Fort (MSW 3361) SM is approximately 100m to the west of it. Although the scheme will not physically affect the monument in any way, the issue of historic setting is still relevant. The extent of the potential impacts to the historic setting of the fort are not known at this time, given the lack of detailed design.

The majority of the listed buildings in the study area are within the River Road Conservation Area, and will not be affected in any way by the proposed scheme. The sole exception may be ‘The Cairo Club’ at no. 61

Surrey Street, which is a listed building located near to the line of flood walls. The settings of listed buildings are protected in the Arun Local Plan.

Buried archaeology is perhaps less of an issue than that regarding the designations above. This is owing to the fact that archaeological intervention in this area has not detected any significant archaeology, and also that much of the area in question lies outside of the historic core of the town, thereby reducing the chances for the presence of such features.

There is also the possibility for buried timber remains within the river corridor, such as boat or ship wrecks, timber revetments, structures associated with wharves or quaysides and general material associated with seaborne trading activity. Areas of foreshore often see a high degree of such activity and the remains of boats or shoreline structures can often remain well-preserved owing to water-logging.

There are three known monuments along the line of the proposed scheme; the site of a swing bridge (MWS 5736), harbour (MWS 3107) and windmill (MWS 3115). All three sites are likely to have buried remains associated with them, and any construction across them or in their vicinity may have an adverse impact on them.

The HUCA data has indicated that the zones along the east side of the river have a generally low archaeological potential. Most of this area appears to have been reclaimed since the 18<sup>th</sup> century and any shallow archaeological deposits surviving are likely to date from this time. However, these could still be deemed, following further examination, to be of some significance and worthy of avoidance or mitigation.

Buried at depth below the present mean water level palaeoenvironmental deposits are likely to exist. These may take the form of peaty deposits interleaved with episodes of alluvial deposition. Buried environments of this type are typical of coastal areas which, prior to post-medieval or modern development, were often areas of marshy river delta. Deposits may be further preserved by the reclamation of these marshy areas in the 18<sup>th</sup> and 19<sup>th</sup> centuries. In addition, the present course of the River Arun may be within a much earlier river glacial river channel. If in existence, this might contain artefacts, microfossils and pollen relevant to the very early prehistoric environment. Such deposits, should they exist, would be adversely affected by the insertion of new defences, although the features themselves might be of limited archaeological significance.

The flint-and brick buildings fronting on to the river (Photo 1) may suffer adverse effects from the proposed scheme. It is likely that any impacts on these buildings, would require mitigation, and may have an impact on the wider historic environment of the town as a result through changes to the historic setting of the river corridor. If, for instance, the buildings require demolition, a programme of standing building recording to a level deemed appropriate by the local planning authority might mitigate the effect of their removal. Damage as a result of piling near the buildings might also occur, in which case engineering solutions should be sought to minimise any adverse effect.

#### **4.4**

#### ***Future Actions for Consideration***

The study detected no Historic Parks and Gardens, Registered Battlefields or World Heritage Sites within the site boundary or the wider study area. There will be no issues outstanding regarding designations of this kind.

In order to inform detailed design and avoid any costly delays later on in the project timetable, it would be of benefit to the client to engage Arun District Council's Conservation team in consultation at an early stage in the design process. Detailed design could have to take into account the requirements for construction in the Conservation Area. It is possible that Conservation Area Consent will be required for the portion of the scheme that passes through the River Road Conservation Area.

The impacts of the proposed scheme on two historic properties should also be raised with the Arun DC Conservation team. These include Riverside Autos, which fronts on to the river (Photo 1 in Appendix 2). Although not listed, appropriate mitigation might have to be implemented to offset adverse impacts on its structure and historic setting. The potential impacts to the historic setting of the Cairo Club listed building should also be investigated. This is a Grade II listing, and therefore any consultation will be with the local planning authority and not English heritage (EH), although EH may well be consulted by Arun DC. It is also possible that listed building consent will be required should the setting of the Cairo Club be adversely affected, though consultation with Arun DC Conservation team will clarify this.

The regional EH planner has been consulted as part of this study by the Environment Agency with respect to potential impacts and consents related to Littlehampton Fort. EH responded by indicating that Scheduled Monument Consent (SMC) was not necessary in this instance, but that EH would like to be included in any further consultation regarding the nature of the proposed scheme and the potential impacts on the setting of the designation.

The WSCC Senior Archaeologist has been consulted about the scheme, and the comments received have been incorporated into this report. The WSCC Archaeologist will advise on the need for further detailed assessment, and if so it's likely scope as a consultee through the EIA and planning process. The necessity and scope of likely archaeological investigation and/ or mitigation may also be outlined at that stage.

Having appraised the cultural heritage data, it is thought unlikely that the presence of known buried archaeology along the course of the scheme would compromise the design of the proposed scheme in any way. Subject to location and design it may be necessary to implement archaeological monitoring, and potentially recording in advance, along sections of the scheme in order to record any historic structures or deposits, and therefore achieve mitigation through preservation by record. The client should be aware that sufficient funds should be set aside for any such interventions.

Consultation between the client and the WSCC Senior Archaeologist John Mills revealed that the palaeoenvironmental resource within the site and study area was a significant issue.

Mr Mills indicated that borehole data from further upstream of the scheme at Arundel was assessed, showing significant thicknesses of alluvial deposition. This has been identified as having potential for long sequences of deposited microfossils and plant remains in the peaty deposits interleaved with the alluvium. The potential thickness of the alluvial deposits within the scheme is likely to be higher than the 29 metres of alluvium detectable upstream. In addition to the geoarchaeologically significant peaty deposits, the glacial till underlying the alluvium may inform the local research cycle on the nature of the environment at the end of the last ice age.

Given the likelihood of piling being an element of the proposed scheme construction, the WSCC Archaeologist recommended geoarchaeological monitoring of boreholes prior to scheme construction in order that the quality of the alluvial deposits can be assessed prior to commencement of the scheme. The client must therefore bear in mind that geoarchaeological assessment is a requirement which might need to be implemented at some stage of the scheme.

The potential archaeological resource in the foreshore area might require assessment of some kind prior to implementation of the scheme. The nature of any such work should be discussed with the WSCC Archaeologist in the next round of consultation, prior to scheme implementation.

Given the slightly higher archaeological potential of the River Road Conservation Area in comparison to the other stretches of the river, it might be of benefit to minimise the amount of open groundworks in this area to reduce the coverage of any potential archaeological mitigation applied.

#### 4.5

#### ***Risk Table***

Feature/ Monument	Potential Impacts	Actions
River Road Conservation Area	Impacts to the appearance of the Conservation Area from proposed scheme	Consultation with Arun DC Conservation team, as well as Environment Agency Cultural heritage and Landscape specialists to discuss extent of work and ways to mitigate potential impacts. Potential need for Conservation Area Consent
Littlehampton Fort SM	Changes to historic setting	Consultation has been carried out with English Heritage's regional historic environment planner. EH has confirmed SMC is not required. Consultation with EH will be on-going
Potential archaeological features in foreshore	Physical damage or disturbance from scheme construction	A subject to be included in further assessment and/ or consultation. Possible mitigation required, although the nature of, and the necessity for, this will be

		discussed with the WSCC Archaeologist and the Environment Agency Cultural Heritage team prior to scheme implementation
Buried palaeoenvironmental resource	Physical damage to buried peaty deposits of geoarchaeological significance from piling and sheeting	Borehole logs from first phase of ground investigation will be made available to the WSCC Archaeologist and the Environment Agency Cultural Heritage team or interpretation. Further geoarchaeological assessment or mitigation to be determined following further consultation
Riverside Autos historic building on riverside	Potential physical damage to historic building, depending on proposals	Consultation with Arun DC Conservation and the Environment Agency Cultural Heritage team is required to explore consequences of removal or damage of buildings. Mitigation requirement possible e.g. standing building recording
Cairo Club listed building	Potential impacts to the historic setting of the Cairo Club LB in the River Road Conservation Area	Consultation with Arun DC Conservation and the Environment Agency Cultural Heritage team to take place to discuss potential impacts to the historic settings of listed buildings

## **Appendix 1 Report Figures**

Figure 1: Indicative Heritage Plan, 1 of 2

Figure 2: Indicative Heritage Plan, 2 of 2

Figure 3: Archaeological Sensitivity Plan

## Appendix 2 Photographs



Photo1: Riverside Autos – an historic flint and brick construct from the 19<sup>th</sup> century fronting on to the River Arun



## Legislation and Planning

This appendix report provides a summary of the main legislation and planning policies that affect the proposed scheme, the methods used for the assessment of archaeology and heritage, a gazetteer of archaeological and heritage features, and summary of the key archaeological impacts and a series of photographs taken during the walkover survey. Figures are provided in Volume Two of the Environmental Statement.

### National Legislation and Planning Policy

#### ***Ancient Monuments and Archaeological Areas Act (1979, as amended by the National Heritage Act 1983 and 2002)***

Scheduled Monuments are defined as nationally important ancient monuments and archaeological sites which are included on a Schedule maintained by the Secretary of State. Scheduled Monuments are afforded statutory protection and require Scheduled Monument Consent for works affecting them, for which statutory consultation with English Heritage will have to be undertaken.

#### ***Planning Act 1990 (Conservation Areas and Listed Buildings)***

This Act details the guidance that local authorities could put in place to designate individual buildings and Conservation Areas, and the statutory protection afforded them.

#### ***National Planning Policy Framework (Adopted March 2012)***

The National Planning Policy Framework (NPPF) cancelled (through Annex 3 of the document) Planning Policy Statement (PPS) 5: Planning for the Historic Environment on 27th March 2012, which was originally used in assessing the impacts of this scheme.

The policies below from NPPF states the approach used by local planning authorities to determine planning applications in relation to cultural heritage.

#### Section 12: Conserving and enhancing the historic environment

*‘128. In determining applications, local planning authorities should require an applicant to describe the significance of any heritage assets affected, including any contribution made by their setting. The level of detail should be proportionate to the assets’ importance and no more than is sufficient to understand the potential impact of the proposal on their significance. As a minimum the relevant historic environment record should have been consulted and the heritage assets assessed using appropriate expertise where necessary. Where a site on which development is proposed includes or has the potential to include heritage assets with archaeological interest, local planning authorities should require developers to submit an appropriate desk-based assessment and, where necessary, a field evaluation.*

*129. Local planning authorities should identify and assess the particular significance of any heritage asset that may be affected by a proposal (including by development affecting the setting of a heritage asset) taking account of the available evidence and any necessary expertise. They should take this assessment into account when considering the impact of a proposal on a heritage asset, to avoid or minimise conflict between the heritage asset’s conservation and any aspect of the proposal.*

*141. Local planning authorities should make information about the significance of the historic environment gathered as part of plan-making or development management publicly accessible. They should also require developers to record and advance understanding of the significance of any heritage assets to be lost (wholly*

*or in part) in a manner proportionate to their importance and the impact, and to make this evidence (and any archive generated) publicly accessible. However, the ability to record evidence of our past should not be a factor in deciding whether such loss should be permitted.'*

### **Local Planning Policy**

The Local Development Scheme (LDS) is a timetable for the production of a Local Plan. A draft Local Plan (Local Plan 2013 – 2028) has been produced and is awaiting approval. The draft policies are set out below, as it is anticipated that the scheme will have to conform to these.

The draft Local Plan has the strategic objective of 'protecting and enhancing Arun's outstanding landscape, coastline and historic built environment so reinforcing local character and identity' (Arun District Council 2012).

## **Chapter 18: Conservation and Archaeological Heritage**

### **Policy SP22: Historic Environment**

*'The Council will grant planning permission for development proposals that conserve or enhance the historic environment of the district, specifically:*

*Within Conservation Areas, development proposals must preserve or enhance the character or appearance of the area;*

- For Statutory Listed Buildings, development proposals must preserve the building or its setting or any features of special architectural or historic interest it possesses;*
- Within residential areas, development proposals must respect the intrinsic character of these areas;*
- For Locally Listed Buildings, development proposals must preserve the building or its setting or any features of value it possesses; and*
- Within Historic Parks and Gardens, development proposals must respect the special historic character and quality of these areas, their settings or historic views or vistas.*

*Development likely to prejudice any of the above, including their settings, will be refused.*

*Any proposals for development will be required to comply with all other relevant policies and reflect any relevant appraisals or management proposals adopted by the Council.*

*The Council will encourage the re-use of vacant or underused Listed Buildings or unlisted buildings by approving proposals that contribute positively to Conservation Areas either individually or as part of wider strategies for regeneration. Where changes of use are proposed, the Council will consider these in a flexible way but will favour proposals which improve public access where these are not prejudicial to existing character or appearance.*

*The Council will take a pro-active stance to any heritage assets that may be at risk. This will include working with property owners to find a use that will enable them to be put back in to use.*

*Development proposals involving the demolition of Listed Buildings or adversely affecting a Conservation Area will not be permitted other than in exceptional circumstances where repair or reuse are not practicable options and where replacement buildings and uses of exceptional quality are proposed.'*

## **Policy DM 29: Listed Buildings**

*Proposals affecting statutory Listed Buildings will be required to:*

- *Preserve or enhance the historic character, qualities and special interest of the buildings;*
- *Be necessary and not detrimental to the architectural and historical integrity and detailing of a Listed Building's exterior;*
- *Protect the architectural and historical integrity and detailing of a Listed Building's interior*
- *Protect the special interest of buildings of architectural or historic interest; and*
- *Protect, and where possible enhance the setting of the building.*

*There is a presumption in favour of the preservation or enhancement of Listed Buildings and structures and therefore the total or substantial demolition of a Listed Building will only be permitted in wholly exceptional circumstances, and where it meets the following specific criteria:*

- *clear and convincing evidence has been provided that viable alternative uses cannot be found, through, for example the offer of the unrestricted freehold of the property on the market at a realistic price reflecting its condition and that preservation in some form of charitable or community ownership is not possible;*
- *the redevelopment would produce substantial benefits for the community which would decisively outweigh the resulting loss from demolition or major alteration; and*
- *the physical condition of the building has deteriorated, through no fault of the owner/ applicant for which evidence can be submitted, to a point that the cost of retaining the building outweighs its importance and the value derived from its retention. A comprehensive structural report will be required to support this.*

*The Council will support proposals for alternative uses for Listed Buildings which retain their structure and preserve character and setting where the change will provide for the long term conservation of the structure and fabric of the building.*

*The Council will only support alterations to Listed Buildings in order to mitigate climate change where such proposals respect the significance of the Listed Building and do not have an adverse impact on its appearance, character or historic fabric.*

*The council will only approve a proposal for enabling development where there is no other alternative option available and the benefits of such as scheme outweigh any dis-benefits that arise.*

*Developments shall also be consistent with all other local plan policies.*

### **Policy DM 30: Buildings or Structures of Character**

*The Council will continue to identify and compile a list of locally important buildings and structures which make a positive contribution to local distinctiveness using the following criteria:*

- 1. Buildings of outstanding design, detailing, appearance or special interest because of the use of materials.*
- 2. Buildings which are extremely good examples of traditional or established style, or of unusual type.*
- 3. In special cases, buildings or structures which contribute towards the local townscape or have important historical associations.*
- 4. All buildings must be largely intact and not adversely affected by later extensions or alterations.*
- 5. Preferably, although not exclusively, they should make a positive contribution to their surroundings or the street scene.*

*Planning permission will only be granted for development which results in the loss of existing Buildings or Structures of Character when it can be demonstrated that the building or structure can not be put to a beneficial use or re-use. Replacement structures will need to be of a high quality design.*

*Proposals for the alteration or extension of buildings on the local list will be expected to relate sensitively to the building or structure and its setting and respect its architectural, landscape or historic interest. The Council will seek to preserve features of such buildings which contribute to that interest.*

*Developments shall also be consistent with all other local plan policies.*

### **Policy DM 31: Conservation Areas**

*Planning permission will normally be granted for proposals within or affecting the setting of a Conservation Area, provided that:*

- New buildings acknowledge the character of their special environment in their layout, form, scale, detailing, use of materials and the spaces created between buildings;*
- They retain or emphasise the qualities of the townscape or streetscape in the area;*
- Alterations or additions to existing buildings are sensitively designed, constructed of appropriate materials and are sympathetic in scale, form and detailing and retain or emphasise the features and qualities of the existing buildings, townscape or streetscape in the area;*
- Building materials which contribute to the character of the area are retained or re-used wherever possible;*

- *Traditional features such as shop fronts, walls, railings, paved surfaces and street furniture are retained and restored;*
- *Unsympathetic features are removed and missing features are restored or reinstated;*
- *High quality soft and hard landscaping is provided;*
- *Trees, hedgerows and other significant landscape features are protected and landscaping incorporated appropriate to the character and appearance of the area;*
- *It retains historically significant boundaries, important open spaces and other elements of the area's established pattern of development, character and historic value, including gardens, roadside banks and verges;*
- *It does not harm important views into, out of or within the Conservation area.*

*Within Conservation Areas, permission for development involving demolition or substantial demolition will only be granted, subject to conditions, if it can be demonstrated that:*

- *The structure to be demolished makes no material contribution to the special character or appearance of the area; or,*
- *It can be demonstrated that the structure is wholly beyond repair or incapable of beneficial use; or*
- *It can be demonstrated that the removal of the structure and its subsequent replacement would lead to the enhancement of the area*
- *Permission has been granted for the redevelopment of the site*

*Developments shall also be consistent with all other local plan policies.*

## **Policy DM 32: Areas of Special Character**

*Within Areas of Special Character, as defined on the Proposals Map, planning permission will be granted subject to:*

- 1. the retention of buildings and other features such as boundary walls, hedges, trees, railings, open spaces, etc. which make positive contributions to the special character of the areas;*
- 2. the maintenance of an appropriate mix of uses where this is an important element in the character of an area;*
- 3. new development making a positive contribution to the special character of these areas, particularly with regard to the characteristics identified by the Local Planning Authority.*

*Developments shall also be consistent with all other local plan policies.*

## Policy DM 33: Sites of Archaeological Interest

*There will be a presumption in favour of the preservation of scheduled and other nationally important monuments and archaeological remains. Where proposed developments will have either a direct impact on sites listed in Table 18.1 (i.e. developments requiring scheduled monument consent) or where developments will have an indirect impact on the settings of those sites listed in Table 18.1, permission will only be granted where it can be demonstrated that development will not be harmful to the archaeological interest of these sites.*

*In all such instances;*

- 1. Applicants must arrange for a desk based archaeological assessment of the proposed development site to be undertaken by a suitably qualified person. The archaeological assessment will take the form of a factual review of the known information on historic assets and an appraisal of these assets. This information shall accompany the planning application, and, where not supplied, will be required before any planning application is determined and*
- 2. where the Planning Authority has reason to believe, either from the archaeological assessment as above, or from other evidence sources, that significant archaeological remains may exist, further assessment in the form of a field evaluation will be required to be carried out before the planning application is determined. Any field survey undertaken shall be carried out by a professionally qualified archaeological organisation or consultant only. All stages of archaeological fieldwork shall be subject to a Written Scheme of Investigation approved by the local planning authority. No development shall take place on the proposed development site until the applicant, or their agents or successors in title, is in receipt of a Written Scheme of Investigation that has been approved by the local planning authority or*
- 3. A field evaluation as above, which shall include a historic environmental record of the archaeological site without the requirement to undertake a separate desk based archaeological assessment*
- 4. preservation in situ of archaeological sites or remnants of such sites, is the preferred option. However, where the assessment, which shall be subject to a Written Scheme of Investigation, shows that the preservation of archaeological remains in situ is not justified, conditions may be attached to any permission granted that development will not take place until provision has been made by the developer for a programme of archaeological investigation and recording. Any such programme shall be carried out prior to the commencement of the development;*
- 5. whenever practicable, opportunities should be taken for the enhancement and interpretation of archaeological remains left in situ. Developers shall record any heritage assets to be lost (wholly or in part) in a manner proportionate to their importance and possible impact, and to make this evidence (and any archive generated) publicly accessible.*

*Developments shall also be consistent with all other local plan policies.*

## Methodology

This chapter deals with archaeological and heritage assets. In this instance 'heritage' can be defined as meaning built heritage and historic townscape. Archaeology can refer to both buried and extant earthwork remains.

This chapter is based on a cultural heritage appraisal (Halcrow 2010) in addition to the results of additional data gathering since that report was produced. The appraisal and additional data sources utilised have been reproduced in this appendix.

The study area has considered cultural heritage in terms of potential direct impacts on the archaeological sites and monuments, historic townscape and built heritage present within the footprint of proposed development and an area approximately 250 metres projecting outwards from the scheme. This includes a consideration of the potential visual impacts within the same study area.

The array of archaeological and heritage assets, including formal survey data such as Rapid Coastal Zone Assessment, Historic Landscape Character and Extensive Urban Survey, have been reproduced on the supporting drawings.

The 2010 study utilised the following sources in order to highlight the main constraints and opportunities of the scheme:

- The West Sussex historic Environment Record (WSHER) for archaeological sites and monuments data;
- The Sussex Extensive Urban Survey (EUS) data for Littlehampton;
- Historic Landscape Characterisation (HLC) data; and
- Designated datasets (scheduled monuments and listed buildings).

The 2010 report is appended to this ES. Following on from detailed design, the following sources have been utilised to inform the full assessment of the scheme:

- A new WSHER search;
- A new HLC dataset;
- The Arun District Council [website](#) for Conservation Areas, Areas of Special Character and Buildings and Structures of Character;
- Historic maps, including Tithe Maps and Ordnance Survey (OS);
- Ground investigation data;
- Unpublished archaeological reports;
- Published archaeological journals; and
- The results of a site walkover survey, including a foreshore inspection.

Aside from establishing the known baseline, these sources assisted in the identification of any site of potential significance not present in the HER data as well as the archaeological potential along the scheme. This allowed a higher degree of confidence in the results of the assessment, and in the proposed mitigation.

### *Impact Assessment Approach and Criteria*

The proposed scheme has been assessed to a detailed level, with a three-stage approach undertaken to gauge the impacts of the proposed scheme. The value of each receptor has been established; the level of potential impact estimated, and the resulting significance of effect established.

The value of each individual cultural heritage receptor has been established using the criteria outlined in Table 1, while the magnitude of the impact has been defined in Table 2. The determination of the significance of any impacts follows the matrix provided in Table 3.

*Table 1: General criteria for classifying the value or sensitivity of environmental resources or receptors*

Value	Criteria
Very High	<p>World Heritage Sites (including buildings and those inscribed for their historic landscape qualities)</p> <p>Assets of acknowledged international importance</p> <p>Assets that can contribute significantly to acknowledged international research objectives</p>
High	<p>Scheduled Monuments (inc. with standing remains)</p> <p>Designated historic landscapes of outstanding interest</p> <p>Undesignated assets of schedulable quality and importance</p> <p>Assets that can contribute significantly to national research objectives</p> <p>Grade I and II* Listed Buildings</p> <p>Other Listed Buildings that can be shown to have exceptional qualities in their fabric or historical associations</p> <p>Conservation Areas containing very important buildings</p> <p>Undesignated structures of clear national importance</p> <p>Undesignated landscapes of outstanding interest, high quality or importance and of demonstrable national value</p> <p>Well-preserved historic landscapes, exhibiting considerable coherence, time-depth or other critical factors</p>
Medium	<p>Designated or undesignated assets that contribute to regional research objectives</p> <p>Undesignated historic landscapes that would justify special historic landscape designations, or landscapes of regional value</p> <p>Averagely well-preserved historic landscapes with reasonable coherence, time-depth or other critical factor</p> <p>Grade II Listed Buildings</p> <p>Conservation Areas containing buildings that contribute significantly to its historic character</p> <p>Historic Townscape or built-up areas with important historic integrity in their buildings, settings or built settings</p>
Low	<p>Designated and undesignated assets of local importance</p> <p>Robust undesignated historic landscapes and historic landscapes with importance to local interest groups</p> <p>Historic landscapes whose value is limited by poor preservation and/ or poor survival of contextual associations</p> <p>Assets compromised by poor preservation and/or poor survival of contextual associations</p> <p>Assets of limited value, but with potential to contribute to local research objectives</p>



Value	Criteria
	<p>'Locally Listed' buildings</p> <p>Historic (unlisted) buildings of modest quality in their fabric or historical association</p> <p>Historic Townscape or built-up areas of limited historic integrity in their buildings, or built settings</p>
Negligible	<p>Assets with very little or no surviving archaeological interest</p> <p>Buildings of no archaeological or historical note, or buildings or an intrusive character</p> <p>Landscapes with little or no significant historical interest</p>
Unknown	<p>The importance of the resource has not been ascertained, or buildings with some (hidden) potential for historical significance</p>

*Table 2 - General criteria for classifying the magnitude and nature of environmental effects*

Magnitude	Definition
Major negative	<p>Change to most or all key archaeological materials, such that the resource is totally altered</p> <p>Comprehensive changes to setting</p>
Moderate negative	<p>Changes to many key archaeological materials, such that the resource is clearly modified</p> <p>Considerable changes to setting that affect the character of the asset</p>
Minor negative	<p>Changes to key archaeological materials, such that the asset is slightly altered</p> <p>Slight changes to setting</p>
Negligible	Very minor changes to archaeological materials, or setting
No change	No change
Minor positive	Small beneficial change to extant or buried archaeology or historic structure, for instance from added protection to a light improvement in setting from a superior design compared with the existing
Moderate positive	Better and long-term protection added to archaeological monument or historic structure, and/or an improvement to the receptor's setting
Major positive	Superior and very long-term protection afforded to historic structure or archaeological monument, with a great improvement to the setting of the receptor from an improved design and/ or removal of existing feature which is detrimental to setting

## Potential Impacts

The nature of potential impacts arising from the development has been described and an objective assessment of the level of significance of each impact has been defined as far as practicable.

There is no accepted universal definition of what constitutes a significant impact. The definition varies according to the environmental factor under consideration and the context in which the assessment is made. Much depends on the availability of data relating to existing environmental conditions and the value applied to these conditions. However, for this assessment, the level of significance of impacts has been defined using a combination of the sensitivity or value of the receiving environment and the magnitude of impact, each of which having been assessed independently according to the above defined criteria. This results in the following of significance of impact:

*Table 3 - Impact significance based on sensitivity or value of receptor and magnitude of impact*

Magnitude	Sensitivity/Value		
	Very High/High	Medium	Low/Negligible
High or Major	Major Significance	Moderate Significance	Minor Significance
Medium or Moderate	Moderate Significance	Minor Significance	Negligible Significance
Low or Minor	Minor Significance	Negligible Significance	None
Negligible	Negligible Significance	None	None

In the definition of magnitude of impact, consideration has been given to any legislative or policy standards or guidelines, and/or the following factors:

- The nature of change, for example, whether the environment or receptor has been enhanced or impaired (generally defined as positive or negative);
- The size of the change, for example, the area of land or number of people affected and the degree of change from existing conditions;
- The scale of change resulting from impacts or the degree of change from existing conditions;
- Whether the effect is temporary (and short, medium or long term) or permanent;
- Whether there are any cumulative effects;
- Direct, indirect and secondary effects have also been taken into account.

## Mitigation

The approach to mitigation measures is consistent with guidance provided in 'The Preparation of Environmental Statements for Planning Projects that require Environmental Assessment – a good practice guide (HMSO, 1995)', which considers mitigation as a hierarchy of measures ranging from prevention of environmental effects by avoidance down to compensation for effects that cannot be remedied. The mitigation hierarchy comprises:

*Table 4 – Mitigation hierarchy*

Level	Definition
Prevention	To prevent adverse environmental effects at source, for example, through choice of site, site layout or design, or specification of construction methods
Reduction	If adverse effects cannot be prevented, steps taken to reduce them through methods to minimise the cause of impact at source, to abate impacts on site or abate impacts at receptor location
Remedy/ Offset/  Compensation	When effects remain that cannot be prevented or reduced, they are offset by remedial or compensatory action such as provision of environmental improvements, opportunities for access and informal recreation, creation of alternative habitats or prior excavation of archaeological features

### Assessment of Setting

The scheme has the potential to affect the setting of heritage assets such as listed buildings and area designations such as Conservation Areas, and their locally listed equivalents.

Setting is defined in the English Heritage document 'The Setting of Heritage Assets' 2011 as follows:

*'...setting embraces all the surroundings (land, sea, structures, features and skyline) from which the heritage asset can be experienced from or with the asset....elements of a setting may make a positive or negative contribution to the significance of an asset, may affect the ability to make that significance, or may be neutral'*

*'the extent and importance of setting is often expressed by reference to visual considerations. Although views of or from an asset will play an important part, the way in which we experience an asset in its setting is also influenced by other environmental factors such as noise, dust or vibration; by spatial associations; and by our understanding of the historic relationships between places.'*

Historic and aesthetic setting is therefore a factor for consideration in this study, and may apply even when two buildings or structures are not visible from one another. Setting can, therefore, be more extensive than the curtilage of buildings.

### Historic Landscape Characterisation

HLC identifies areas or units of land (which become the HLC polygons) based on their key historic landscape attributes. These units are assigned character types together with their key identifying attributes. The Sussex HLC identifies the mapped remains of land use at the landscape scale [e.g. field boundary scale, field shapes, boundary types but not earthwork types], that demonstrate the many human activities that have formed the current landscape. It is a large scale characterisation which provides a broad-brush overview of the present day landscape.

### Arun Extensive Urban Survey

The Extensive Urban Survey (EUS) is an archaeological, historical and historic townscape study of Littlehampton (Harris 2009) carried out as part of the Sussex Extensive Urban Survey on behalf of West Sussex and East Sussex County Councils. The project aimed to:

- Archaeological and historical environment research and management;
- Informing strategic and local policy;
- Underpinning urban historic land and buildings management and interpretation;

Encouraging the integration of urban historic characterization into the process of protecting and enhancing urban character.

The study is a synthesis of available sources up to the time of production. The analysis of the origins and development of each town studied included key historic structures and areas and informed the county wide HLC study. Historic Urban Character (HUC) zones were created for each town, and an estimation of archaeological potential and historic environment value was given. The HUC zones are presented on a drawing supporting this assessment.

## Gazetteer of Archaeological and Heritage Assets

WSSC Ref	Name	Description
<b>Scheduled Monuments</b>		
<b>MWS 3361/ DWS 324</b>	<b>Littlehampton Fort</b>	<b>The remains of Littlehampton fort, which was built in 1854. Part of a 19<sup>th</sup> century defence array along the South coast</b>
<b>Listed Buildings</b>		
<b>DWS 1378</b>	<b>No. 1 River Road</b>	<b>A Grade II listed building – a three-storey early 19<sup>th</sup> century residence</b>
<b>DWS 1379</b>	<b>No. 12 River Road</b>	<b>A Grade II listed building – a three-storey early 19<sup>th</sup> century residence</b>
<b>DWS 776</b>	<b>No. 20 Surrey Street</b>	<b>A Grade II listed building – a three-storey early 19<sup>th</sup> century residence</b>
<b>DWS 803</b>	<b>No. 12 River Road</b>	<b>A Grade II listed building – a three-storey early 19<sup>th</sup> century residence</b>
<b>DWS 804</b>	<b>No. 10 River Road</b>	<b>A Grade II listed mid 19<sup>th</sup> century two storey house</b>
<b>DWS 869</b>	<b>Nos. 7 and 8 River Road</b>	<b>Grade II listed early/ mid 19<sup>th</sup> century houses</b>
<b>DWS 877</b>	<b>No. 34 Surrey Street</b>	<b>A Grade II listed early 19<sup>th</sup> century residence</b>
<b>DWS 778</b>	<b>The ‘Cairo Club’ (61, Surrey Street)</b>	<b>A Grade II listed early 19<sup>th</sup> century house</b>
<b>DWS 777</b>	<b>No. 37 Surrey Street</b>	<b>A Grade II listed late 18<sup>th</sup> century three storey house</b>
<b>DWS 881</b>	<b>No. 59 Surrey Street</b>	<b>A Grade II listed late 18<sup>th</sup> century three storey house</b>
<b>DWS 1394</b>	<b>The White Hart Pub (32 Surrey Street)</b>	<b>A Grade II listed mid-18<sup>th</sup> century pub</b>
<b>Non-designated Monuments</b>		
<b>MWS 3106</b>	<b>Harbour</b>	<b>A new channel was cut through the beach in 1733-35, and the harbour has seen relatively few changes since then, though the pier has been rebuilt several times</b>

<b>MWS 3107</b>	<b>Wharves</b>	<b>Travis and Arnold timber yards are the site of 19<sup>th</sup> century wharves</b>
<b>MWS 3108</b>	<b>Climping Shipyard</b>	<b>A boatbuilding and repair yard (Hillyard and Osborne) where vessels of up to 600 tons were once built. Dates from 1839</b>
<b>MWS 3109</b>	<b>Littlehampton gasworks</b>	<b>The town's first gasworks at no. 48 Pier Road was built in 1847, and was strategically-placed to receive sea-borne coal. The flint and brick buildings remain</b>
<b>MWS 3112</b>	<b>Littlehampton brewery</b>	<b>The main building of George Constable's brewery, in yellow brick, with a ventilator, dates to 1860. The building is now used as a bottling plant</b>
<b>MWS 3114</b>	<b>Littlehampton gun battery</b>	<b>A gun battery used to be present on the east side of the River Arun mouth, prior to the construction of Littlehampton Fort on the west side. The battery is present on historic maps from 1793-1825 after having been authorised by warrant in 1759. This was as a deterrent to French privateers and remained in military hands until after the Napoleonic wars. The fort was dismantled around 1834 and was used as a coastguard station</b>
<b>MWS 3115</b>	<b>Towermill</b>	<b>A windmill was made for Climping and is shown on the Tithe Map of 1843. The site is now covered by an amusement arcade, after the land was sold to Billy Butlin in the 1930's</b>
<b>MWS 4374</b>	<b>Post-medieval structures at Floyd's Corner</b>	<b>Possible access point for launching and landing boats into the river prior to 18<sup>th</sup> century development. Archaeological investigation found 18<sup>th</sup> or 19<sup>th</sup> century structures from the period that superseded the boat area</b>
<b>MWS 5736</b>	<b>Littlehampton Swing Bridge</b>	<b>The swing bridge was built in 1908 to replace a ferry and was made obsolete by a new bridge half a mile upstream. The bridge was demolished in 1980 and replaced by a footbridge</b>
<b>MWS 6571</b>	<b>Malthouse</b>	<b>A 19<sup>th</sup> century malting kiln on East Street. The structure was still extant in the early 1970's</b>
<b>MWS 6574</b>	<b>Industrial buildings</b>	<b>Several small workshops and stores between the site of the old swing bridge and MacWester Marine. These were built between 1800 and 1843, and are flint and brick two-storey structures</b>
<b>MWS 7055</b>	<b>Wharf building, River Road</b>	<b>Assessment and archaeological investigation found the buried remains of wharf-side buildings</b>
<b>MWS 7563</b>	<b>WWII defence feature</b>	<b>A WWII defence work on the west bank of the River Arun at the entrance to Littlehampton harbour</b>
<b>MWS 8184</b>	<b>WWII defence feature</b>	<b>Littlehampton's WWII perimeter defences</b>
<b>MWS 8296</b>	<b>Marker post</b>	<b>War department boundary post</b>
<b>MWS 8297</b>	<b>Rifle ranges</b>	<b>Two rifle ranges shown on 1875 and 1899 OS maps</b>
<b>MWS</b>	<b>Anti-tank</b>	<b>A set of 16 anti-tank cylinders placed next to the</b>

8298	cylinders	quayside entrance
MWS 8642	Oyster pond	Shown on Tithe Map as 'Oyster Pond house Garden etc' used originally for the storage of oysters but now used as a boating lake
MWS 8643	Preventative houses	'Preventative Houses Gardens etc' on Tithe Map and as a 'Coastguard Station' on later OS maps
MWS 9428	Multi-period archaeological site	Land off Courtwick Lane was archaeologically investigated to reveal a sequence of deposits ranging from the Bronze Age, late Iron Age and Romano-British. Some Anglo-Saxon and Medieval features were identified also
MWS 9464	War Memorial	Located in the rear wall of the Steam Packet Public House's beer garden. The memorial takes the form of a plaque in remembrance of WWI victims
<b>Find Spots</b>		
MWS 3088	Roman coins	Roman coins found just to the east of the pier. Presumably brought down from upstream in river silts
MWS 3097	Bronze Age axe	A palstave dredged from the mouth of the River Arun
MWS 5734	Roman coin	A Roman coin was found in the foundations of a shop in Surrey Street. The coin dates to the 4 <sup>th</sup> century
<b>Maritime</b>		
MWS 8528	Littlehampton Port	<p>Archaeological investigation has traced the historic development along the east bank of the River Arun. This revealed a chalk well from the 18<sup>th</sup> century and a large 19<sup>th</sup> century wharf building. The dock was infilled at the end of the 19<sup>th</sup> century, with alterations made to the wharf building. Tiebacks relating to a late 19<sup>th</sup> and early 20<sup>th</sup> century river defence wall were also recorded.</p> <p>The investigation results have been integrated with cartographic and documentary sources to trace the process of wharf building and the subsequent development of the east bank of the River Arun in the later post-medieval period</p>
<b>Rapid Coastal Zone Assessment</b>		
MWS 8297	Rifle Ranges	
MKM 1721	WWII beach scaffolding	
MKM 1710	WWII beach scaffolding	
MKM 1709	WWII beach scaffolding	
MKM 1959	Post-medieval drainage system in Climping	Land drainage to the west of the River Arun
MKM	Site of WWII	

1736	defensive blocks	
MKM 1856	Site of WWII military camp	
MKM 1738	Site of WWII anti tank blocks	
MKM 1741	WWII barbed wire fence	Littlehampton Fort
MKM 1824	19 <sup>th</sup> century Palmerston Fort	
MKM 1796	Site of WWII water storage tank	
MKM 1825	18 <sup>th</sup> or 19 <sup>th</sup> century gun battery	
MKM 1748	WWII pillbox	
MKM 1866	Historic field boundary	
MKM 1967	20 <sup>th</sup> century mooring point	
MKM 2034	Landing stage (19 <sup>th</sup> / 20 <sup>th</sup> century)	
MKM 2033	Post-medieval extraction pits	
MKM 1998	Historic field boundaries	
MKM 1249	Land drainage system	
MKM 1248	Site of WWII anti tank cubes	
MKM 1964	20 <sup>th</sup> century landing stage	
MKM 1965	20 <sup>th</sup> century landing stage	
MKM1966	20 <sup>th</sup> century landing stage	
MKM 1968	20 <sup>th</sup> century timber yard	
MKM 1963	Post-medieval/ 20 <sup>th</sup> century groynes	
MKM 1961	Undated curvilinear bank at Climping	
MKM 1962	Undated linear bank, Climping	

MWX 8917	Site of old limekiln	
MWX 8918	Site of Landing stage	
MWX 8919	Site of Landing stages	
MWS 5736	Site of swing bridge	
MWX 8928	Site of Iron works	
MWX 8930	Site of Wharf	
MWX 8931	Site of Wharf	
MWX 8932	Site of gasworks	
MWX 8933	Gravel pits	
MWS 3115	Towermill	
MWX 8934	Coastguard Station	
MWX 8935	Lifeboat house	
MWX 8936	Lighthouse	
MWX 8937	Signal House	
MWX 8938	Pier	
MWX 8939	Groynes	from Littlehampton to Ferring
MWX 8940	Drill hall	
MWX 8941	Saw mills	
MWX 8942	Sluice house	
MWX 8780	Two sluices	Ryebank Rife
MWX 8917	Site of landing stage	West beach of River Arun
MWX 8918	Wharf and landing stages	Western beach of River Arun



MWX 8919	Littlehampton shipyard	River Arun foreshore
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## Construction Impacts

The scheme is described in Section 3 and will comprise new sheet piled vertical flood defence walls in Reaches 1-4. The sheet piling will be 2.0-2.4m riverward of the existing, with new raised and widened landscaped promenades in Reaches 1 and 2. The new promenade height will be up to 1.25m higher than the existing ground surface. Extensive landscaping across Arun Parade and Pier Road will also be part of the scheme. The existing hard surfacing will be replaced.

The piling will be carried out using a land-based crane in Reaches 1 and 2. In Reaches 3 and 4 limited land space will require piling is undertaken from a floating barge in the river.

Reach 5 will see the existing defences raised.

Reach 6 will see the reconfiguration of the existing earth embankments to create a new inter-tidal zone. Where existing embankments are going to be retained, these will be raised.

The vibration impacts from the driving of sheet piling into the river bed are potential sources of impact to historic buildings that lie adjacent to the scheme. The potential vibration impacts of large plant moving around the river frontage to facilitate the piling process is also a potential source of impact.

The removal of existing hardstanding within the footprint of the new promenade and the landscaped areas will also have minor vibration impacts and will expose buried soil horizons and structures.

## Operation Impacts

The completed project will serve to enhance the flood protection afforded Littlehampton. The historic buildings within the flood risk zone, including the area designations which they lie in, will be given long-term added protection.

The landscaping within the Reach 1 and 2 boundaries will significantly change the appearance of the east bank of the river; notably the new promenade. Given the proposed layout of the proposals, and the materials used, this will enhance this portion of the town by using materials that are sympathetic with local build material. This will complement the surrounding built heritage, and enhance the public appreciation of the local historic town character. The historic grain of the sea front and riverfront developments will be retained.

## Site Walkover

### Heritage Features



Reach 1: Locally Listed Lighthouse (1940's construction)



Reach 1: Lighthouse and Pier (Locally Listed)



Reach 1: Vegetated mound by children's 'castle' slide is the earthwork remnants of a post-medieval gun battery



Reach 2: Cadet Headquarters, Pier Road (Locally Listed Building)





Reach 2: South Terrace Area of Special Character



Reach 3: Riverside Autos Locally Listed Building



Reach 3: Riverside Autos



Reach 3: Building adjacent to Riverside Autos



Reach 3: The Steam Packet public house Locally Listed Building adjacent to scheme boundary



Reach 5: The Arun View public house (Locally Listed Building)





Reach 6: Disused winch, presumably for hauling boats from the river from an adjacent slipway (marked on 1973 OS map)



Reach 6: Disused water treatment facility (located on the old line of WWII defences through Littlehampton)

## Foreshore Survey



Reach 3: No features in foreshore



Reach 3: No features in visible parts of foreshore along pontoon 'quay'





Reach 4: Foreshore south of footbridge. Service receptor boxes being installed. Note service cables emerging from waterline



Reach 4: Some wooden features by the outfall structure. Potential associations with the site of the former Swing Bridge



Reach 4: No significant features in foreshore



Reach 6: Stakes in foreshore, part of possible landing stage



Reach 6: remnants of wooden jetty. Possibly part of slipway visible on 1973 OS map

Heritage Features outside the scheme boundaries



Reach 1: View over to Littlehampton Fort SM (to right of picture)





Littlehampton Fort, with Reach 1 in background

## References

Arun.gov.uk, accessed via the World Wide Web on 19<sup>th</sup> February 2013

Arun District Council 2012 Local Plan – Consultation Doc, 19<sup>th</sup> July 2012

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Bradley, T and Phillpotts, C 2006 The development of the Port of Littlehampton, East Sussex and excavations at East Bank, River Road, in Sussex Archaeological Collections 144 (2006) pp155-168

English Heritage 2011 The Setting of Heritage Assets

Halcrow 2010 Littlehampton Arun Tidal Defences (East Bank): Cultural Heritage Appraisal

Harris, R B 2009 Littlehampton: Historic Character Assessment Report, Sussex Extensive Urban Survey, April 2009

# Appendix F – Biodiversity

This appendix contains the following reports:

- Ecological scoping report, March 2009
- Phase 1 habitat refresher survey and bat potential assessment, October 2012
- Aquatic invertebrates desk study and habitat assessment, May 2013
- Reptile mitigation method statement, March 2013
- Water vole survey, May 2013
- Invasive plant species method statement, December 2012

# **Environment Agency**

River Arun PAR

Ecological Scoping Report

March 2009

**Halcrow Group Limited**

**Environment Agency**  
River Arun PAR  
Ecological Scoping Report  
March 2009

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# **Environment Agency**

## **River Arun PAR**

### **Ecological Scoping Report**

#### **Contents Amendment Record**

This report has been issued and amended as follows:

Issue	Revision	Description	Date	Signed
1	0	Draft report	23.03.09	BB
1	1	Reviewed report plus comments	06.04.09	BB

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# 1

## Introduction

### 1.1

#### ***Background***

Halcrow Group Limited was commissioned by the Environment Agency (EA) to undertake an ecological baseline survey of the site of a flood alleviation scheme, along the east bank of the River Arun from the river mouth to a point just to the north east of Littlehampton (Grid references – TQ028012 and TQ012032 respectively).

This report presents the results of an Ecological Scoping Survey, involving a site visit undertaken during February 2009, to collect baseline ecological information for habitats and species associated with the sites in relation to the proposed development works. The report also provides recommendations for further surveys where it is felt that more information is required, and advice on mitigation measures where possible.

### 1.2

#### ***Objectives***

The approach to establishing the environmental baseline found within this report has been achieved through:

- A desk study involving a review of records of habitats and species from the local area (within a 2km radius around the site);
- An Extended Phase 1 Habitat survey (IEA, 1995) identifying the main habitats on the site and the presence of, or potential for, protected and/or notable species;
- A preliminary assessment of the nature conservation value of the site.

This baseline information was then used to fulfil the following objectives:

- Identification of potential constraints and opportunities to the project;
- Identification of any further surveys which may be necessary and to broadly outline mitigation measures for potential adverse impacts.

### 1.3

#### ***Proposed Construction Activities***

This report provides a preliminary assessment of ecological features which may potentially be affected by the River Arun PAR. This scheme aims to undertake a

number of flood alleviation measures; the precise details of which are yet to be finalised, along the east bank of the River Arun. Possible measures include the construction of a flood wall along the eastern river frontage through Littlehampton and raising the height of the flood embankment along the east bank of the section of river upstream of Littlehampton.

#### **1.4**

##### ***Limitations***

The conclusions drawn in the report are considered correct although any subsequent additional information may allow refinement of the conclusions. It should be noted that:

- Access was not gained to the certain areas of the site where there was dense impenetrable vegetation or swampy ground, and consequently these areas were surveyed from nearby viewpoints. Therefore it is possible that certain ecological features occurring here may not be covered within this report.
- The report has been prepared under the express instructions and solely for the use of EA for the specified project;
- The findings of this report represent the professional opinion of experienced ecologists. Halcrow does not provide legal advice and the advice of lawyers may also be required;
- All work carried out in preparing this report has utilised and is based upon Halcrow's current professional knowledge and understanding of current relevant UK standards and codes, technology and legislation. Changes in this legislation and guidance may occur at any time in the future and cause any conclusions to become inappropriate or incorrect. Halcrow does not accept responsibility for advising EA or other interested parties of the facts or implications of any such changes;
- This report has been prepared using factual information contained in maps and documents prepared by others. No responsibility can be accepted by Halcrow for the accuracy of such information;
- Populations of animals and plants are often transient in nature and a single survey visit can only provide a general indication of species present on site. Time of year when the survey was carried out and other variations will also influence the results of the survey (e.g. it is possible that some flowering plant species which flower at other times of the year may have been missed). The possibility exists for other species to be present on the site which were not recorded during the survey.

## 2 Methodology

### 2.1 *Desk Study*

A desk-based study was undertaken to gather existing records of protected or notable species and designated sites within the site and the surrounding area. This information was collected from a data search carried out by the Sussex Biodiversity Records Centre (SxBRC), National Biodiversity Network (NBN) Gateway (<http://data.nbn.org.uk/>), (and the 'MAGIC' (Multi-agency Geographic Information for the Countryside) website ([www.magic.gov.uk](http://www.magic.gov.uk))).

Note that no data relating to badgers *Meles meles* is currently available from SxBRC. Full records for this species may be obtained from the local badger group at a later stage of the project if considered necessary. For the purposes of this report badger data has been obtained from NBN Gateway.

### 2.2 *Extended Phase 1 Habitat Survey*

An Extended Phase 1 Habitat survey of the site was undertaken on the 4<sup>th</sup> of February 2009.

#### 2.2.1 *Scope of the survey*

For the purposes of the desk study the survey area extended to a distance of 2 km either side of the site of the proposed scheme.

The Extended Phase 1 Habitat site survey area included a strip of land extending a minimum distance of 50m either side of the area anticipated to be affected by measures intended as part of the proposed scheme, often extending to a boundary feature. This area was comprehensively surveyed for features of ecological interest and all Phase 1 Habitats identified, in order to identify any ecological constraints that would be likely to apply to the scheme within this zone. This area is referred to within this document as the 'site', 'surveyed section' or 'survey area'. Other important adjacent and connecting features outside of this zone, such as badger setts, hedgerows and woodland, were also noted during the site visit where possible.

#### 2.2.2 *Survey technique*

Within the survey area every parcel of land was classified, recorded and mapped in accordance with a list of ninety specified habitat types (JNCC, 1993), using

standard colour codes. This allows rapid visual assessment of the extent and distribution of different habitat types. Target notes were used to provide supplementary information on features too small to map, or to provide supplementary details, for example relating to species composition, structure and management.

This basic methodology was extended to also provide more detail in relation to habitats with potential to support rare or protected fauna, as described by Institute of Environmental Assessment (IEA, 1995).

### 2.2.3

#### *Evaluation criteria*

Habitats and species were evaluated where possible in relation to a geographical frame of reference, i.e. international value being most important, then national, regional, county, district, local and lastly, within the immediate zone of influence of the proposals only (based on the guidance from the Institute of Ecology and Environmental Management, IEEM, 2006).

Value judgements are based on various characteristics that can be used to identify ecological resources or features likely to be important in terms of biodiversity. These include site designations (such as Sites of Special Scientific Interest (SSSI)), or for undesignated features, the size, conservation status (locally, nationally or internationally), and the quality of the ecological resource. In terms of the latter, 'quality' can refer to habitats (for instance if they are particularly diverse, or a good example of a specific habitat type), other features (such as wildlife corridors or mosaics of habitats) or species populations or assemblages.

## 3

## Results

### 3.1

#### 3.1.1

#### *Desk Study*

##### *Landscape setting*

The survey area lies within the South Coast Plain & Hampshire Lowlands Natural Area (Natural Area number 75<sup>1</sup>). The landscape of the South Coast Plain and Hampshire Lowlands is split between the generally open, often featureless landscape of the coastal plain and the more varied



landscape in the west. The Natural Area contains a number of nature conservation features. Although relatively small in extent, the south-facing slopes of Portsdown Hill support some high quality chalk grassland, and the chalk rivers of the Itchen and Test flow through the Natural Area, supporting fine examples of threatened habitat and several key species. The floodplains of the Rivers Test and Itchen contain some botanically rich neutral grassland and elsewhere in the Natural Area fen and fen-meadows occur, especially where chalk springs arise at the foot of the downs.

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<sup>1</sup> [http://www.naturalareas.naturalengland.org.uk/Science/natural/NA\\_Details.asp?NA\\_ID=75&S=&R=6](http://www.naturalareas.naturalengland.org.uk/Science/natural/NA_Details.asp?NA_ID=75&S=&R=6)



## 3.1.2

*Statutory and Non-statutory Site designations**Table 1 – Nearby site designations*

Site name	Location in relation to proposed site	Description
<b>Statutory sites:</b>		
Climping Beach Site of Special Scientific Interest (SSSI)	TQ 020 010	The site comprises a stretch of coastline with a vegetated shingle beach, behind which is a sand dune system. The intertidal zone supports important populations of wintering birds including numbers of wintering sanderling (up to 300 recorded) which are of European significance.
<b>Non-statutory sites:</b>		
Littlehampton Golf Course and Atherington Beach, Site of Nature Conservation Importance (SNCI)	TQ 020 013	Calcareous grassland, ditch and shingle beach. Littlehampton Golf Course is of outstanding importance botanically. Although much of its grassland has been 'improved' there are patches of species-rich turf. The southern edge of the golf links includes an area of dry dune grassland, adjacent to the sand dune system of Climping Beach SSSI. The site also includes an area of vegetated shingle beach, a nationally uncommon habitat.

### 3.1.3

#### *Existing Records of Rare and Protected Habitats/ Species*

Recent records were obtained from the desk study area for the following species which may potentially be impacted by the proposed development:

*Table 2 - Recent records of rare/ protected species*

Species	Nearest Location	Year Recorded
<b>Flora, a number of uncommon plant species typical of coastal grazing marshes have been recorded to the north of the survey area:</b>		
Borrer's saltmarsh-grass <i>Puccinellia fasciculata</i> (Nationally scarce, UK BAP Priority, Red Data Book 'Vulnerable')	TQ010035 – c.250m north of northern limits of survey area	1997
Marsh stitchwort <i>Stellaria palustris</i> (UK BAP Priority, Red Data Book 'Vulnerable')	TQ014042 - c.1km north of northern limits of survey area	1997
Marsh-mallow <i>Althaea officinalis</i> (Nationally scarce)	TQ008026 – alongside River Arun, c.200m upstream of survey area	1997
<b>Fauna:</b>		
Badger	TQ00 (Records exist for this and all surrounding 10km x 10km squares)	1969
Bottle-nosed dolphin <i>Tursiops truncatus</i>	Offshore records south of river mouth, e.g. at TQ033003	2002
Brown long-eared bat <i>Plecotus auritus</i>	Adjacent to west bank of River Arun at TQ002037 – c.1km upstream of survey area	1997
Common lizard <i>Lacerta vivipara</i>	Numerous records from locations along the river within the survey area e.g. TQ019022	1999
European water vole <i>Arvicola terrestris</i>	Adjacent to west bank of River Arun at TQ003039	2004
Grass snake <i>Natrix natrix</i>	TQ0005 – Two record, e.g. adjacent to the River Arun, approximately 2km upstream of survey area	1987
Great crested newt <i>Triturus cristatus</i>	A concentration of records at and around TQ006009, c2km west of river mouth	2003
Serotine bat <i>Eptesicus serotinus</i>	c.1.5km west of River Arun at Climping village - TQ003014	1994

Species	Nearest Location	Year Recorded
Slow-worm <i>Anguis fragilis</i>	Several records within Littlehampton and to the north, e.g. TQ020027 (c.300m from the river)	2003

### 3.2

#### ***Extended Phase 1 Habitat Survey***

##### 3.2.1

##### *General Site Description:*

The following describes the habitats that were classified on and around the site and should be read in conjunction with the Phase 1 Habitats Map/ Site Plan (see Appendix A, Figure 1):

The survey area comprises the lower tidal section of the River Arun and its adjacent habitats. The survey was primarily focussed on habitats present on the east bank of the river, and the survey was carried out exclusively from this side of the river. Nonetheless an effort was made to identify and map habitats and ecological features present on the west side of the river, where possible, from this vantage point.

The east bank of the river predominately comprises urban habitats such as residential housing, light industrial and footpaths/ roads within Littlehampton. These frequently extend right up to the vertical pilings which form the river's edge along much of the surveyed section. At and around low tide there is a strip of inter-tidal mud along both sides of the river. The river mouth opens on to a foreshore made up of shingle, sand and mud. At the upstream end of the surveyed section north of the A259 road crossing, there is an area of grassland both on and behind the river embankment. This opens out to form an extensive area of coastal grazing marshes and drainage ditches at and beyond the northern limits of the surveyed area. The strip of grassland within the survey area which lies between the river embankment and the A259 also contains other habitats such as a drainage ditch flanked by common reed *Phragmites australis* dominated inundation vegetation. A dense strip of scrub and trees occur along the road embankment adjacent to this.

On the west bank of the river there is an important area of sand dune and dune grassland (Climping Beach SSSI and Littlehampton Golf Course and Atherington Beach SNCI) behind the beach; including part of a golf course. Further upstream from here there are a number of boatyards along the river bank, followed by unmanaged grassland and scrub along the river embankment up to the end of the

surveyed section. Land use beyond this to the west comprises arable fields, bounded by drainage ditches flanked by tall grassy vegetation and scrub.

The following 14 habitats were identified within the survey area and are described in more detail below:

- Amenity grassland
- Arable land
- Brackish water
- Broad-leaved trees
- Buildings and hard-standing
- Coastal grassland
- Dense and scattered scrub
- Drainage ditches
- Dune grassland
- Inter-tidal mud
- Inundation vegetation
- Open dune
- Saltmarsh
- Sand/ shingle above high water.

### 3.2.2

#### *Habitats*

##### **Amenity grassland**

Mapped areas of amenity grassland occur within the urban area of Littlehampton, with numerous smaller areas within domestic gardens and the grounds of industrial/commercial premises. These typically comprise shown-mown grass of limited ecological value, but these areas may also support a number of ornamental trees and shrubs which are potentially of value as roosting, nesting and foraging habitats for bat and bird species.

##### **Arable land**

The area to the west of the river mainly comprises arable land. The fields themselves are of very limited ecological value, but are flanked by ditches and other field boundaries which can support a wide range of plant and animal species.

### **Brackish water**

The section of the River Arun surveyed is tidal and contains brackish water which appeared turbid at the time of the survey. This section of river is likely to support a range of 'coarse' and sea fish typical of this habitat.

The pond to the east of the river close to the mouth is a marine lake that is filled using sea water (see Target note 1, Photograph 1). This pond is circular with vertical concrete sides with a footpath around it. The water did not appear to contain any aquatic vegetation at the time of the survey, and appeared to be of very limited ecological value.

### **Broad-leaved trees**

Exposed conditions occurring at this site are unfavourable to the majority of tree species, although a number of hardy tree specimens including holm oak *Quercus ilex* were recorded close to the river mouth.

### **Buildings and hard-standing**

A large continuous area of buildings and hardstanding occurs along the east bank of the River Arun within the survey area. This comprises a mixture of industrial and domestic uses; with amenity areas along the coastal edge, followed by tight-knit housing which often backs directly onto the river and industrial yards along the river's edge in the north-eastern part of Littlehampton. These areas are typically subject to high levels of disturbance and are consequently of relatively low value for wildlife species. However, domestic houses or disused industrial structures or buildings, especially those of an older construction may offer suitable habitats for roosting bats and nesting bird species, as well as having suitable wildlife habitats in their gardens.

### **Coastal grassland**

Coastal grassland recorded within the survey area encompasses three types:

- Semi-improved grassland inland from the dune grassland at the river mouth.
- Coastal floodplain grassland at the northern end of the survey area.
- Relatively unmanaged tall grassland in marginal habitats along ditch banks and river embankments.

Semi-improved grassland on the west bank of the river, inland from the dune grassland was not visited during the current survey, but is likely to resemble the dune grassland and to contain species which prefer free-draining coastal sandy

soils. Much of this has been managed for the purposes of the golf course, although patches of species-rich turf remain. The area is part of a SNCI and is of importance as it supports a wide range of uncommon plant and invertebrate species as well as migrant birds.

Coastal floodplain grassland occurs across a wide area at the northern end of the survey area, and a narrow strip of this habitat extends southwards along the east bank of the river to the A259 road crossing (see Target note 2, Photograph 2). Coastal floodplain grassland typically consists mainly of low-lying, periodically inundated pastures or meadows with or without ditches which maintain water levels, and which contain standing brackish or fresh water. Almost all areas are grazed or cut for hay or silage. Many of the wildlife species found in floodplain grasslands are rare or threatened, and some are endemic to this habitat. The Arun river is known to have important areas of floodplain grasslands or 'levels'. Almost all these areas are grazed and some are cut for hay or silage. Wet grasslands are one of the richest wildlife resources in the UK, because they often form a transition zone between wet and dry habitats. Approximately 500 species of vascular plants have been recorded from UK wet grassland and associated drainage channels. The drainage channels alone support some 130 of Britain's 170 species of brackish and fresh water vascular plants. Wet grassland is particularly important for the notable invertebrate and plant species, and the large number of breeding and wintering birds which it supports.

The relatively unmanaged tall grassland is characterised by grassy vegetation dominated by larger grass species such as sea couch *Elytrigia atherica* and false oat-grass *Arrhenatherum elatius*, with frequent tall herbs such as mugwort *Artemisia vulgaris* and cow parsley *Anthriscus sylvestris*. Scrub species such as bramble *Rubus fruticosus* agg. and hawthorn *Crataegus monogyna* occur frequently and often form dense stands.

### **Dense and scattered scrub**

As stated above, scrub occurs at numerous locations within the surveyed area. Often this comprises scattered individual bushes (typically dominated by hawthorn and bramble), but these have joined to form blocks of dense scrub in places.

### **Drainage ditches**

A number of drainage ditches occur within the survey area. These were slow-flowing and contained up to 1m depth of water at the time of the survey. The channels appear to be relatively silty and are flanked by common reed.

### **Dune grassland**

Dune grassland was not visited during the current survey, but its ecological interest is well documented as it forms part of Climping Beach SSSI. A wide range of uncommon plant and invertebrate species occur within this habitat.

### **Inter-tidal mud**

Bare strips of mudflat, exposed at low tide, occur along the banks of the River Arun and large shallow areas are present along the coastal frontage. This habitat consists of soft muds and sands and supports large populations of marine invertebrates. These in turn support a wide range of foraging wading birds and wildfowl, and along the coastal frontage important populations of wintering birds occur (the numbers of wintering sanderling, in particular, are of European significance).

### **Inundation vegetation**

Tall reed-dominated inundation vegetation occurs in strips along drainage ditches within the survey area. Note that this habitat was generally present in narrow marginal strips and could not be mapped on Appendix A due to their small size.

One area of this habitat was identified within the zone which may be impacted by the proposed scheme in the northern part of the survey area (see Target note 3, Photograph 3)

Reedbeds are defined in the Sussex Habitat Action Plan as ‘wetlands dominated by stands of common reed, where the water table is at or above ground level for part of the year’. They tend to incorporate areas of open water and ditches. These marginal stands support many important species, particularly birds, molluscs and moths. Uncommon plants such as marsh mallow may also occur in this habitat.

### **Open dune**

Open sand dune occurs on the west side of the river mouth and forms another part of Climping Beach SSSI. Stabilised parts of these dunes are dominated by marram-grass *Ammophila arenaria*. Other plants which are present include dune fescue grass *Vulpia membranacea*, sand catchfly *Silene conica*, sand sedge *Carex arenaria* and Nottingham catchfly *Silene nutans*. Sand dunes are fragile systems, susceptible to erosion and often unstable.

### **Saltmarsh**

Narrow strips of saltmarsh vegetation occur along on berms along the River Arun at the upstream end of the surveyed section.

These are typically no more than 3m wide, but contain a range of typical saltmarsh species such as sea purslane *Halimione portulacoides*, sea beet *Beta vulgaris* ssp. *maritima*, common saltmarsh-grass *Puccinellia maritima* and sea aster *Aster tripolium*.

### **Sand/ shingle above high water.**

Areas of sand and shingle beach occur on both sides of the river mouth. This is subject to relatively high levels of human disturbance on the east side and its ecological value is limited. On the west side the beach forms another component part of Climping Beach SSSI and supports areas of vegetated shingle. Plant communities here are mainly restricted to sheltered areas behind the main shingle bank, and include yellow horned poppy *Gaucium flavum*, sea kale *Crambe maritima* and sea holly *Eryngium maritimum*.

### **3.2.3**

#### **Species**

This section describes the species which are either recorded on site or are deemed as potentially occurring on the site due to the presence of suitable habitat (a checklist indicating presence or likely absence of protected/ notable species is provided in Appendix D):

#### **Amphibians**

No potential great crested newts (GCN) breeding ponds were identified within the survey area, and no records for this or other amphibian species were obtained within 500m of the survey area<sup>2</sup>. However records were obtained within the desk study area and suitable terrestrial habitat (relatively unmanaged grassland and scrub) does occur within the survey area.

Suitable terrestrial habitat on the east bank within the zone likely to be affected by the proposed scheme is limited to the coastal grassland and scrub habitats in the upstream section. This area is cut off from nearby habitats by the River Arun, a busy road and a railway track. These are likely to considerably reduce or prevent any potential dispersal of any nearby GCNs into this area. Furthermore aquatic

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<sup>2</sup> Current Natural England guidance recommends that impacts on this species should be considered for any development works occurring within 500m of a breeding pond.



habitats within 500m of this area consist of drainage ditches and the River Arun; neither of which provide optimal conditions for this species.

Consequently it is considered that GCNs and other amphibian species are unlikely to be adversely impacted by the proposed scheme and are scoped out at this stage.

### **Badgers**

The survey area was searched for badger setts, and/or signs of badger activity, which would indicate the presence of a nearby sett, and no signs were identified. Much of the survey area would be considered unsuitable for badger setts as it is low-lying and prone to seasonal flooding, but raised embankments within this area may possibly be suitable. Dense scrub vegetation and lack of access to all areas of the riverbank prevented thorough examination of all suitable locations, and NBN Gateway records suggest that badgers are likely to occur in the area. Consequently it is considered that badger setts may possibly exist within the area which will be affected by the proposed scheme, although the potential for this is low.

### **Bats**

Bats roosts may occur within industrial or residential buildings within the survey area. Grassland and scrub within the survey area is sub-optimal as foraging or commuting habitat for bat species, but bats may occur here. Records of two bat species were obtained as part of the desk study.

### **Birds**

A number of opportunistic records of bird species were made during the site survey, including gull and waders species (e.g. common gull *Larus canus*, black-headed gull *Larus ridibundus*, turnstone *Arenaria interpres* and redshank *Tringa totanus*) within the inter-tidal zone on the coastal frontage. A number of widespread garden bird species were observed in the remaining parts of the survey area, including Red Listed Birds of Conservation Concern (RSPB, 2002) such as house sparrow *Passer domesticus* and starling *Sturnus vulgaris*.

### **Invertebrates**

Drainage ditches and other aquatic habitats present on site may contain ecologically important and diverse communities of aquatic invertebrates.

### **Reptiles**

The area mapped as coastal grassland is potentially highly suitable habitat for reptile species; especially areas where there are patches of scrub and any piles of

debris suitable as refugia/ hibernacula and bare areas suitable for basking activities. Records for three of the widespread reptile species were obtained as part of the desk study, with records for common lizard and slow-worm from inside or very close to the survey area.

### **Water voles**

No signs of water vole activity were identified during the current survey, but the ditch within the survey area at the location indicated by Target note 3 appeared highly suitable for water voles.

Drainage ditches elsewhere within the survey area may also provide suitable habitat for water voles with relatively deep, slow-flowing water within the channels and sloping densely vegetated bank-sides. Furthermore a recent record exists for this species from a location just to the west of the River Arun.

### **Invasive Plants**

No invasive plant species were recorded during the site visit, although as stated above, it was not possible to access all areas, and it is possible that invasive plant species exist within the survey area.

## 4

## Legislation

### Badgers

Badgers are listed under Schedule 6 of the Wildlife and Countryside Act which grants them partial protection. This protection is extended by the Protection of Badgers Act 1992 (Badger Act) which makes it an offence to take, injure or kill a badger, interfere with a sett, sell or possess a live badger, or mark or ring a badger without a licence. Under the Act disturbance is illegal without a licence. English Nature has published guidelines to be adopted when determining whether an activity is 'disturbing' i.e. a licence is required when:

- Using heavy machinery (generally tracked vehicles) within 30m of any entrance to an active sett;
- Using lighter machinery (generally wheeled vehicles) particularly for any digging operation, within 20m; and
- Light work such as hand digging or scrub clearance within 10m.

Licences are not normally issued during the badger breeding season (December – June inclusive).

### Bats

Bats and their roosts are fully protected by three pieces of legislation: the Wildlife and Countryside Act 1981 (and subsequent amendments), The Conservation (Natural Habitats &c) Regulations and the CRoW Act 2000, and six species of bats are UK Biodiversity Action Plan (BAP) priority species.

The above legislation makes it an offence to:

- Intentionally kill, injure or take a bat.
- Possess or control a live or dead bat, any part of a bat, or anything derived from a bat.
- Intentionally or recklessly damage, destroy or obstruct access to any place that a bat uses for shelter or protection. This is taken to mean all bat roosts whether bats are present or not.
- Intentionally or recklessly disturb a bat while it is occupying a structure or place that it uses for shelter or protection.
- Make a false statement in order to obtain a licence for bat work.

### **Breeding Birds**

Birds are protected by the Wildlife and Countryside Act, 1981 (as amended). This legislation makes it an offence to intentionally or recklessly kill, injure or take away any wild bird. It is also an offence to take, damage or destroy the nest of any wild bird while it is in use or being built or to take or destroy the egg of any wild bird. In addition, certain species are listed on Schedule 1 of the WCA. This makes it an additional offence to intentionally or recklessly disturb the adults while they are in and around their nest or intentionally or recklessly disturb their dependent young. Such species are considered to be in greater need of legal protection or of high nature conservation priority.

Birds of conservation concern are also included on the Red and Amber lists (RSPB, 2002). Birds on the Red list are those of high conservation concern and include common and widespread species which have experienced steep declines in numbers, such as starling *Sturnus vulgaris*. Birds on the Amber list are of medium conservation concern and include the dunnoek *Prunella modularis*. A number of Red or Amber listed species are likely to occur within the site.

### **Reptiles**

The four common and widespread species (common lizard, slow-worm, grass snake and adder *Vipera berus*) are partially protected under the Wildlife and Countryside Act 1981 (as amended). They are protected against intentional killing and injuring and trade (i.e. sale, barter and exchange, transporting for sale and advertising to sell or buy). The handling and translocation of these reptiles does not require a licence.

### **Water Voles**

All water voles are afforded protection under the Wildlife & Countryside Act 1981 (as amended) and as a priority species in the UK Biodiversity Action Plan (UK BAP). Recent changes in 2008 mean that this species is now fully protected under Section 9 of the Act. In summary, current legal status makes it an offence to intentionally or recklessly damage or destroy or obstruct access to any structure or place which is used for shelter or protection or to disturb water voles while they are using such a place.

### **Biodiversity Action Plan (BAP) Designations / Birds of Conservation Concern Listings**

UK BAP designations relate to species or habitats which are regarded as being of national conservation concern, and for which Biodiversity Action Plans have been

prepared. Pond habitats above a certain minimum quality have recently been included in the list of UK BAP Priority habitats, and certain species which may potentially occur within the site which otherwise receive no legal protection are designated as BAP Priority species. Local (County level) BAPs also exist for species or habitats considered a conservation priority at the County level.

Note that BAP designations and status as RSPB 'Birds of Conservation Concern' do not offer any further legal protection, but planning authorities are required to prevent these species from being adversely affected by development in accordance with Section 74 of CROW act (lists the UKBAP species) and Planning Policy Statement 9; Biological and Geological Conservation (PPS9 - <http://www.communities.gov.uk/index.asp?id=1143832>) – see below.

#### **Planning Policy Statement Note 9 – Biodiversity and Geological Conservation**

Planning Policy Statement 9 (PPS9), published in August 2005, outlines the Government's commitment to the conservation of wildlife and natural features. It is mainly concerned with the protection of statutorily designated sites, although PPS9 also seeks to ensure that planning policies maintain, enhance, restore or add to biodiversity and geological conservation interests. The policies and guidance within PPSs are a material planning consideration and key points of relevance to birds state that:

- Planning policies and planning decisions should aim to maintain, and enhance, restore or add to biodiversity and geological conservation interests. In taking decisions, local planning authorities should ensure that appropriate weight is attached to designated sites of international, national and local importance; protected species; and to biodiversity and geological interests within the wider environment. (Paragraph 1(ii))
- Local authorities should take measures to protect the habitats of [Biodiversity Action Plan] species from further decline through policies in local development documents. Planning authorities should ensure that those species are protected from the adverse effects of development, where appropriate, by using planning conditions or obligations. (Paragraph 16)

**Invasive Plants**

It is an offence to plant or encourage the growth of certain invasive species such as Japanese knotweed *Fallopia japonica*.

## 5 Site Evaluation

Two designated sites are present within the survey area. Climping Beach SSSI is of value at the **national** level, and Littlehampton Golf Course and Atherington Beach SNCI is of value at the **county** level.

The following habitats which are present within the survey area either are or may meet the criteria for UK BAP Priority habitats:

- Brackish water
- Coastal grassland
- Drainage ditches
- Dune grassland
- Inter-tidal mud
- Inundation vegetation
- Open dune
- Saltmarsh.

Habitat Action Plans have been produced giving detailed information and advice for the above habitats<sup>3</sup>. These habitats may be of value up to the **national** level, where sufficient areas of favourable quality habitat exist, and particularly where these form part of existing designated sites. The remaining habitats present within the survey area are considered to be of much lower value, but may contain features within them which are of higher value, e.g. drainage ditches within arable areas.

The bird community, reptiles, water voles, assemblages of plant and invertebrate species present within the study area may be of importance up to the **national level**, especially where these form part of Climping Beach SSSI. Bat species are protected under EU law and could potentially be of value up to **international** level.

Where levels of ecological value have been allocated to the various ecological features identified within the study area these are provisional judgements, based on

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<sup>3</sup> <http://www.ukbap.org.uk/>

available data, and may be found to be less than the levels indicated following further species surveys, e.g. reptile surveys.



## 6

## Potential Impacts

At this stage (i.e. without precise details of the locations of all proposed construction works) it is difficult to identify the magnitude or significance of impacts. Furthermore this report does not constitute a full Ecological Impact Assessment (EcIA, following IEEM 2006) but indicates likely negative impacts based on available information and uses terminology which is consistent with current EcIA guidelines. An EcIA may be required at a later stage, and can be undertaken based on the results of the current survey. A number of possible negative impacts may occur, but it should be borne in mind that the negative impacts associated with the proposed scheme are likely to be largely temporary in nature and will only affect a narrow strip of land where construction works are to take place.

The proposed scheme relates to proposed development works on the east bank of the River Arun. Consequently impacts are predicted to largely be limited to ecological features located on this side of the river. Therefore impacts on Climping Beach SSSI and Littlehampton Golf Course and Atherington Beach SNCI and the dune grassland and open dune occurring within these sites are considered to be unlikely.

There is potential for impacts to arise to the following UK BAP Priority habitats: brackish water, coastal grassland, drainage ditches, inter-tidal mud, inundation vegetation and saltmarsh.

Adverse impacts on reptiles, water voles and aquatic invertebrates are likely to be restricted to areas of suitable habitat on the east bank of the river in the northern part of the survey area.

Table 3 provides a summary of where impacts may occur without mitigation.

*Table 3 – Summary of potential impacts on ecological features identified as potentially occurring as a result of the proposed construction activities on the River Arun..*

Ecological Feature	Potential Impacts
<b>Designated Sites</b>	No adverse impacts anticipated as a result of the proposed scheme
<b>Habitats:</b>	
Brackish water and inter-tidal mud	Adverse impacts (destruction or fragmentation) possible as a result of replacement/ reinforcement of pilings along river banks
Coastal grassland, drainage ditches, saltmarsh and inundation vegetation	Adverse impacts (destruction or fragmentation) possible as a result of embankment raising in upstream section of survey area
<b>Species:</b>	
Badgers	Badgers becoming trapped in excavations*. Disturbance to any unidentified setts*(Risk of damage to setts considered to be relatively low as none located within survey area, but entire site not accessed.
Bats	Interruption of dispersal routes across works area Damage, destruction or obstruction of buildings containing bats may cause disturbance, injury or death to a bat.*
Birds	Disturbance caused by artificial lighting.* Loss of nests, and/or disturbance to nests in active use (any disturbance to nesting birds on Schedule 1 of WCA prohibited by law) including skylark and other ground nesting birds in grassland habitat.* Loss of nesting habitat. Impacts also possible involving disturbance of wintering flocks of roosting or foraging birds.
Invertebrates	Loss of habitat suitable for assemblages of invertebrates in drainage ditches.
Reptiles	Injury or death to reptiles.* Damage to, destruction or obstruction of suitable reptile habitat. Works area may constitute a barrier to natural dispersal or movement. Habitat fragmentation.

Ecological Feature	Potential Impacts
Water voles	Impacts possible if any inundation habitats affected by construction works and include: Injury or death to water voles and damage to, destruction or obstruction of suitable water vole habitat.*
* Reasonable effort must be made to avoid these occurrences according to the relevant sections of wildlife legislation.	

## 7 Recommendations

### 7.1

#### ***Further Surveys***

*Reptiles* - A reptile survey is recommended following recommended guidelines to provide further details of locations and population size estimates of any reptiles inhabiting areas where construction works are proposed within the coastal grassland habitats on the river embankments and within floodplain grassland.

*Bats* – Bat roosts may occur within the site survey area within buildings. Consequently it is recommended that any buildings which are to be disturbed or demolished should be searched by a licensed bat worker.

*Invertebrates* - It is recommended that a survey is carried out for notable aquatic invertebrates present in any drainage ditches which are to be disturbed as part of the proposed works.

*Water voles* - It is recommended that a water vole survey is undertaken of any drainage ditches which are to be disturbed as part of the proposed scheme. Water voles often forage some distance from the waters edge. Therefore an assessment of drainage ditches as water vole habitat should include a 2m buffer where appropriate.

## 7.2

### *Mitigation*

Mitigation measures can be based on:

- **Avoidance** through re-location, re-design or changes in the construction programme (e.g. carrying out works outside of bird breeding season);
- **Reduction** involving lessening the severity of an impact which cannot be avoided (e.g. erecting an exclusion fence for reptiles around the works area); and
- **Compensation** through habitat creation or enhancement.

It will be possible to significantly reduce or ameliorate any potential adverse impacts by including mitigation measures into the design stage of the development. Examples of this could include carrying out works on a given area at a time of year (such as avoiding the bird breeding season for tree/shrub removal) and removal of potential bird breeding habitat under ecological supervision.

## 7.3

### *Generic mitigation measures*

The following mitigation should be carried out as part of the proposed scheme:

1. Suitable breeding bird habitat occurs within all habitats throughout the site. All trees/shrubs/reeds and vegetation more than 0.5m high (e.g. bramble thickets), and open grassland which is not short-grazed should be considered as potentially suitable for breeding birds. It is recommended that this habitat is avoided by undertaking the works outside of the bird breeding season (September – early February), or removing any suitable habitat outside of the bird breeding season.
2. Where this is not possible the construction works should be relocated as much as is possible to avoid disturbance to bird breeding habitat.
3. Any construction works undertaken within the bird breeding season where suitable bird breeding habitat exists will require a site check for breeding birds by a suitably qualified ecologist. This should take place no more than two days prior to commencing construction. This is to ensure that no disturbance to active bird nests occurs. If a nest is found the nest must be cordoned off and works adjacent to this nest must be delayed until such a time that the chicks have fledged from the nest. This should be supervised by a suitably qualified ecologist.
4. Standard site procedures, as recommended by the Environment Agency, such as; PPG5 – Works and Maintenance in or near water will be required to ensure that no contaminants/ effluent are released into nearby aquatic environments.

5. When areas containing rabbit warrens are disturbed, this should be done in as humane a manner as is possible in keeping with the requirements of the Mammals Act 1996, preferably the services of a qualified pest controller should be used.
6. All excavations left overnight should be provided with a ramp to enable easy escape of badgers and other fauna.
7. Where construction works occur within UK BAP habitats, these should be restored to their original condition as quickly as possible in order to minimise loss of key species and colonisation by invasive weed species.
8. British Standard/National Joint Utilities Group Guidelines (NJUG)<sup>4</sup> should be followed when working in close proximity to trees or shrubs at all times during construction. According to NJUG Guidelines the root protection area is four times the circumference of the trunk (circumference is measured around the trunk at a height of 1.5m above ground level). The distance is measured from the centre of the trunk to the nearest part of any excavation or other work. Consequently, where possible the development area should be modified to avoid tree Root Protection Areas (RPAs) as much as is possible.

## 8 Enhancement opportunities

Enhancement opportunities will be required to compensate for any negative impacts incurred as part of the proposed scheme. But further measures should also be considered in order to result in an overall positive impact as required by PPS9. These could be accommodated within the development site and may include creation of new areas of brackish reedbed or saltmarsh (see sections below), through allowing tidal water to access areas behind the river embankment.

There is scope to create habitats of high ecological value in this way and to create suitable habitats for notable species. However the key area where there is potential for habitat enhancement may already qualify as UK BAP Priority habitat. Consequently any proposed enhancements should be subject to review by Natural England to ensure that ecological benefits are optimised.

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<sup>4</sup> the British Standard, BS 5837:2005 Trees in relation to construction Recommendations and National Joint Utilities Group, Guidelines For The Planning, Installation and Maintenance of Utility Services in Proximity to Trees (April 1995)

### *BAP habitat – Reedbed*

Nationally there are about 5000 hectares of reedbed in the UK, consisting of approximately 900 sites, but only about 50 are greater than 20ha. The known reedbed source in Sussex currently only extends to about 65ha. On Sussex wetlands, reeds generally form a significant component of the ditch flora but are prevented from colonising further by grazing practices and water level control.

Two types of reedbed are generally recognised – reed swamp (National Vegetation Communities (NVC) such as S4 (*Phragmites australis* swamp and reedbeds) and reed fen (NVC – S26 *Phragmites australis* – *Urtica dioica* tall herb fen). Reed swamp is permanently waterlogged with a summer surface level of around 20cm. Reed swamp is likely to contain pure stands of reed. Reed fen has a water level at or below the surface in summer and is likely to be more botanically diverse.

In order for reedbeds to establish themselves successfully it would be necessary to maintain water levels up to 30cm depth of water over part of the site in summer months. Typical key species and their water level requirements that could be used in the reedbed include:

- Common reed – preferred water level -20 to 0cm, but can tolerate up to +50cm of water above ground level,
- Grey club-rush *Schoenoplectus tabernaemontani* – preferred water level +20cm to 30cm but can tolerate up to +60cm and
- Sea club-rush *Bolboschoenus maritimus* - preferred water level -20cm to 20cm but can tolerate up to +60cm.

Likely time-scale for the creation of reedbed habitat is around 1-2 years providing that any planting is carried out in Spring, if planting is carried out later in the year then the reedbed will take longer to become established.

Shallow excavation could also be undertaken on the site to provide areas of shallow open water.

*BAP habitat – Saltmarsh*

Regular regulated tidal exchange to the area behind the embankment could also permit the creation of saltmarsh vegetation. There are a number of existing case studies for this type of habitat creation, where it appears that saltmarsh habitats can be successfully established relatively rapidly.

## 9

## Conclusions

There is potential for the proposed scheme to impact on a number of ecological receptors. The key issues relate to, but are not limited to the following:

- Notable/ UK BAP Priority habitats including: Brackish water, inter-tidal mud, coastal grassland, drainage ditches, saltmarsh and inundation vegetation
- Protected/ notable species and their habitats, particularly reptiles, water voles and invertebrates.

This report provides details of an ecological site survey and desk study of existing data carried out to assess the baseline nature conservation value of the site, to identify where further ecological surveys are required and to identify the key constraints and opportunities to development.

There is scope to implement ecological enhancement measures as part of the proposed scheme. It is recommended that consultation with Natural England is undertaken when precise scheme details are produced, to agree mitigation measures for protected species of flora and fauna where this is deemed necessary. This will aid in the development of design proposals and mitigation plans for the development.



*Table 4 – Summary of recommended actions for each ecological receptor*

Ecological Feature	Level of Importance	Recommended Action
UK BAP Priority habitats	Up to national level	Mitigation measure 7
Aquatic invertebrates	Potentially of up to national level importance	Survey of aquatic invertebrates where relevant habitats to be disturbed
Badgers	Protected under UK law	Mitigation measure 6
Bats	Protected under International law	Any buildings to be disturbed should be searched by a licensed bat worker.
Breeding birds	Breeding birds protected under UK law Of national level importance for breeding birds	Mitigation measures 1-3
Reptiles	Protected under UK Law	Reptile survey where relevant habitats to be disturbed
Water voles	Protected under UK Law	Water vole survey where relevant habitats to be disturbed

Botanical Society of the British Isles (2004), *UK Plant List*

Institute of Ecology and Environmental Management (2006), *Guidelines for Ecological Impact Assessment within the United Kingdom*

Institute of Environmental Assessment (1995). *Guidelines for Baseline Ecological Assessment*. E & FN Spon. London.

Joint Nature Conservation Committee (1993), *Handbook for Phase 1 Habitat Survey. A Technique for Environmental Audit*, Joint Nature Conservation Committee, Peterborough.

Rose F (2006), *The Wild Flower Key*, Frederick Warne and co., London

RSPB (2001), *The Population Status of Bird in the UK. Birds of Conservation Concern: 2002-2007*; RSPB Sandy, Beds.

## **Appendix A: Phase 1 Habitats Map/ Site Plan**

*Figure 1 – Map of Phase 1 Habitats and Target notes*

## Appendix B: Target Notes

Target Note (TN) Number	Description of Feature
1	Marine lake within amenity grassland area - lacking in any evident features of ecological interest
2	Narrow strip of coastal grassland extending southwards along the east bank of the river to the A259 road crossing with strip of scrub habitat along the base of and up the side of the road embankment
3	Area of reed-dominated inundation vegetation along ditch within strip of coastal grassland

## Appendix C: Site Photographs



Photograph 1 – Marine lake within amenity grassland



Photograph 2 – Strip of coastal grassland behind river embankment



Photograph 3 – Reed-dominated inundation vegetation

## Appendix D - Potential for Protected Species to be present/absent at the site

Species	Presence/ Likely absence within areas impacted by proposed scheme
Bats	Active in the area, roosts likely in buildings within survey area
Badgers	May be active in the area, but no setts or other signs identified
Diverse invertebrate communities	Likely to be present within coastal grassland – both terrestrial and aquatic
Dormouse	No suitable habitat present
Great crested newts	Unlikely to be present within site survey area
Breeding (and wintering) birds	Present
Reptiles	Likely to be present within suitable habitat in the survey area
Water vole	May be present on site within ditches in coastal grassland
White-clawed crayfish	No suitable habitat present

## Technical note

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<b>Project</b>	Littlehampton - River Arun East Bank Tidal Walls	<b>Date</b>	18 October 2012
<b>Note</b>	Phase 1 Habitat Refresher & Bat Potential Assessment	<b>Ref</b>	DCARUN
<b>Author</b>	A. Honeysett		

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### **1** *Introduction*

1.1 The Environment Agency is proposing to carry out improvement works to the coastal flood defences on the east bank of the River Arun from the mouth of the river at Littlehampton to a point just to the north-east of Littlehampton (NGR TQ028012 - TQ 012032).

1.2 This report forms an addendum to the original River Arun PAR – Ecological Scoping Report carried out in 2009 for that project. The purpose of this survey is to review the Phase 1 data collected at the time and highlight any significant changes in habitat types present.

1.3 This report will also confirm proposed mitigation measures for the potential presence of bats within the study area following a survey of the area on the 11<sup>th</sup> September 2012.

1.4 A revised desk-based study was also carried out to gather any further records of protected or notable species and designated sites within the site and the surrounding area. A report was commissioned from the Sussex Biodiversity Record Centre (SxBRC) to cover the land affected by the proposed works. The findings are presented below.

### **2** *Findings for the Arun 2009 Phase 1 refresher survey*

2.1 There has been no change in the vegetation types present along the Arun flood embankment since 2009.

2.2 The only change has been the location of a patch of Japanese knotweed located along the boundary between Riverside Industrial Estate and Tarmac compound, approximate grid reference NGR TQ 01765 02340.

## Arun East Bank Tidal Walls – Phase 1 Refresher Survey and Bat Potential Assessment

- 2.3 The original habitat map and target notes have been updated accordingly to show the location of the patch of Japanese Knotweed, Appendix A – Figure 1 and Target Notes.

### 3 ***Desk Study update for 2009 phase 1 survey***

#### 3.1 *Site Designations*

A summary of nature conservation designations within the original phase 1 study area are outlined in the table below:

*Table 1 – Nearby Statutory and Non-Statutory Designations*

Site Name	Location in relation to proposed site	Description
<i>Statutory Sites</i>		
Climping Beach Site of Scientific Interest (SSSI)	TQ 020 010	The site comprises a stretch of coastline with a vegetated shingle beach, behind which is a sand dune system. The intertidal zone supports important populations of wintering birds including numbers of wintering sanderling (up to 300 recorded) which are of European significance.
<i>Non-Statutory Sites</i>		
Littlehampton Golf Course & Atherington Beach Site of Nature Conservation Importance (SNCI)	TQ 020 013	Calcareous grassland, ditch and shingle beach. Littlehampton Golf course is of outstanding importance botanically. Although much of its grassland has been ‘improved’ there are patches of species-rich turf. The southern edge of the golf links includes an area of dry dune grassland, adjacent to the sand dune system of Climping Beach SSSI. The site also includes an area of vegetated shingle beach, a nationally uncommon habitat.



## Arun East Bank Tidal Walls – Phase 1 Refresher Survey and Bat Potential Assessment

## 3.2 Protected Species

Table 2 – Updated records of rare/protected species which may be impacted by the proposed scheme.

Species	Nearest Location	Year Recorded
<b>FLORA: a number of uncommon plant species typical of coastal grazing marshes have been recorded to the north of the survey area:</b>		
Borrer's saltmarsh-grass <i>Puccinellia fasciculata</i> (Nationally scarce, UKBAP Priority, Red Data Book 'Vulnerable')	TQ 010035 – c. 250m north of northern limits of survey area	1997
Marsh Stitchwort <i>Stellaria palustris</i> (UK BAP Priority, Red Data Book 'Vulnerable')	TQ 014042 – c. 1km north of northern limits of survey area	1997
Marsh mallow <i>Althaea officinalis</i> (nationally scarce)	TQ 008026 – alongside River Arun, c.200m upstream of survey area	1997
<b>FAUNA</b>		
Badger <i>Meles meles</i>	TQ00 (records exist for this and all surrounding 10km x 10km squares)	1969
Bottle-nosed dolphin <i>Tursiops truncatus</i>	Offshore records south of river mouth e.g. at TQ033003	2002
Brown long-eared bat <i>Plecotus auritus</i>	Adjacent to west bank of River Arun at TQ002037 – c. 1km upstream of survey area	1997
Common lizard <i>Lacerta vivipara</i>	Several records within the survey area e.g. TQ015025,	2010

## Arun East Bank Tidal Walls – Phase 1 Refresher Survey and Bat Potential Assessment

	TQ015027, TQ015030 & TQ018023	
European water vole <i>Arvicola terrestris</i>	Adjacent to west bank of River Arun at TQ003039	2004
Grass snake <i>Natrix natrix</i>	TQ0005 – Two record, e.g. adjacent to the River Arun, approximately 2km upstream of survey area.	1987
Great crested newt <i>Triturus cristatus</i>	A concentration of records at and around TQ006009, c2km west of river mouth	2003
Serotine bat <i>Eptesicus serotinus</i>	c.1.5km west of River Arun at Climping village – TQ003014	1994
Slow worm <i>Anguis fragilis</i>	Several records within the survey area e.g. TQ015025, TQ015030 & TQ015031	2010
West European Hedgehog <i>Erinaceus europaeus</i> (SxBAP, UKBAP priority species. NERC act 2006)	A record within the study area along the A259 embankment, Littlehampton, TQ016026	2010

## 4

**Bat Potential Assessment of Trees located within Reach 6**

## 4.1

A number of trees/mature hawthorn are present towards the northern part of Reach 6 and along the toe of the Highways Agency Road embankment for the A259, see photo 1

Arun East Bank Tidal Walls – Phase 1 Refresher Survey and Bat Potential Assessment

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Photo 1 – General view of Reach 6 looking north.

- 4.2 A site visit was carried out on the 11<sup>th</sup> September to determine the potential for bats to be present and/or using a tree for roosting purposes of the trees in Reach 6. Features indicating possible usage of a tree by roosting bats include: presence of woodpecker/rot holes; cavities within the trunk/branches; splits, cracks, crevices within the trunk, branches, beneath the bark; and rub/scratch marks around potential access points.
- 4.3 Based upon the suitable features present, the trees were inspected and assigned as, high, medium, low or negligible value, relating to likely presence of roosting bats, see Table 1. The survey was undertaken in accordance with recognised methodologies (Mitchell-Jones & McLeish, 2004 & Bat Conservation Trust, 2007).

## Arun East Bank Tidal Walls – Phase 1 Refresher Survey and Bat Potential Assessment

**Table 1: Description of bat roosting potential categories for trees (adapted from Bat Conservation Trust (2007)).**

Bat Roosting Potential	Description
Confirmed	Confirmed bat roost tree with evidence indicating the presence of bats, e.g. live/dead bats, droppings, scratch marks, rub marks and/or urine staining.
High	Trees that have a high potential to support bat roosts include presence of suitable roosting features such as woodpecker/rot holes, cavities, splits and no obstructions below a cavity entrance, the entrance is upward leading and the tree has a high degree of connectivity to the surrounding landscape.
Moderate	Some potential for roosting bats but is less than ideal. For example, there may be presence of dense ivy and/or a suitable cavity but it could be slightly obstructed below the entrance.
Low	Usage by bats is considered to be slight. For example, there may be a cavity that is not yet deep enough or the possibility of peeling bark and/ or light ivy coverage and lack of connectivity to suitable foraging habitats.
Negligible	No features present suitable for roosting by bats.

## 4.4

The trees present along the top of the road embankment (from the roundabout to the railway line) between the road crash barrier and the wooden fence at the toe of the embankment consist of relatively young trees dominated by species such as hawthorn *Crataegus monogyna*, cherry *Prunus spp.*, field maple *Acer campestre* and ash *Excelsior fraxinus*. There is negligible potential for roosting bats in these trees therefore no further action is required.

## 4.5

Trees located to the south of the steps at the bottom of the embankment consist of generally more mature trees but still provide low/negligible potential for roosting bats. No further action is necessary in relation to the removal of these trees. See photo 2.

## Arun East Bank Tidal Walls – Phase 1 Refresher Survey and Bat Potential Assessment

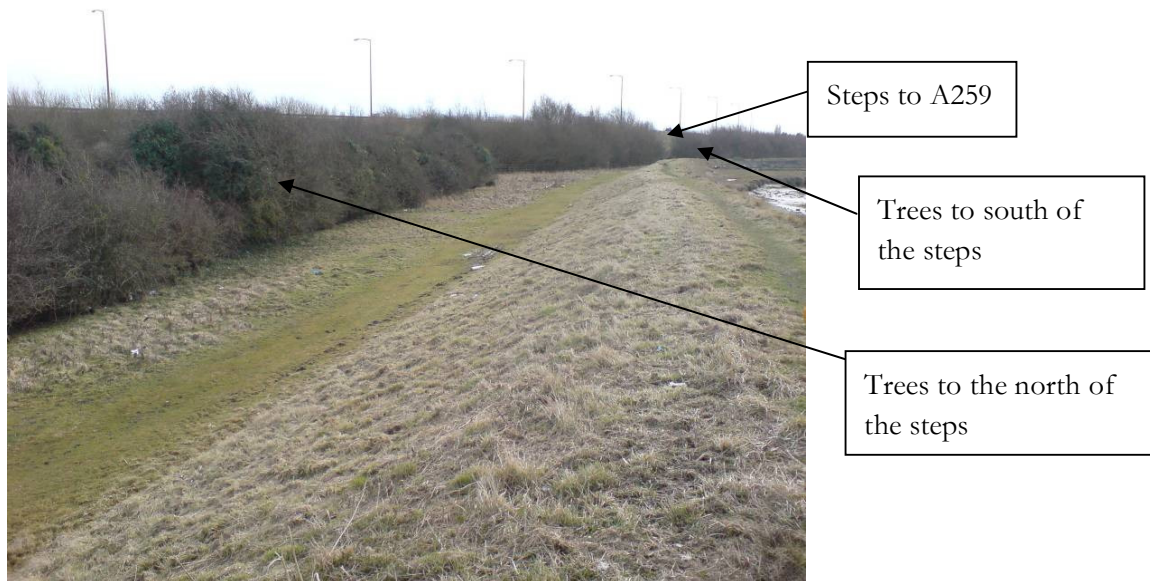


Photo 2 – Overview of Reach 6 looking south

## 4.6

Trees located to the north of the steps at the bottom of the embankment (see photo 2) comprise of a number of mature hawthorn with ivy cover and a mature yew tree with numerous cracks and crevices within the bark providing a medium-low potential for roosting bats, see photos 3-5. Prior to the removal of these trees all cracks and crevices that can be reached from ground level are to be checked with an endoscope by a suitably qualified ecologist. If no evidence of bats is recorded the trees are to be felled under a watching brief with all features i.e. cracks, crevices to be section felled.



Photo 3 – Crack/crevice in hawthorn tree

Arun East Bank Tidal Walls – Phase 1 Refresher Survey and Bat Potential Assessment

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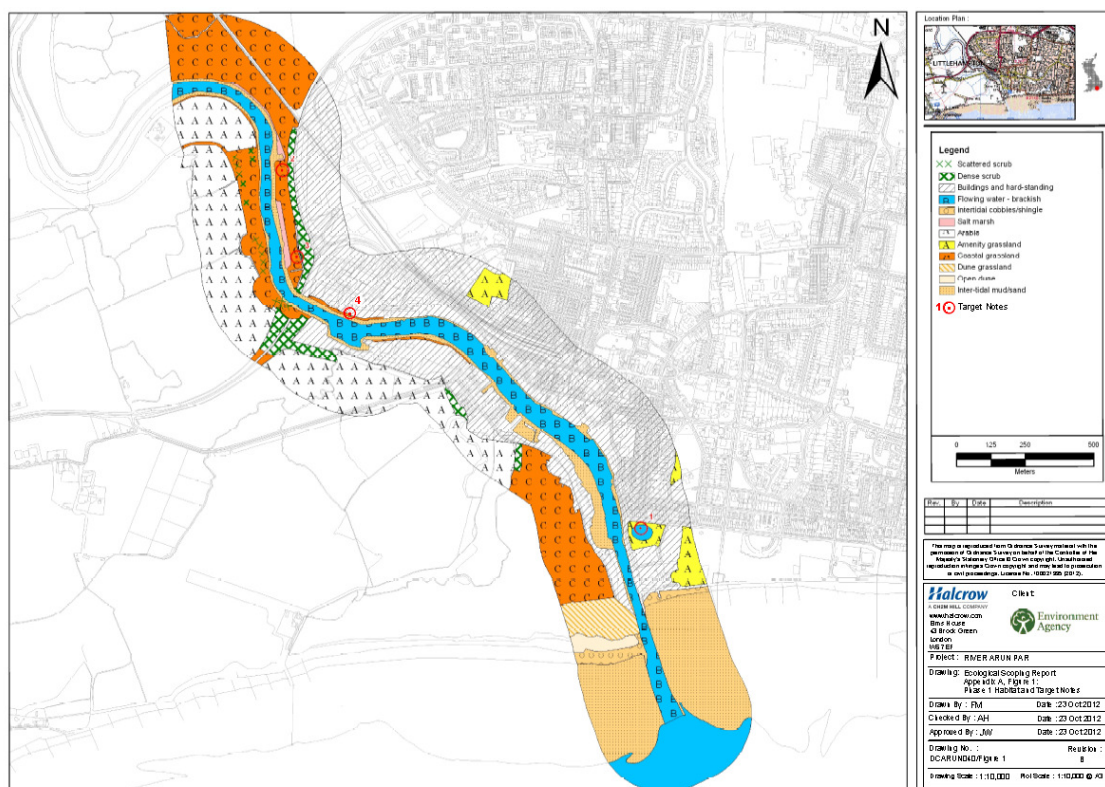
Photos 4 & 5 – Ivy clad hawthorn trees with various cracks and crevices on the trunk

- 4.7 It should be noted that if a roosting bat is confirmed during the watching brief and endoscope check an application for a European Protected Species Licence (EPSL) to permit the removal of these trees will need to be applied for. It is recommended that the tree works are carried out a minimum of three months in advance of any construction works to avoid any potential delays to the works.
- 4.8 The risk of finding roosting bats within these areas surveyed is generally considered to be relatively low overall.



## Arun East Bank Tidal Walls – Phase 1 Refresher Survey and Bat Potential Assessment

## Appendix A – Phase 1 habitat plan and Target notes (revised)



## Target Notes

Target Note Number	Description of Feature
1	Marine Lake within amenity grassland – lacking in any evident features of ecological interest.
2	Narrow strip of coastal grassland extending southwards along the east bank of the river to the A259 road crossing with strip of scrub habitat along the base of and up the site of the road embankment.
3	Area of reed-dominated inundation vegetation along ditch within strip of coastal grassland.
4	Small area of Japanese knotweed <i>Fallopia japonica</i> recorded along the river embankment between the boundary of Riverside Industrial estate and Tarmac compound, approximate location TQ 01765 02340.

## **Environment Agency**

Littlehampton Arun East Bank Tidal Walls  
Aquatic Invertebrate Desk Study & Habitat  
Assessment  
May 2013

**Halcrow Group Limited**





## **Environment Agency**

Littlehampton Arun East Bank Tidal Walls  
Aquatic Invertebrate Desk Study & Habitat  
Assessment  
May 2013

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## Environment Agency

### Littlehampton Arun East Bank Tidal Walls Aquatic Invertebrate Desk Study & Habitat Assessment

#### Contents Amendment Record

This report has been issued and amended as follows:

Issue	Revision	Description	Date	Signed
0	1	Draft	28.3.13	A. Honeysett
0	1	Draft Review	4.4.13	G. Langer
1	2	Final report	24.5.13	A. Honeysett

# Contents

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## APPENDICES

Appendix A – Figure 1 – Reach Locations

# 1

## Introduction

The Environment Agency is proposing to carry out improvement works to the coastal flood defences on the east bank of the River Arun from the mouth of the river at Littlehampton to a point just to the north-east of Littlehampton, West Sussex (NGR TQ028012 – TQ 012032).

Halcrow Group Ltd (Halcrow) was commissioned by the Environment Agency to undertake an aquatic invertebrate desk study and habitat assessment of a ditch to be impacted by the proposed flood defence improvement works at Littlehampton.

The overall study area for the project has been divided into six reaches and further sub-reaches. A plan showing the location and extent of the reaches and sub-reaches is provided in Appendix A – Figure 1 Reach Locations. The ditch which is the subject of this assessment is located within Reach 6.

# 2

## Objectives

The objectives of the study were to assess whether the ecological value of the ditch in terms of providing habitat for important aquatic invertebrate assemblages and species of conservation concern was high enough to warrant further investigations to assess any potential impacts.

The approach to establishing the potential for key aquatic invertebrate species to be present within the study area has been achieved through:

- A desk study investigating any previous records of key aquatic invertebrate species within the local area (approximate 1km);
- A site visit to assess the key habitat features of the ditch.

This baseline information was then used to fulfil the following objectives:

- Identification of key aquatic invertebrates present within the ditch in Reach 6 located within the site boundaries of the improvement flood defence works;
- Identification of any further surveys which may be necessary and to broadly outline mitigation measures for potential impacts, where necessary.

### 3 Method

The desk study focussed on establishing records of key aquatic invertebrate species within the surrounding area (approximately 1km) and in particular any records located within the study ditch (approx. centre point is NGR TQ 01580 02574).

To date (March 2013) the works have not been finalised and so the actual impacts to the ditch are currently unknown, however the worst case scenario will involve culverting a short section of the existing ditch, approximately 10m to allow for widening and improvement works to be carried out on the flood defence embankment.

A desk based study to identify key aquatic invertebrate species within approximately 1km of the site boundaries was undertaken with information collected from the following sources:

- National Biodiversity Network Gateway – [www.nbn.org.uk](http://www.nbn.org.uk)
- A Sussex biodiversity Record centre search including a review of the following inventories to provide records of protected and notable aquatic invertebrate species:
  - Sussex rare species inventory;
  - Sussex protected species register;
  - Sussex environmental survey directory; and
  - UK BAP species inventory.

A site visit was also undertaken on the 4<sup>th</sup> October 2012 to assess the habitat of the ditch and its immediate surroundings.

## 4 Results

### 4.1

#### ***Desk Study***

The results of the desk study showed that no records of international or nationally protected aquatic invertebrates have been previously recorded within the vicinity of the works.

The nearest international species of importance, the little whirlpool Ramshorn snail *Anisus vorticulus* has been recorded approximately 11km to the north of the site within Amberley wild brooks.

Key habitat features for the little whirlpool ramshorn snail include; grazing marshes which are well drained, unpolluted calcareous water of well vegetated marsh drains with preferences for ditches which are >3m in width and >1m in depth and a diverse flora but moderate emergent vegetative cover. The snails are often found with other molluscs and floating on the surface amongst duckweed within ditches located in wet fields that flood in winter enabling the young to colonise new ditches.

### 4.2

#### ***Habitat Assessment***

A site visit was undertaken on the 4<sup>th</sup> October 2012 as part of the update to the previous phase 1 habitat survey carried out in 2009 where the ditch located within Reach 6 was also assessed.

The ditch is approximately 200m in length before it goes into a culvert underneath the A259, with relatively steep sided banks. The channel appears to be relatively silty with little or no flow and at the time of the survey contained up to 1m depth of water particularly in the southern section. The section of ditch which runs in a north-south direction across the site (approximately 160m) is dominated by common reed *Phragmites australis* and in places is choked by the reed with little visible open water. See photo 1.

The section of ditch running west (from the river) – east (approximately 40m) is dominated by bramble on its southern banks and dense grassland and rush species

overhanging its northern bank with little species diversity. There is no emergent vegetation within the channel. It was also noted that rubbish had also been deposited within the ditch adjacent to the trash screen and there was oil sheen over the surface of the water. See photo 2



Photo 1 – view of ditch looking North

Photo 2 – view of ditch looking East

Habitat surrounding the ditch comprised of relatively unmanaged tall grassland characterised by grassy vegetation dominated by larger grass species such as sea couch *Elytrigia atherica* and false oat-grass *Arrhenatherum elatius* with frequent tall herbs such as mugwort *Artemisia vulgaris* and cow parsley *Anthriscus sylvestris*. Scrub species such as bramble *Rubus fruticosus* agg. and hawthorn *Crataegus monogyna* occur frequently and often form dense stands.

## 5 Discussion and Recommendations

The results of the desk study have shown that the ditch supports low floral species diversity with only emergent vegetation (common reed) being present within the section of the ditch running north – south with very little if any emergent/submerged vegetation being recorded within the section of the ditch running west to east.. The ditch is likely to receive run-off from the A259 as evidenced by the oily sheen visible on the surface and this would reduce the water quality of the ditch. The lack of submerged macrophytes and the high degree of shading by common reed would also reduce the habitat quality. Taking these factors into account it is highly unlikely that the ditch will support aquatic invertebrates of notable importance. Also, given the above and the type of habitat surrounding the ditch it is possible to scope out the presence of the little whirlpool ramshorn snail with confidence.

Other features associated with ditch habitat such as breeding birds e.g. moorhen, sedge warbler etc and water vole and reptiles have been considered separately.

To date (March 2013) the final design of the works has not been confirmed within this reach, however, the worst case scenario would be that approximately 10m of the ditch would need to be culverted as part of the improvement works to the flood defences. This equates to just 5% of the overall ditch length being lost with



the section of ditch to be lost dominated by low species diversity of grass and bramble vegetated banks including the area of the ditch which is prone to dumping of rubbish adjacent to the trash screen (as shown in photo 2).

As a result of this study it is recommended that no further surveys are required for aquatic invertebrates, however, the following mitigations measures are recommended in order to prevent any detrimental impacts to the ditch and its inhabitants during the construction works and potentially enhance the ditch environment:

- If culverting works are to be carried out as part of the works, any dredgings/sediment from the ditch should be placed on the banks of unaffected sections of the ditch for a minimum of 48 hours to allow any invertebrates to return to the ditch habitat;
- During construction works standard site procedures as recommended by the Environment Agency such as PPG5 – Works and Maintenance in or near water will be required to ensure that no contaminants/effluents are released into nearby aquatic environments.
- Removal of rubbish present within the ditch will improve the quality and visual appearance of the water.

## 6 References

- Halcrow (2012) Phase 1 Habitat Refresher & Bat Potential Assessment Technical Note
- Halcrow (2010) Arun PAR Ecology Scoping Report

## Appendix A –

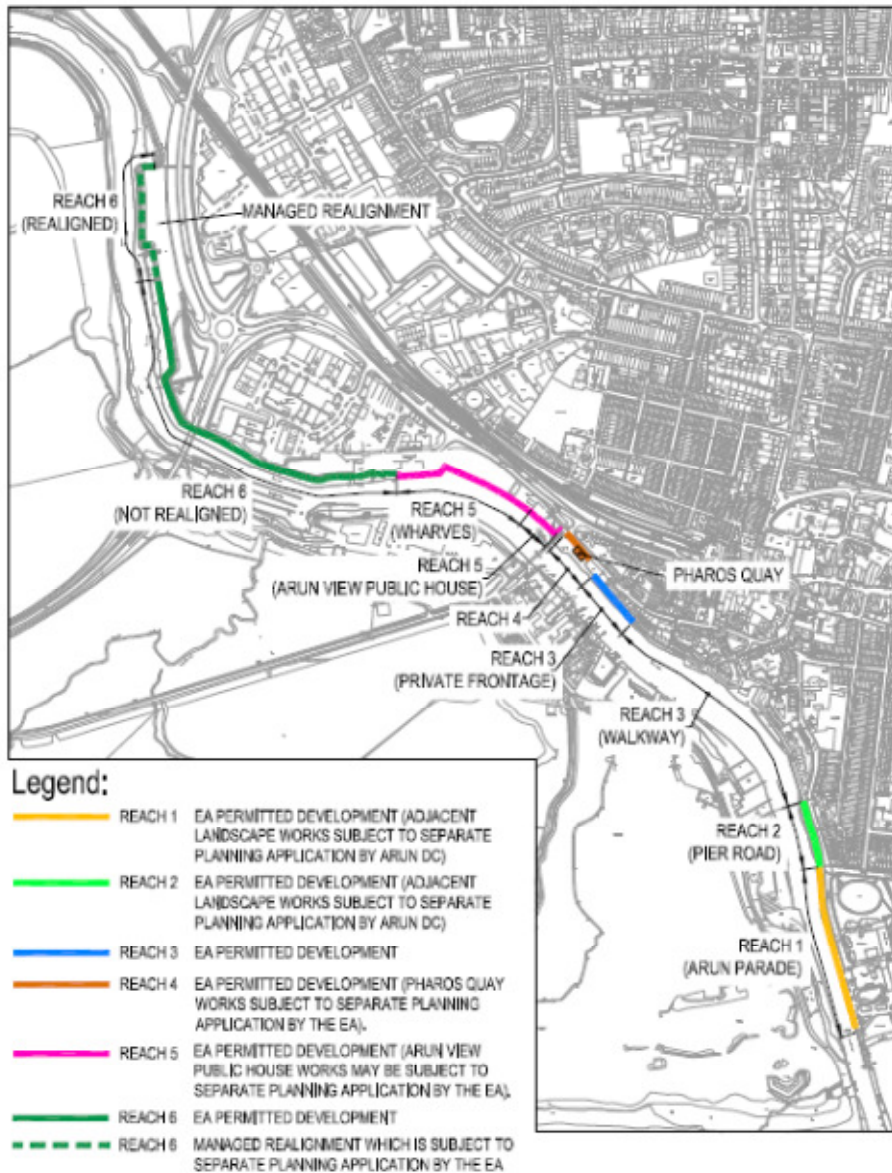


Figure 1 – Reach Locations

## Technical note

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<b>Project</b>	Littlehampton Arun East Bank Tidal Walls	<b>Date</b>	7 March 2013
<b>Note</b>	Reptile Mitigation Method Statement version 1	<b>Ref</b>	
<b>Author</b>	Amanda Honeysett	<b>Reviewer</b>	Glenn Langler

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This technical note describes methods for the mitigation of reptile populations which currently inhabit the flood embankments and associated grasslands which are to be improved as part of the Littlehampton Arun East bank Tidal Walls Scheme. The scheme extends from TQ 502827 101315 (the mouth of the River Arun at Littlehampton (from the landward end of the training wall, not including the wooden pier)) to TQ 501498 103069 (approximately 1km north of the A259 road bridge where the railway line passes beneath the A259). Only the last 1km (approximately) of the scheme provides suitable reptile habitat (NGR TQ 019 023 to TQ 015 030) as the rest of the scheme lies within the built up area of Littlehampton and habitats here have been classified as unsuitable for reptiles (Halcrow (Aug 2010) Littlehampton Arun (East Bank) Tidal Walls Scheme – Reptile Survey Report).

All habitats deemed suitable for reptiles to establish populations which may be impacted by the works and to establish areas which may be used as receptor sites where translocated populations may be released was undertaken in 2010 by Halcrow Group Ltd. The survey identified three areas where reptiles were present within the works footprint with low populations of common lizard *Lacerta xootoca vivipara* and slow worm *Anguis fragilis* being recorded. A further two potential areas deemed suitable as receptor sites were also surveyed. Low populations of both common lizard and slow worm were also recorded within these proposed receptor sites. Appendix A Figures 1a and 1b show the location of the areas surveyed for reptiles and the proposed receptor sites.

A recent visit to these sites has shown that the quality of the habitat currently present for reptiles is similar to that recorded in 2010. However, the proposed reptile receptor area 2 (see Figure 1a) is now unsuitable to be used as a receptor site due to a change in the management of the land. Although two main areas were identified to be used as receptor sites the primary receptor site is considered to be of an adequate size (approximately 1827m<sup>2</sup>) to accommodate the low population of translocated reptiles, particularly as there are good green commuting corridors providing suitable habitat for reptiles to disperse into the wider environment. The secondary receptor site was to ensure that a small population was kept in the immediate vicinity to allow for dispersal back on to the earth embankments once vegetation had re-established. However, small numbers of reptiles caught within site 3 could potentially be moved to reptile receptor area 3 in order to keep a local population of reptiles in the immediate vicinity.

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version 1

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Specific measures proposed for the mitigation of reptiles are described below. For each site where reptiles were recorded, (see table 1) one or more of these measures will be implemented as detailed in the mitigation programme in Table 2.

Site (including NGR centre point)	Habitat	Species Recorded
1  TQ 018 023	A relatively narrow strip of earth embankment dominated by unmanaged semi-improved grassland with large patches of scrub. The embankment is adjacent to a large area of bare ground on the west and the river to the east side.	Common lizard (max count =1)
2  TQ 017 023	An earth embankment dominated by areas of unmanaged semi-improved grassland with frequent areas of scrub, ruderal vegetation and occasional trees. The embankment is adjacent to the river on the east side with a sheet metal fabrication warehouse on the west side of the bank.	No reptiles recorded
3  TQ 015025	An area of land dominated by unmanaged semi-improved grassland and large patches of scrub. A drainage ditch flanked by common reed lies along the eastern and southern boundaries of the site.	Common lizard (max count = 2) & Slow worm (max count = 1)
4  TQ 015027	An area of land dominated by unmanaged semi-improved grassland with frequent patches of scrub and occasional trees. An area of broad-leaved trees lies along the eastern boundary of the site adjacent to the highways road embankment.	Common lizard (max count = 1)

Table 1 – Summary of habitats and species present in surveyed areas

A mitigation plan showing the proposed works for each area can be found in Appendix A  
Figures 2a & 2b – Ecological Mitigation Plan.

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*Mitigation Categories*

Specific mitigation measures have been placed into 4 categories. For any one of the four areas where mitigation is proposed, one or more of the measures may be used as detailed in Table 1.

The mitigation measures are:

- *Sensitive Habitat Removal*
- *Translocation*
- *Habitat Creation*
- *Monitoring*

*Sensitive Habitat Removal*

This involves the removal of habitat where reptiles may be present. Sensitive removal of habitat is undertaken by an experienced contractor under the careful supervision of an ecologist providing an ecological watching brief (ECoW). This type of mitigation measure will be used in those areas/habitats that are considered to provide a low suitability for reptiles (and hence a low risk of reptiles being encountered).

Sensitive removal of habitat will consist of hand clearing objects which may provide suitable cover for reptiles such as branches, logs, bricks and rubble and pieces of wooden sheeting etc. This will be complemented by a finger-tip search of the area by an ecologist, where all reptiles encountered will be captured and removed to a safe area outside of the works footprint.

Where natural habitat is to be removed the following methodology will be implemented. Trees and shrubs will be felled during the winter period in order to avoid issues with nesting birds. Those trees providing potentially suitable habitat for roosting bats will be removed under a bat method statement or a European Protected Species (EPS) licence. Stumps will be left at an appropriate height (approx 50-75cm) before full removal in March or April when reptiles have completed hibernation. During the tree removal ground disturbance will be kept to a minimum so as not to disturb hibernating reptiles.

For the removal of grass and herbaceous vegetation (the majority of suitable reptile habitat is grassland), two-stage strimming will be employed. Prior to topsoil removal the vegetation in these areas should be removed via two-stage strimming with hand-held trimmers. Stage 1 should cut the grass to a height of no less than 10cm, and stage 2 should take the grass down to as close to

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ground level as is feasible. All strimming should be undertaken starting in the central part of the area to be cut and moving outwards so as to cause any reptiles present to disperse naturally towards safe areas beyond the works footprint. The strimming should be undertaken in dry (preferably sunny conditions with temperatures above 15 °C). An ecologist will provide a watching brief during the strimming to ensure that any reptiles encountered are captured and removed.

### *Translocation*

Where it is considered that avoidance of reptiles is not possible and displacement is not feasible due to a lack of suitable adjacent habitat, reptiles will be captured and released into a safe (receptor) area. A receptor site has already been created for this scheme (see below). Trapping of reptiles will take place in spring (March to June) or autumn (August to October) and will precede any works which are due to take place. It has already been established that low populations of common lizard and slow worms are present within the area so trapping will be conducted over a period of 60 suitable days<sup>1</sup>. “Suitable” refers to days where temperatures are between 13 °C and 18 °C, winds are not excessive and rain is not continuous or heavy.

For each site, tiles (pieces of roofing felt app. 50 x 50cm) and tins (small sections of corrugated iron) will be placed on the site at least one week prior to trapping. This will allow sufficient time for them to become “bedded down” and for reptiles to become familiar with them. The number of tiles used will depend on a number of factors including the size of the site, with the ecologist deciding on how many to use on the day of laying them on site.

For the majority of reaches where trapping is proposed one or two ecologists will work simultaneously, checking the tiles and capturing reptiles as they go. Captured reptiles will be kept in pillow cases until they are released into the receptor area. Reptiles will only be kept in this way for a maximum of three hours before they are released. Tiles will be checked continuously each day (Mon-Fri) from 8am until 5pm.

During the 60 day capture period, some sensitive habitat removal will be undertaken. This is because as reptiles are removed and numbers of resident reptiles decrease, the ones that remain

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<sup>1</sup> Herpetofauna Groups of Britain and Ireland (HGBI, 1989), *Evaluating Local Mitigation/ Translocation Programmes: Maintaining Best Practice and Lawful Standards*. HGBI Advisory Notes for Amphibian and Reptile Groups (ARGs)

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will have a greater area to inhabit. By sensitively removing some of this habitat we will be able to reduce the amount of habitat and keep the numbers of captured reptiles high.

It is possible, that in some circumstances more than 60 days for capture may be required. For example, unsuitable weather conditions may result in cancelled trapping days or higher than medium reptile populations may require more trapping effort. Usual practice under these scenarios would result in a continuation of trapping so that more than 60 days are undertaken.

It will be the responsibility of the ecological clerk of works (ECoW) to monitor the trapping programme for each reach and to decide when it is appropriate to implement sensitive habitat removal. This will generally need to be decided within the first 15-30 days of the trapping period.

*Habitat Creation (receptor site)*

A receptor site has been identified just to the north of the railway line at the northern end of the scheme (approximate centre of the site is NGR TQ 01567 03110). The site is currently subject to two types of management with the bottom half of the field used for hay production and the top half is left unmanaged, although rabbits do keep part of the site grazed allowing a mosaic of habitats to be present making it ideally suited for reptiles. A small population of common lizard and slow worm were recorded here in 2010 which would suggest that low habitat quality may be preventing the establishment of larger populations. However, given the highly suitable corridor habitat along the margin of this site enabling individuals to disperse easily it is considered ideal as a receptor site for the low numbers of reptiles expected to be caught prior to the works. . Further enhancement works will be carried out to the site providing additional hibernacula and basking places in the form of log piles from trees removed as part of the scheme.

Long-term protection of the translocated reptile populations has been secured through talks with the landowner. He has stated that he has no plans to change the management of the site primarily due to the fact that it is not suitable for arable or grazing use and that it will remain as it is for the foreseeable future.

Once the scheme is completed and vegetation becomes re-established on the flood embankments it is likely that the habitat will establish into suitable habitat over time. This will provide suitable habitat for the translocated population to disperse into providing the Environment Agency maintain a management regime which does not cut the grass too short or too often.

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*Monitoring*

It is important that the success of the translocation scheme is tested and the results made available to allow for inclusion into future management programmes for reptile mitigation. Generally, this would comprise a comparison of before and after surveys to see if the translocation programme has been a success. Therefore, it is recommended that a series of post scheme surveys are undertaken. Works are due to be completed in spring 2015. Monitoring surveys of the receptor site should be undertaken over a period of 1, 3 and 5 years post works which will mean surveys being completed in 2015, 2017 and 2019.



Table 2. Timetable of mitigation measures for each area

Site	Description of reptile habitat	Construction Timetable	Mitigation proposed	Mitigation Timetable	Effort
1	Relatively narrow strip of earth embankment dominated by unmanaged semi-improved grassland with large patches of scrub. The embankment is adjacent to a large area of bare ground on the west and the river to the east side.	April – Sept 2014	Sensitive habitat removal under an ecological watching brief required.  NB – If when carrying out the habitat removal works a large number of reptiles are being seen/ caught then works should cease and a translocation programme commenced (this can be carried out simultaneously with the translocation works in areas 3 and 4.	<b>August – October 2013.</b>	Ecological watching brief required.
2	An earth embankment dominated by areas of unmanaged semi-improved grassland with frequent areas of scrub, ruderal vegetation and occasional trees. The embankment is adjacent to the river on the east side with a sheet metal	April – Sept 2014	Sensitive habitat removal under an ecological watching brief required.  NB – If when carrying out the habitat removal works a large number of reptiles are being seen/ caught then works should cease and a translocation programme commenced (this can be carried out simultaneously with the translocation works in areas 3 and 4.	<b>August – October 2013</b>	Ecological watching brief required

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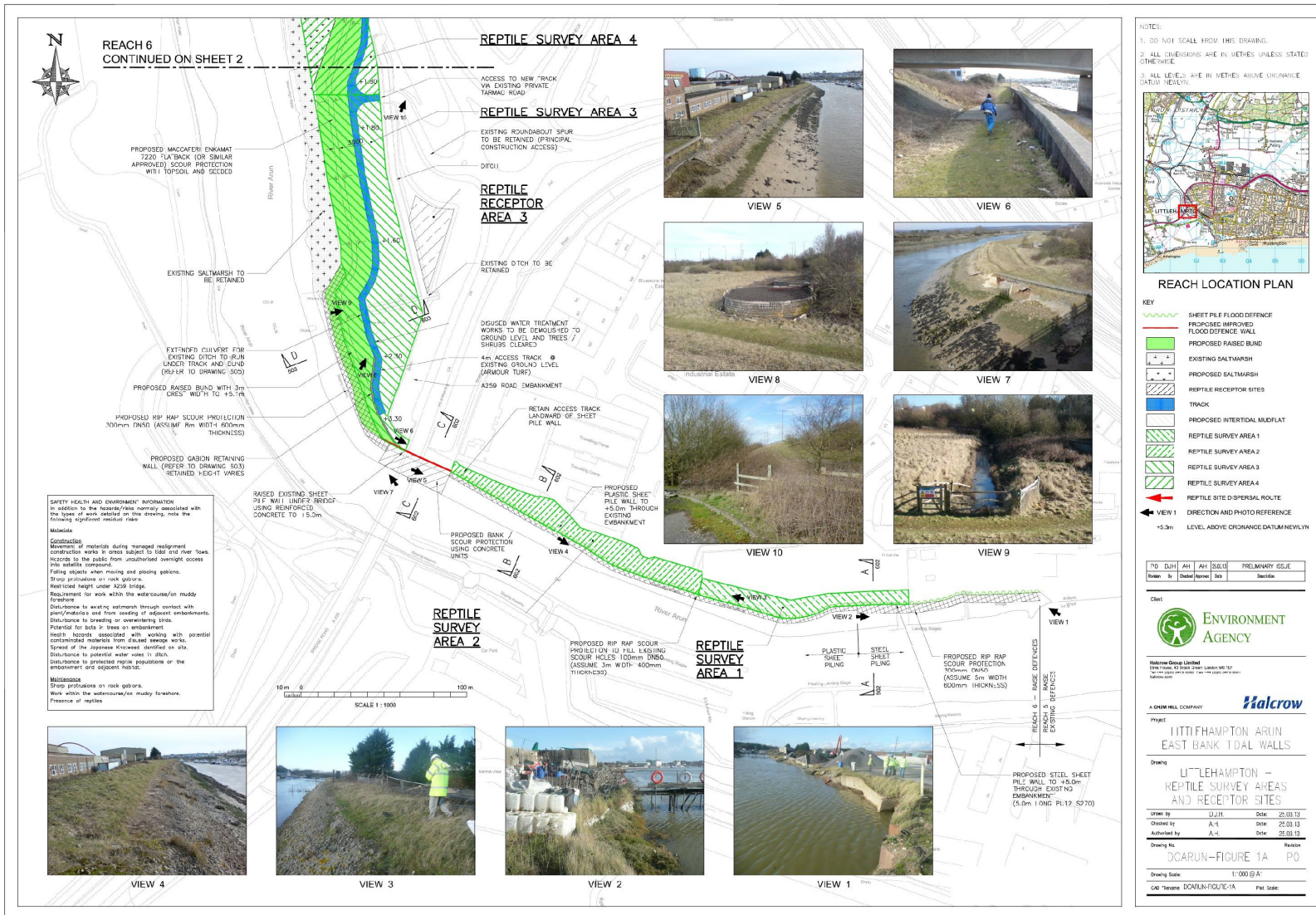
Site	Description of reptile habitat	Construction Timetable	Mitigation proposed	Mitigation Timetable	Effort
	fabrication warehouse on the west side of the bank				
3	An area of land dominated by unmanaged semi-improved grassland and large patches of scrub.	April – Sept 2014	Translocation of reptiles combined with sensitive habitat removal.	<b>June – September 2013</b>	1 person for up to 60 days.
4	An area of land dominated by unmanaged semi-improved grassland with frequent patches of scrub and occasional trees.	April – Sept 2014	Translocation of reptiles combined with sensitive habitat removal	<b>June – September 2013</b>	1 person for up to 60 days.

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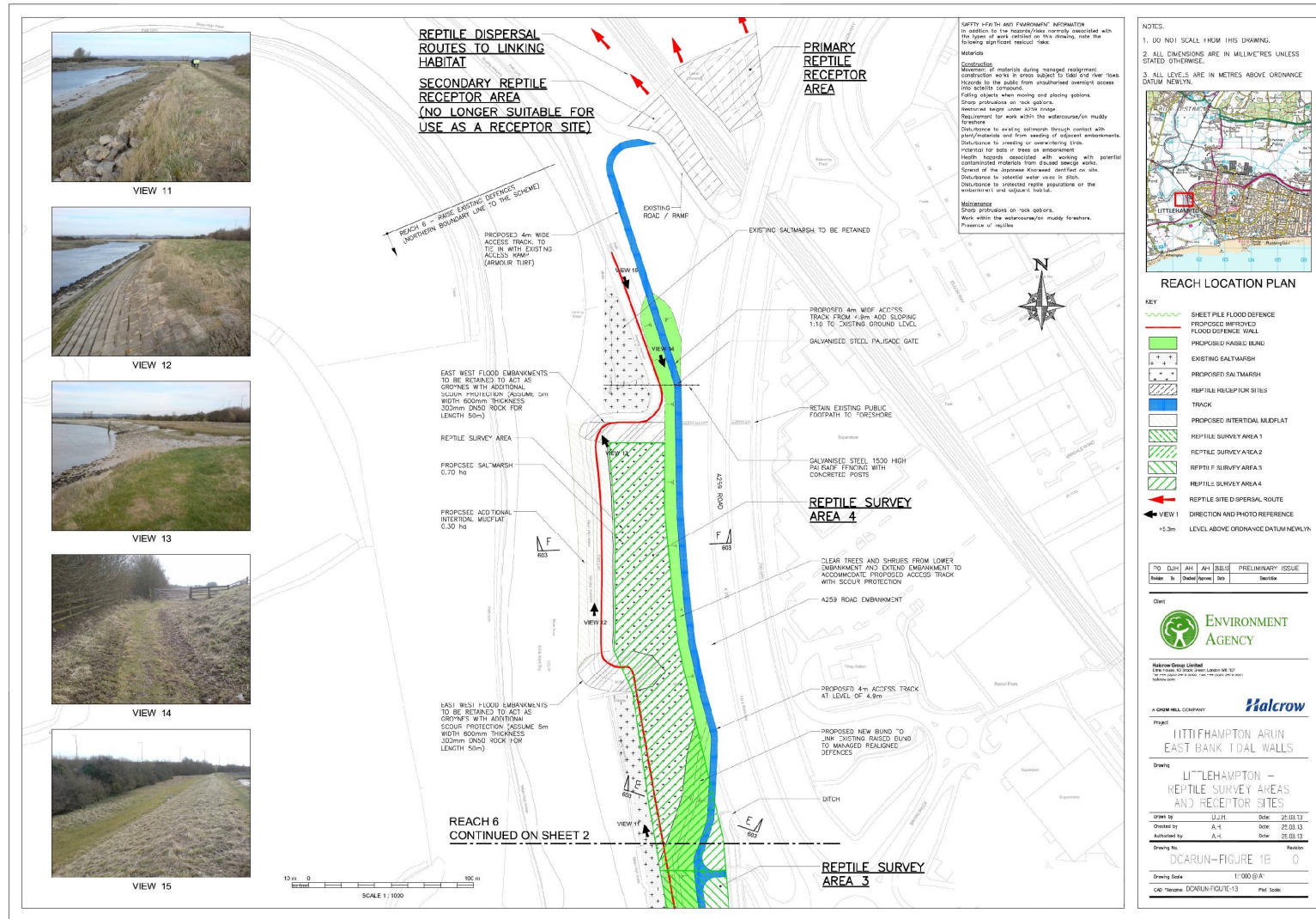
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Appendix A - Figures

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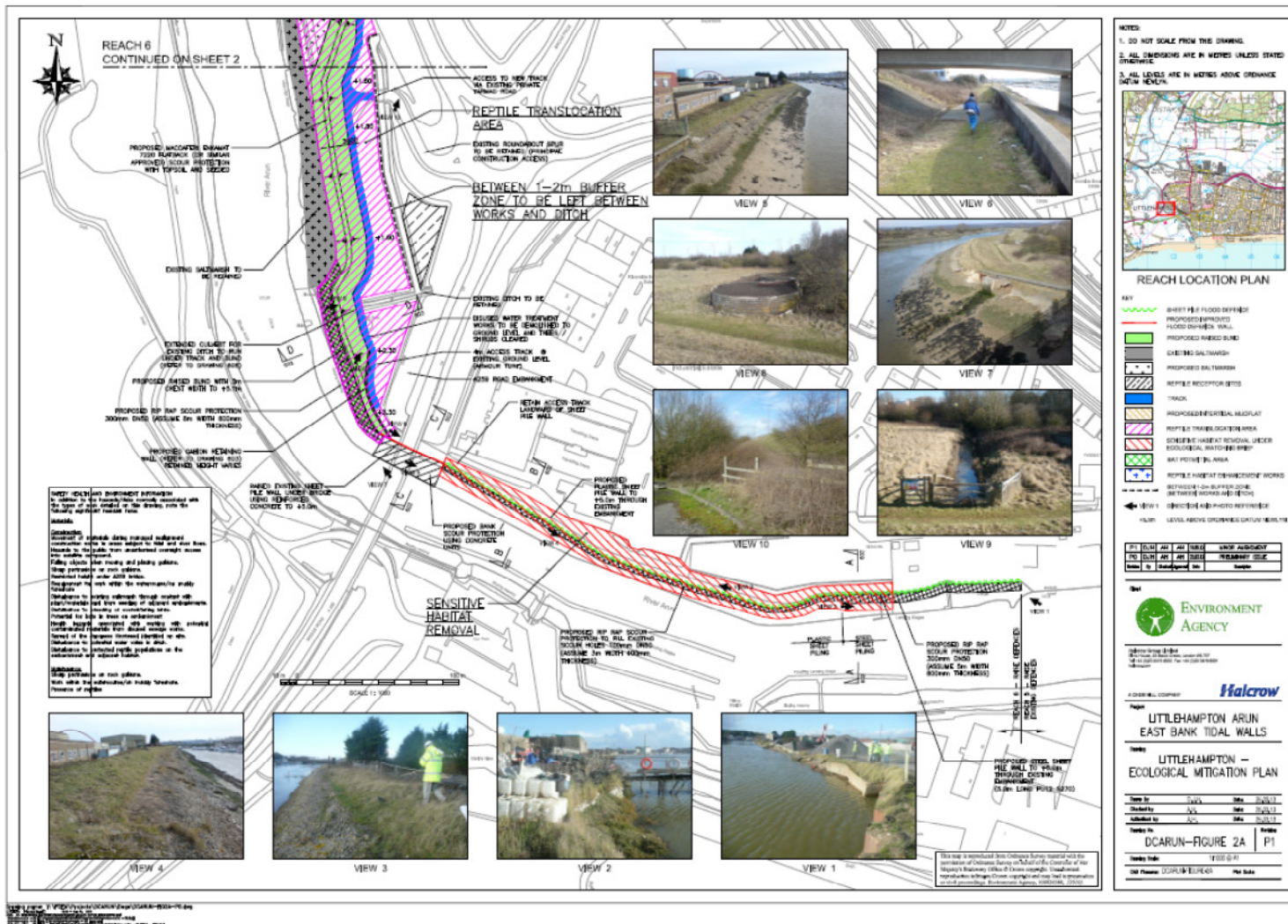


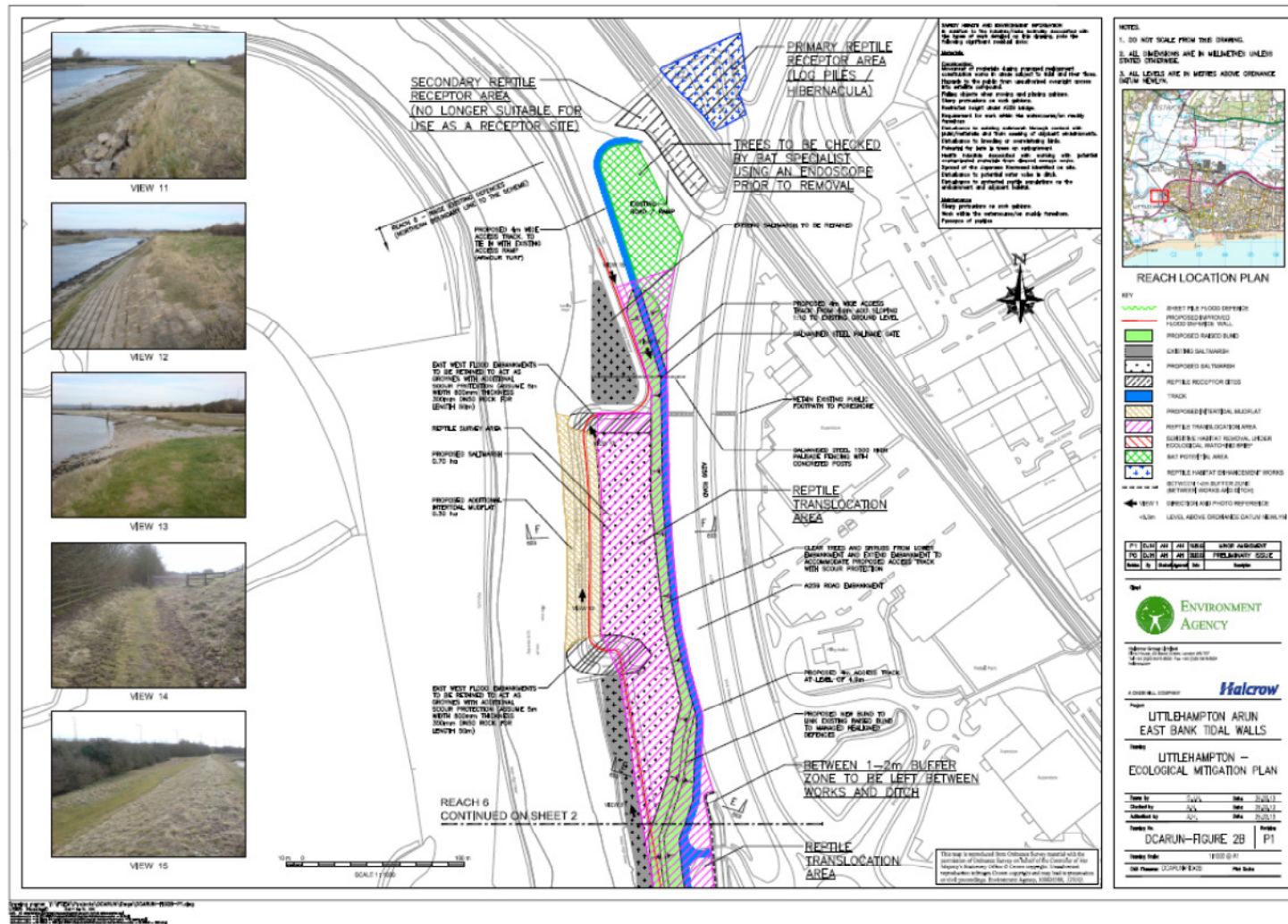
Project Littlehampton Arun East Bank Tidal Walls Note Reptile Mitigation Method Statement version 1





## Project Littlehampton Arun East Bank Tidal Walls Note Reptile Mitigation Method Statement version 1





## Technical note

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<b>Project</b>	Littlehampton Arun East Bank Tidal Walls	<b>Date</b>	2-May-13
<b>Note</b>	Water Vole Survey	<b>Ref</b>	
<b>Author</b>	Amanda Honeysett	<b>Reviewer</b>	Glenn Langler

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### **1** *Background*

**1.1** The Environment Agency is proposing to carry out improvement works to the coastal flood defences on the east bank of the River Arun from the mouth of the river at Littlehampton to a point just to the north-east of Littlehampton, West Sussex (NGR TQ028012 – TQ 012032).

**1.2** Halcrow Group Ltd (Halcrow) was commissioned by the Environment Agency to undertake a water vole survey of a ditch to be impacted by the proposed flood defence improvement works at Littlehampton. The objectives of the study were to confirm presence/absence of water vole activity within the ditch and to outline appropriate mitigation measures if deemed necessary.

**1.3** The overall study area for the project has been divided into six reaches and further sub-reaches. A plan showing the location and extent of the reaches and sub-reaches is provided in Appendix A – Figure 1 Reach Locations. The ditch which is the subject of this assessment is located within Reach 6.

**1.4** This technical note presents the findings of the water vole survey which was carried out in April 2013. To date (April 2013) the works have not been finalised and so the actual impacts to the ditch are currently unknown, however the worst case scenario will involve culverting a short section of the existing ditch, approximately 10m to allow for widening and improvement works to be carried out as part of the flood defence embankment.

**1.5** A desk based study was also undertaken (as part of the Phase 1 addendum) to gather existing records of water voles within the site and surrounding area.



**2*****Methods***

## 2.1

## 2.2

A water vole survey was undertaken on 30<sup>th</sup> April 2013 following the methods of Strachan and Moorhouse (2011). A thorough physical examination of all accessible banks of the ditch was undertaken to try and confirm field signs which would indicate the presence of water voles. Signs searched for included:

- Burrows in the bankside and on top of the bank set back from the water body up to 3m from the top of the bank;
- Water vole nests;
- Droppings and well used latrines, notes were made of the age and number of droppings;
- Feeding piles of chewed vegetation and other feeding signs; and
- Runs through the vegetation.

**3*****Results***

## 3.1

No records of water voles were found during the desk study within the immediate vicinity of the works. The closest record is approximately 1.8km to the north of the survey site, located in the village of Ford.

## 3.2

The ditch is approximately 200m in length before it goes into a culvert underneath the A259, with relatively steep sided banks. The channel appears to be relatively silty with little or no flow and at the time of the survey contained less than 1m depth of water particularly in the southern section where parts of the ditch had dried up.

## 3.3

The section of ditch which runs in a north-south direction across the site (approximately 160m) is dominated by common reed *Phragmites australis* and in places is choked by the reed with little visible open water except for approximately 10m of ditch in the middle where there is deep open water (greater than 1m) with little or no common reeds apart from bramble on the western bank. See photos 1 and 2.



*Photo 1 – Ditch looking north*



*Photo 2 – Open water located within the middle of the ditch*

#### 3.4

The section of ditch running west (from the river) – east (approximately 40m) is dominated by bramble on its southern banks and dense grassland and rush species overhanging its northern bank with little species diversity. There is no emergent vegetation within the channel. It was also noted that rubbish had also been deposited within the ditch and there was an oil sheen over the surface of the water adjacent to the trash screen. See photos 3 and 4.



Photo 3 – Ditch looking west

Photo 4 – Ditch looking east

3.5 No evidence of water voles were recorded within the ditch within Reach 6. A copy of the survey form is presented in Appendix B.

3.6 Other species noted on site were the presence of sedge warbler *Acrocephalus schoenobaenus* nesting within the reeds with common lizard *Lacerta zootoca vivipara* observed in the grassland adjacent to the ditch. Young fox footprints were also observed in the exposed mud within the ditch.

#### 4 ***Evaluation and Recommendations***

4.1 No evidence of water voles were recorded during the survey, this is likely to be due to a number of reasons including the fact that there is very little open water present within the ditch and it is likely that it dries out during the summer months, the water quality appears to be of poor quality due to an oil sheen present across the surface of the water, and the lack of species diversity along with the increasing presence of rubbish within the ditch. Further, it is likely that the ditch receives significant road run-off from the A259. The ditch is also fairly short in length providing limited habitat for water voles and is isolated from any other ditch network system thereby limiting movement of any water voles in or out of the area.

4.2 It is therefore considered that water voles are absent from the ditch and therefore no further specific water vole mitigation works are required.

4.3 However it should be noted that other species are present either within the ditch (sedge warblers) where it is recommended to keep the current stands

of common reed which provide important habitat for breeding sedge warblers, or adjacent to the ditch (common lizards) where appropriate mitigation measures are to be put in place prior to works commencing in the area. Mitigation measures for reptiles are presented in a separate method statement.

Appendix A –

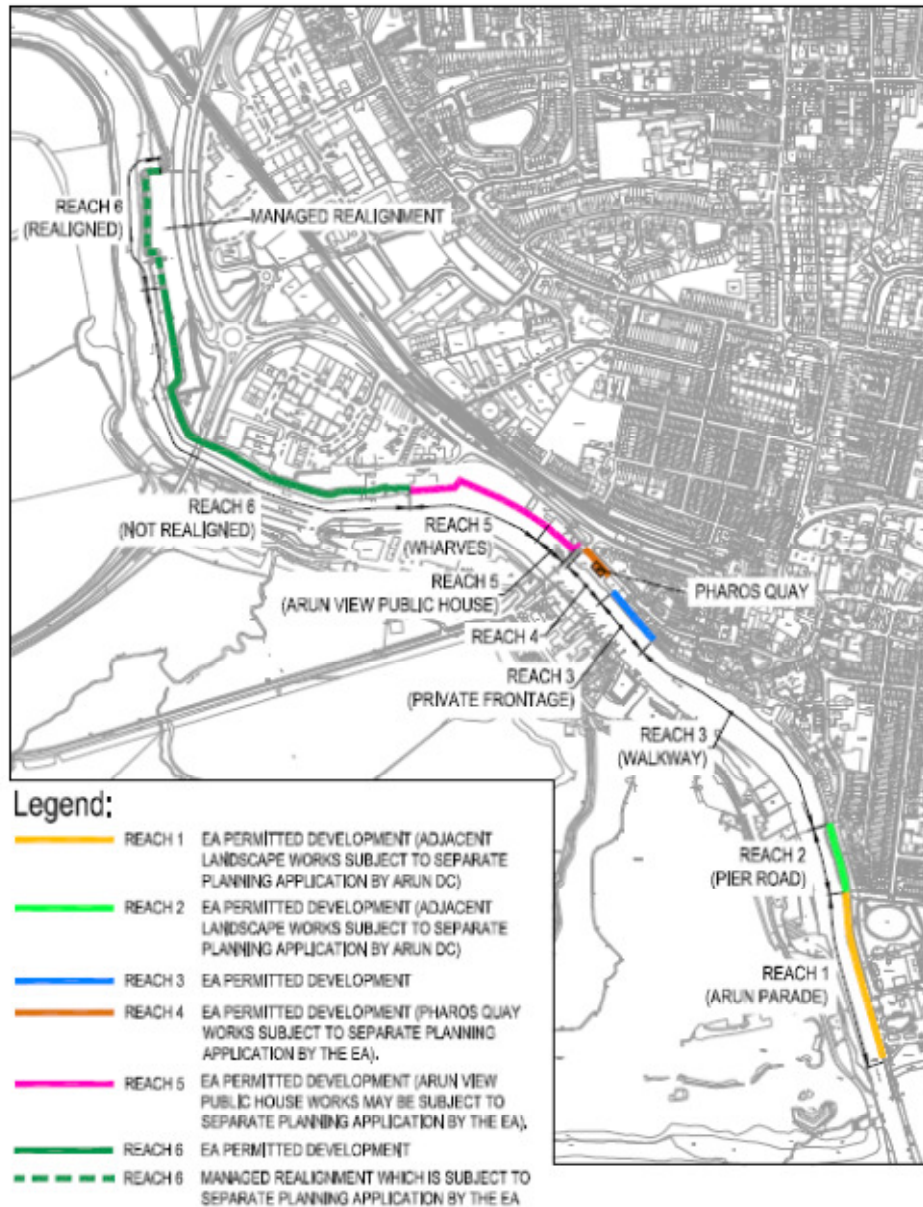


Figure 1 – Reach Locations



## Appendix B –

## WATER VOLE SURVEY FORM

BACKGROUND INFORMATION			
Site name/river <u>Littlehampton Tidal Walls - Reach 6 / Ditch off R. Arun</u>			
Site number <u>1</u>	10km square <u>          </u>	Grid ref <u>TQ01585 02548</u>	
County <u>West Sussex</u>	Water Authority <u>          </u>		
Recorder <u>AH/GAL</u>	Date <u>30/4/13</u>		

HABITAT INFORMATION (mark features on map)			
Survey distance <u>0.2</u> km	<b>Shore/bank</b> <input type="checkbox"/> Boulders <input type="checkbox"/> Stones <input type="checkbox"/> Gravel <input type="checkbox"/> Sand <input type="checkbox"/> Silt <input checked="" type="checkbox"/> Earth <input type="checkbox"/> Rock cliffs <input type="checkbox"/> Earth cliffs <input type="checkbox"/> Canalized <input type="checkbox"/> Poached <input type="checkbox"/> Reinforced (man-made)	<b>Bordering land use</b> <input type="checkbox"/> Upland grass <input checked="" type="checkbox"/> Permanent/temporary grass <input type="checkbox"/> Mixed broadleaf woodland <input type="checkbox"/> Conifer wood <input type="checkbox"/> Peat bog <input type="checkbox"/> Arable crop <input type="checkbox"/> Salt marsh <input type="checkbox"/> Urban/industrial <input type="checkbox"/> Park/garden <input type="checkbox"/> Heath <input type="checkbox"/> Fen <input type="checkbox"/> Cattle/grazing <input type="checkbox"/> Bank fenced?	<b>Vegetation (DAFORN)</b> <input checked="" type="checkbox"/> Bankside trees <input type="checkbox"/> Bushes <input type="checkbox"/> Herbs <input type="checkbox"/> Submerged weed <input type="checkbox"/> Reeds/sedges <input type="checkbox"/> Tall grass <input type="checkbox"/> Short grass  <b>Disturbance:</b>
<b>Habitat</b> <input checked="" type="checkbox"/> Ditch <input type="checkbox"/> Dyke <input type="checkbox"/> Gravel pit <input type="checkbox"/> Pond <input type="checkbox"/> Lowland lake <input type="checkbox"/> Upland loch <input type="checkbox"/> Reservoir <input type="checkbox"/> Running water <input type="checkbox"/> Marsh/bog <input type="checkbox"/> Canal	<b>Bank profile</b> <input type="checkbox"/> Flat < 10° <input checked="" type="checkbox"/> Shallow < 45° <input type="checkbox"/> Steep > 45° <input type="checkbox"/> Vertical/undercut	<b>Depth</b> <input checked="" type="checkbox"/> < 0.5m <input type="checkbox"/> 0.5–1m <input type="checkbox"/> 1–2m <input type="checkbox"/> > 2m	<b>Width</b> <input type="checkbox"/> 1m <input type="checkbox"/> 5–10m <input type="checkbox"/> 10–20m <input checked="" type="checkbox"/> 1–2m <input type="checkbox"/> 20–40m <input type="checkbox"/> 2–5m <input type="checkbox"/> > 40m  <b>Current</b> <input type="checkbox"/> Slow <input checked="" type="checkbox"/> Rapid <input checked="" type="checkbox"/> Sluggish (barely visible) <input type="checkbox"/> Fast <input type="checkbox"/> Static

WILDLIFE INFORMATION			
<b>Water voles</b> <input type="checkbox"/> Sightings (count) <input type="checkbox"/> Latrines (count) <input type="checkbox"/> Burrows (count) <input type="checkbox"/> Footprints <input type="checkbox"/> Pathway in vegetation <input type="checkbox"/> Feeding remains <input type="checkbox"/> Cropped grass around tunnel entrance	<b>Rat</b> <input type="checkbox"/> Sightings <input type="checkbox"/> Droppings <input type="checkbox"/> Footprints/runs	<b>Otter</b> <input type="checkbox"/> Sightings <input type="checkbox"/> Droppings <input type="checkbox"/> Footprints/runs	<b>Mink</b> <input type="checkbox"/> Sightings <input type="checkbox"/> Droppings <input type="checkbox"/> Footprints/runs
<b>Other wildlife</b> <input type="checkbox"/> Kingfisher <input type="checkbox"/> Heron <input type="checkbox"/> Coot <input type="checkbox"/> Moorhen <input type="checkbox"/> Waterfowl <input type="checkbox"/> Dipper			
<b>Identified plants from feeding remains:</b> <u>NO SIGNS OF WATERVOLE RECORDED</u>			

# SKETCH OF SITE – vole activity indicated (if any)

KEY TO SYMBOLS (mark route surveyed and direction of flow)		ADJACENT LAND-USE CODES	
Mature trees		Broadleaved wood	BW
Over-hanging branches		Conifer plantation	CP
Fallen tree		Moorland/heath	MH
Exposed roots		Rough pasture	RP
Pollarded tree		Wetland	WL
Sapling		Improved grass	IG
Scrub		Tilled land (crop)	TL
Hedgerow		Suburban/urban devel. (no gardens)	US
Fence		OTHER FEATURES	
Reed/sedge bed		Roadbridge	
Flood bank		Footbridge	
Artificial bank		Weir	
Earth cliff		Culvert	
		Ford	
		Outfall	
		Dredgings/spoil	
		Silt bars	
		Islands	mark position and size

**ADDITIONAL COMMENTS:**

- Rubbish present in ditch
- Sedge warbler resting in reeds
- No signs of water voles recorded
- parts of ditch dried out, deep ponded area within middle of reed section but with little vegetation/cover

## Technical note

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<b>Project</b>	Littlehampton, Arun East Bank Tidal Walls	<b>Date</b>	11 December 2012
<b>Note</b>	Invasive Plant Species Method Statement	<b>Ref</b>	463457
<b>Author</b>	Amanda Honeysett		

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### ***Introduction & Background***

This method statement describes methods for the mitigation of invasive plant species recorded within the zone of influence of the Littlehampton, Arun East Bank Tidal Walls scheme. The Environment Agency (EA) propose to carry out improvement works to existing flood defence structures on the east bank of the River Arun to protect the town of Littlehampton from flooding, with a total length of approximately 3km. Areas subject to construction works have been divided into 6 Reaches; from the mouth of the River Arun at Littlehampton (Grid ref: 502827, 101315) to approximately 1km north of the A259 road bridge where the railway line passes beneath the A259 (Grid ref: 501498, 103069).

One invasive plant species has been previously identified during the various surveys undertaken in relation to this scheme. Japanese knotweed *Fallopia japonica* was recorded during a walkover survey in 2010 as growing amongst a pile of rubbish/concrete debris on the boundary between the Tarmac yard and Riverside Industrial estate along the river frontage OS grid reference TQ 01767 02340 (see Appendix 1) within reach 6a, see Appendix 1 (location) and Appendix 2 (photos).

Japanese knotweed was brought into Britain in the mid nineteenth as an ornamental garden plant. Since then it has spread very quickly in a variety of habitats, especially roadsides, riverbanks and derelict land. It not only displaces native flora but also causes structural damage. Only the female plants occur and, as such, it is sterile and spreads exclusively vegetatively. The plant forms dense stands of fleshy red/green stems up to 2 – 3 metres in height. The root system consists of rhizomes which can spread up to 7 metres from the parent plant and grow to a depth of up to 3 metres. A piece of rhizome the size of a small nail can grow into a new plant wherever it lands.

### ***Legislation***

Section 14(2) of the Wildlife and Countryside Act (WCA, 1981) states that ‘if any person plants or otherwise causes to grow in the wild any plant which is included in Part II of Schedule 9, he shall be guilty of an offence. Japanese knotweed is a plant listed in the Schedule. Anyone convicted of an offence under Section 14 of the WCA 1981 may face a fine of £5,000 and/or 6 months imprisonment, or 2 years and/or an unlimited fine on indictment.



There is potential for the invasive plants recorded to be impacted by construction works which would cause them to be spread and, thus, contravene the WCA.

Potential mitigation strategies for dealing with invasive plant species are described below, and that proposed for Reach 6 is specified in the mitigation timetable in Table 1. This document is a live document and will be updated throughout the construction period as and when necessary.

### ***Mitigation strategies***

There are a number of strategies available to prevent the spread of the invasive species identified.

- Avoidance
- Herbicide treatment
- Cutting
- Digging
- Environmental Clerk of Works (ECW)

### ***Avoidance***

The most effective mitigation method is avoidance. Works should be designed so as not to impact on any areas of Japanese knotweed. **Any nearby plant locations should be fenced off securely** with 'heras' or other robust fencing material in order to prevent access by pedestrians or machinery. **The fencing should be clearly signed** to warn the reader of the reason and need for exclusion.

In the case of Japanese knotweed the **exclusion fencing should be installed at least seven metres from the outermost stem.**

### ***Herbicide treatment***

Japanese knotweed can be sprayed with bioactive formulations of glyphosate. **Japanese knotweed should be sprayed between July and September** (or before cold weather causes the leaves to become discoloured or fall off). Alternatively, once the plants become more developed, the stems can be cut using a sharp scythe or sickle (to prevent either spreading knotweed fragments or hogweed sap) followed by an injection of a 10% solution of glyphosate directly into the stem.

Project Littlehampton Arun East Bank Tidal Walls Note Invasive Plant Species Method Statement

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Japanese knotweed may require more than three years subsequent treatment before full control is achieved. In the case of Japanese knotweed, rhizomes have been known to survive dormant up to twenty years and, therefore, if the soil is to be disturbed chemical treatment cannot be used in isolation as a mitigation strategy.

If the timescale of the works does not allow for the successful treatment of the invasive plants it is still important, as good practice, to treat them whilst they are still in leaf.

*Cutting*

Japanese knotweed can be cut with a sharp scythe or sickle (to avoid spreading viable stem material) above ground so as not disturb the growing crown. The stems can then be left to dry out on top of a robust membrane until brown and crisp. They can then be burnt on site or removed as an inert waste. This needs to be repeated every 2 – 4 weeks throughout the growing season if it is the sole method of treatment.

*Digging*

Japanese knotweed should be treated in situ and **excavation should be viewed as a last resort**, unless it is part of an ‘on site’ treatment method. Material can be excavated and buried in one of two ways. In the first instance, all plants should be treated with a non-residual herbicide, such as glyphosate, before burial. If the material can be buried to a depth of 5 metres then all plant material and soil containing rhizomes can be placed within this excavation, covered in a robust root barrier membrane, of a type that is guaranteed for at least 50 years, and backfilled with inert material or topsoil.

If it is not possible to bury the material to this depth then a cell membrane formulation will be necessary. In this case the infested material should be entirely encapsulated in a root barrier membrane, described above, which should preferably be in one entire piece to reduce the amount of airtight seals required. On this scheme, the material will need to be buried deeper than the recommended 2 metres due to the presence of rabbits which could dig into the membrane and allow plant material to re-grow.

**The amount of material to be buried could potentially be very large** since all soil within at least 7 metres of the last stem and to a depth of 3 metres could be infested with rhizome material.

*Environmental Clerk of Works*

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An Environmental clerk of works shall oversee the implementation of the invasive species method statement, for example, the use of appropriate tool box talks to relevant site staff and monitoring the mitigation works.

***References***

Environment Agency, 2010, *Managing invasive non-native plants: Managing invasive non-native plants in or near fresh water*

Environment Agency, 2006, *The Knotweed Code of Practice: Managing Japanese knotweed on development sites.*

## Project Littlehampton Arun East Bank Tidal Walls Note Invasive Plant Species Method Statement

*Table 1 – Timetable of mitigation measures for Japanese Knotweed*

Reach No.	Invasive Plant Species present	Construction Timetable	Mitigation proposed	Mitigation Timetable	Effort
6a	Japanese Knotweed	May 2014 – Sept 2014	<p>The area of Japanese knotweed should be fenced off from the works with appropriate signage. However, if the area of Japanese knotweed falls within 7m of the footprint of the works then the following mitigation should be followed:</p> <ul style="list-style-type: none"> <li>• Herbicide treatment to be carried out between July 2013 – Sept 2013 (where possible, 2 treatments should be undertaken one in July 2013 and a further one towards the end of the growing season in early autumn 2013) with a third treatment in July 2014. Monitoring of the treatment will need to be carried out throughout the process in order to determine the extent of the Japanese knotweed and its dieback and the need for any further treatments.</li> <li>• If the ground is to be disturbed then the contaminated material will need to be dug up and buried on site ideally to a depth of 5m (see ‘digging’ section above)</li> <li>• If the excavated material cannot be safely buried on</li> </ul>	July 2013 onwards	Contractor/Environmental Clerk of Works supervision and/or EA operations personnel

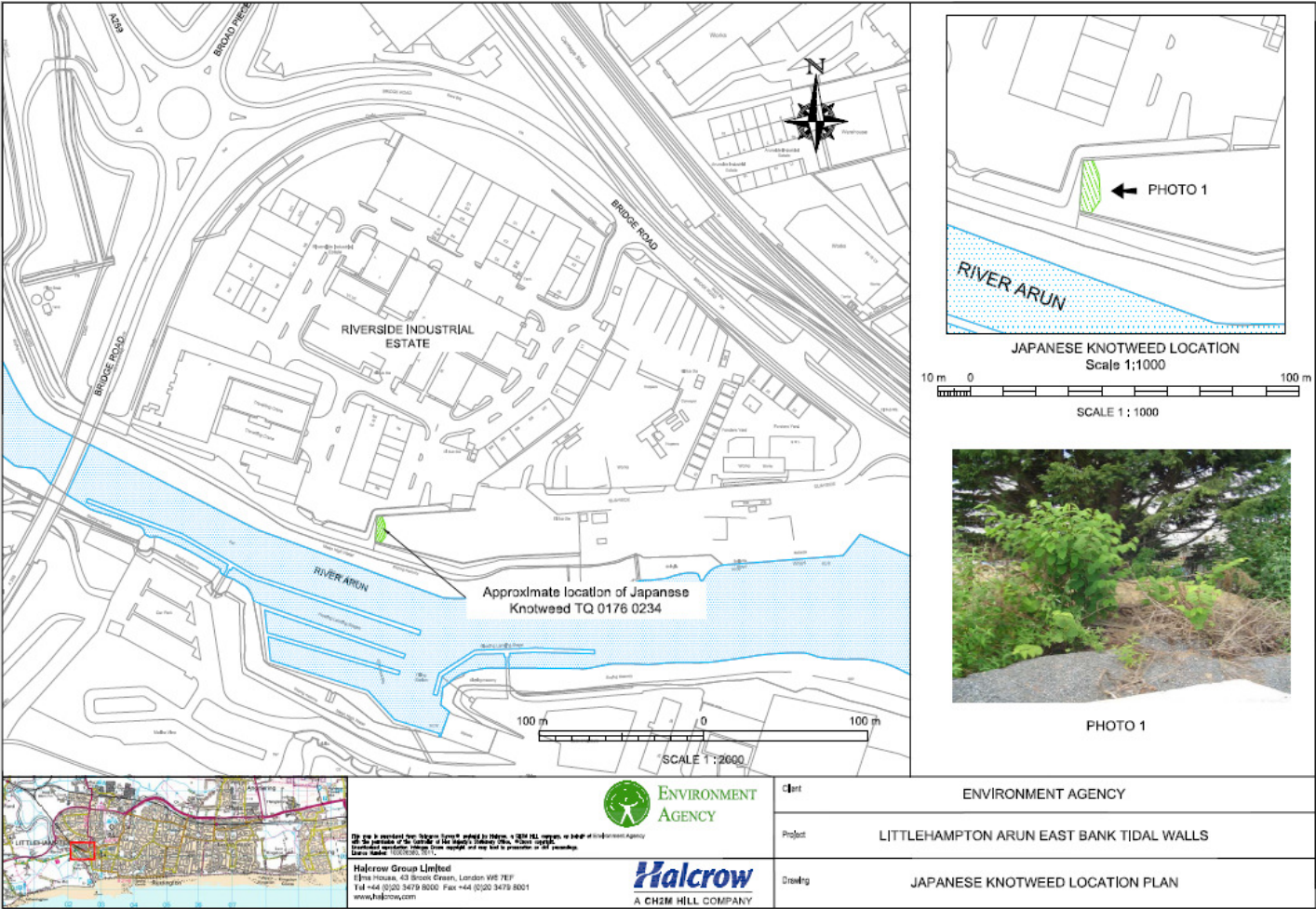
## Project Littlehampton Arun East Bank Tidal Walls Note Invasive Plant Species Method Statement

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Reach No.	Invasive Plant Species present	Construction Timetable	Mitigation proposed	Mitigation Timetable	Effort
			<p>site then it will need to be removed to a licensed landfill and treated as a special waste.</p> <p>Any further works carried out should strictly follow the guidelines set out in the Environment Agency's Japanese knotweed code of practice</p>		

Project Littlehampton Arun East Bank Tidal Walls    Note Invasive Plant Species Method Statement

Appendix 1 Location Map for Japanese knotweed





Project Littlehampton Arun East Bank Tidal Walls Note Invasive Plant Species Method Statement

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*Appendix 2 - Photos*



Photo 1 – Japanese knotweed located in reach 6a between Tarmac and Riverside Industrial Estate



Approx. location of  
Japanese knotweed

(Photo taken in 2010, Present  
situation (2012) more  
rubble/concrete/general rubbish  
has been placed at this end of the  
site with Japanese knotweed  
growing through it.)

Photo 2 – Overview of reach 6a looking north towards Riverside Industrial estate

*Appendix 3* Japanese Knotweed identification

A member of the family Polygonaceae, Japanese knotweed has hollow stems with distinct raised nodes that give it the appearance of bamboo, though it is not closely related. While stems may reach a maximum height of 3–4 m each growing season, it is typical to see much smaller plants in places where they sprout through cracks in the pavement or are repeatedly cut down. The leaves are broad oval with a truncated base, 7–14 cm long and 5–12 cm broad, with an entire margin. The flowers are small, cream or white, produced in erect racemes 6–15 cm long in late summer and early autumn.



# Appendix G – Ground conditions

This appendix contains a copy of the Geo-environmental Risk Assessment prepared following ground investigations undertaken in 2012 for the proposed scheme.

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# Updated Geo-Environmental Risk Assessment

Document: 463457-DOCS-SI-002 Version: 002

Littlehampton Arun Tidal Defences – East Bank

Environment Agency

11 April 2013

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# Updated Geo-Environmental Risk Assessment

Littlehampton Arun Tidal Defences – East Bank

Environment Agency

11 April 2013

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## Document history

### Updated Geo-Environmental Risk Assessment

Littlehampton Arun Tidal Defences – East Bank

Environment Agency

This document has been issued and amended as follows:

Version	Date	Description	Created by	Verified by	Approved by
001	08/03/2013	Draft	Claire Key/Robin Lancefield	Clive Williams	
002	11/4/2103	FINAL	Claire Key/Robin Lancefield	Clive Williams	Guy Green

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463457-SI-002 2012	Interpretive Long Sections
463457-SI-003 2012	Interpretive Long Sections
463457-SI-004 2012	Interpretive Long Sections
463457-GEOENV-001	Reach 6B Conceptual Model
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## **Appendix A—** Summary of site investigation data by Reach.



## Summary

This report is an update of the 2010 report, “Littlehampton Arun Tidal Defences – East Bank Phase 2 Interpretative Geotechnical Report July 2010” which contained a human health and controlled waters risk assessment. This report is updated to include ground investigation data obtained in 2012. It also includes a section on waste management, and an outline design statement (for use with the CL:AIRE Code of Practice declaration).

The study area is split into six reaches. The improvements to Reaches 1 to 5 do not involve significant disturbance of soils and it is considered that there are no significant contamination risks associated with the improvements. For Reach Six plans may involve excavation of defence bunds and re-use of the soils within the scheme. There are no significant contamination issues associated with this approach, although it is recommended that the CL:AIRE Code of Practice is used to facilitate re-use of soil materials within the scheme.

The improvement plans for the study area are not finalised and may be subject to change. It is recommended that the conclusions of this study are revisited once plans are finalised.

## 1 Introduction

### 1.1 Background

The Littlehampton (Arun) East Bank Tidal Walls project comprises the replacement and upgrade of 2.6km of tidal defences. The project boundary extends along the east bank of the River Arun from the estuary mouth at Littlehampton to 500m north of the A259 road bridge. The project is divided into six reaches (Reach 1 to 6) according to existing tidal defences. For ease of comparison this report adopts the same reference system.

The outline design proposals included new steel sheet pile walls, raising of existing defences with reinforced concrete upstands or caps, and raising of embankments with a combination of new plastic sheet piles and new steel sheet piles. Further details on these proposals can be found in the Project Appraisal Report (PAR) produced by Halcrow in May 2011 and the outline design drawings DCARUN- 001,100-104,200-202,300-301,400-401,500-502,600-605, Halcrow, October 2010.

Since outline design the embankment works have been reconsidered and there is now the potential for the realignment of approximately 400m of embankment.

This report is an update of the previous report, “Littlehampton Arun Tidal Defences – East Bank, Phase 2 Interpretative Geotechnical Report, Halcrow, July 2010” focussing on the controlled waters risk assessment, human health risk assessment and soils waste management. This document also includes a “design statement” for the purposes of the CL:AIRE definition of waste – Industry Code of Practice.

### 1.2 Scope

A human health risk assessment has been carried out to assess the risk posed to human health from contaminated land placed in the context of the proposed works.

The methodology follows the requirements of the CLR11 *Model Procedures for the Management of Land Contamination* (Environment Agency, 2004) in identifying land potentially affected by contamination and quantifying the risks.

A controlled waters risk assessment has been undertaken in line with the Environment Agency's Remedial Targets Methodology: Hydrogeological Risk Assessment of Land Contamination, 2006. The methodology applies to soils and groundwater that are already contaminated, where the original surface source of the contamination has ceased.

### **1.3 Limitations of Report**

This report is based on the information that has been made available to Halcrow from the sources presented in the report. The conclusions drawn in the report are considered correct although any subsequent additional information may allow refinement of the conclusions. It should be noted that:

- The report has been prepared under the express instructions and solely for the use of the Environment Agency (EA);
- The findings of this report represent the professional opinion of experienced geotechnical, geoenvironmental scientists and contaminated land specialists. Halcrow does not provide legal advice and, therefore, the advice of lawyers may also be required;
- All work carried out in preparing this report has utilised and is based upon Halcrow's current professional knowledge and understanding of current relevant UK standards and codes, technology and legislation. Changes in this legislation and guidance may occur at any time in the future and subsequently cause any conclusions to become inappropriate or incorrect. Halcrow does not accept responsibility for advising the EA or other interested parties of the facts or implications of any such changes;
- Preparation of this report has been augmented by factual information contained in maps and documents prepared by others. Halcrow can accept no responsibility for the accuracy of such information.

## **2 Site Description**

### **2.1 Location and General Description**

Littlehampton is a seaside resort town and civil parish in the Arun District of West Sussex. The area comprises predominantly low lying land, rising to meet the South Downs to the north. The River Arun is located immediately to the west of Littlehampton town centre. The river frontage is dominated by urban development which is protected by defences from tidal flooding and erosion.

The study site comprises 2.6km of existing sea defences on the east bank of the River Arun between the estuary mouth and approximately 500m to the north of the A259

road crossing. Many of the flood defences along this length have a short residual life (less than 10 years) and will need significant works or replacement to prevent failure or breach in the future. The predicted sea level rises resulting from global warming will also require the defences to be raised.

The study area is shown on drawing number DCARUN-001.

## **2.2 Existing Flood Defence Infrastructure**

The existing defences largely comprise steel and concrete piled retaining walls (combined sheet steel; concrete king post and plank; concrete vertical sections) as well as lesser sections of masonry and concrete gravity walls, armoured revetments and approximately 750m of earth embankment to the north of the study site.

## **2.3 Proposed Flood Defence Works**

The proposed tidal defence scheme is divided into six reaches (Reach 1 to 6) according to the existing tidal defences and this reference system has been adopted in this report for ease of comparison. Currently, the preferred options are summarised within the Project Appraisal Report and the Options Appraisal Report and are shown on the outline design drawings. A brief overview is provided in the subsequent sections. It should be noted that at the time of writing this report the improvement plans for Reach 6B were not finalised.

### **2.3.1 Reach 1 (Drawings DCARUN-100 to 104)**

The existing concrete post and plank wall and the steel sheet piled wall will remain in-situ. A new steel sheet piled wall will be constructed directly in front of the existing defence with a crest level to the full design height. The void between the existing and the new defence will be filled and the promenade reinstated at a raised level, and the width maximised by incorporating a retaining wall adjacent to the road.

### **2.3.2 Reach 2 (Drawings DCARUN-200 to 202)**

The existing concrete wall will remain in-situ. A new steel sheet piled wall will be constructed in front of the existing defence with a crest level to the full design height. The alignment of the wall will tie into the defence line at Reach 1 (proposed) and Reach 3 (existing). This alignment will require some encroachment into the river and some breaking out of the existing concrete structure to the north of the reach. The void between the existing and new defence will be filled. The promenade will be raised to full height with steps down to the existing level of Pier Road and a realigned junction for Arun Parade/Pier Road.

### **2.3.3 Reach 3 (Drawings DCARUN-300 to 301)**

#### **2.3.3.1 Reach 3A**

The majority of the defences in Reach 3A were constructed in 2000 as part of the recent redevelopment of this area and were constructed to a height at least 300mm higher than the other reaches. Therefore, the existing defences have significant residual life, both structurally and in terms of flood defence height. Therefore no works are proposed at present although works will be required in 2030 to raise the defences to the level required by this scheme.

#### 2.3.3.2 Reach 3B

The existing concrete wall and the steel sheet piled wall will remain in-situ. A new steel sheet piled wall will be constructed in front of the existing defence with a crest level to the full design height. To reduce the embedded depth of the piles, the new defence will be tied to the existing defence.

#### 2.3.4 Reach 4 (Drawings DCARUN 400-401)

##### 2.3.4.1 Reach 4A

A sheet piled wall will be constructed riverward of the existing defences to the full design height. The void between the existing and new defences will be filled.

##### 2.3.4.2 Reach 4B

The existing masonry/concrete wall will remain in-situ. A new steel sheet piled wall will be constructed to the full flood defence height. The void between the existing and new defence will be filled.

#### 2.3.5 Reach 5 (Drawings DCARUN-500 to 502)

##### 2.3.5.1 Reach 5A

The existing concrete wall will remain in-situ. The downstream section of the defence comprises of the walls of the pub extension. This extension will be rebuilt at a raised floor level and the flood defence will be raised with a reinforced concrete upstand with timber cladding. The top section of the defence will comprise of glass flood wall to minimise the floor height increase required. The upstream section of this defence currently comprises quay wall with handrail adjacent to a patio. This flood defence will be raised to full height using glass flood wall attached to the existing concrete capping beam.

##### 2.3.5.2 Reach 5B

The existing defences will be raised by dowelling an extra section of reinforced concrete cap. The quay behind the raised cap will remain as existing. In the medium term (approximately year 2030 to tie into the end of Tarmac's lease from Littlehampton Harbour Board), a new sheet piled defence to full height will be constructed riverward of the existing defence.

#### 2.3.6 Reach 6 (Drawings DCARUN-600 to 605)

##### 2.3.6.1 Reach 6A

The existing embankment will be raised to full flood defence height (to year-100 level to account for the long design life of embankments). Due to space constraints and seepage risks, the existing embankment will be raised using a recycled plastic sheet piled cut off. This vertical defence will be cantilevered to provide the increase in height required.

##### 2.3.6.2 Reach 6B

The existing embankment in the downstream reach will be raised to full design height (to include for 100-years of SLR). The two culverts under the A259 and the existing ditch network will remain in situ to provide an area of flood storage for the

tributaries. The existing sluice under the embankment will be extended to accommodate the increased embankment plan area.

The A259 road embankment will provide the flood defence for the upstream reach. To protect the road embankment, the flood defence will be built out at the toe to full flood height and an impermeable geotextile layer will prevent seepage. To provide a 4m wide vehicular access, a mass of granular fill will be added. The embankment will be protected from scour and waves by rip rap.

The existing flood embankment in the northern reach will be substantially removed and the excavated material redistributed to the rear of the site to a level that will maximise the potential area of saltmarsh habitat (and mudflats). The existing perpendicular sections of the existing flood embankment will remain in situ to protect the existing saltmarsh and to encourage additional saltmarsh colonisation and prevent the migration of the River Arun.

### 2.3.7 Geology

British Geological Survey (BGS) Sheet 317/332, Chichester and Bognor (solid and drift) (ref *British Geological Survey (1996) 1: 50 000 Series Solid and Drift Geology Sheet 317/332 Chichester and Bognor*) indicates soils of different geological origin are present within the wider area of the site, including Blown Sand, Tidal River deposits, Raised Beach Deposits and Aeolian Deposits (Brickearth). The underlying bedrock geology is Upper Chalk.

Although Made Ground is not marked on BGS Sheet 317/332 the commercial, residential and light industrial development along the southern half of the site has given rise to quite an extensive lateral and vertical profile of fill material.

No major faults are shown on BGS Sheet 317/332 within close proximity to the site.

A review of the BGS boreholes and site investigation data identified four main lithologies listed as follows;

- (i) Made Ground
- (ii) Alluvium (granular)
- (iii) Alluvium (cohesive)
- (iv) Upper Chalk

The results of the ground investigations generally confirm the findings of the desk study information presented above, proving a general sequence of Made Ground over alluvial deposits over the Upper Chalk. Both the Made Ground and alluvial deposits encountered within the recent ground investigation vary in depth, thickness and consistency along the reach comprising both cohesive and non cohesive (granular) soils. Drawings 463457-SI-001, 463457-SI-002, 463457-SI-003 and 463457-SI-004 show a long section of the geology for the whole scheme.

A former creek has been identified from historical mapping of Reach 6a (i) and Reach 5b (iii).

### 2.3.8 Hydrogeology

The chalk formations are classified by the Environment Agency as a Major Aquifer with soils of high leaching potential. Major Aquifers are highly permeable formations usually with a known or probable presence of significant fracturing. They may be highly productive and able to support large abstractions for public water supply and other purposes. The high leaching potential means the overlying soils have limited ability to attenuate the vertical downward migration of contaminants although there is some limited protection in places afforded by the alluvium.

The site does not lie within a Source Protection Zone and there are no documented groundwater abstractions within 500m of the site.

Given the close proximity of the soils to the river, the depth of the existing flood defence walls and underlying ground conditions the groundwater conditions along the length of the site are complex. It is currently understood from the ground investigations that three groundwater levels within the underlying soils may be present along the site as follows;

- 1) A perched water-table within the Made Ground overlying the cohesive alluvium. This perched water-table is not always present.
- 2) Tidal variation within the underlying granular alluvium and Upper Chalk
- 3) The natural groundwater table within the Upper Chalk

## 3 Site History

### 3.1 Previous land use

The site has been put to a variety of uses since the mid 19<sup>th</sup> century. The land uses with the potential to pollute are described as follows:

Year	Site description
1879	A coastguard station and other unmarked buildings are located at the southern end of site. A gas works is located at NGR 520750,101700. A saw mill is located at NGR 502750,101800. Unmarked buildings (likely to be wharfs and associated engineering works) are located between grid references 502750,101800 to 102200,502300. A railway station is present at NGR 102200,502500. Rural land use is present to the north of the wharfs.
1899	An excavation is present approximately 20m to the north of the Coastguard station. An above ground storage tank is located at NGR 502300,102350. An additional gas works is located approximately 200m to the east of the river at NGR 102500, 502150.
1913	A laundry facility is located at NGR 502300,102300.
1932	An iron works is located 30m from the river at NGR 502350,102200.

Year	Site description
1962	Re-development of coastguard station took place and an amusement arcade/park created. Commercial development between the river and Bridge Road was undertaken.
1970-1982	A coal yard and associated railway sidings are located adjacent to the river between NGR 501800,102300 and 502200,102300. A substation and engineering works is present 50m from the river at approximate NGR 502000,102400. An additional substation is located 25m from the river at NGR 502250,102250. A concrete works is located adjacent to the river and the coal yard at NGR 501700,102400. A filter bed and above ground storage tank are located to the west of the concrete works, which is likely to form part of a sewage works.
1984	The concrete works has been demolished. Further development of the commercial buildings and gas works (NGR 102500, 502150) has taken place.
1991-1995	The commercial development is renamed Riverside Industrial Estate. A retail filling station is present 150m from the river at NGR 501650,102750. The coal yard sidings have been removed. The iron works has been re-developed into residential flats.
2000	Development of a superstore/retail park has taken place at NGR 501700,102700.
2009	The excavation at the southern end of the site is shown as a pond. Further development of the industrial estate beyond the railway line has taken place.

Table 3.1 Site history

Note: National Grid References given are approximate

## 3.2 Potentially Contaminative Land Uses by Reach

The potentially contaminative uses are shown on drawings 463457-SI-001 to 463457-SI-004.

### 3.2.1 Reach 1

No significant contaminative uses although coastguard station and other unmarked buildings are located at the southern end of site.

### 3.2.2 Reach 2

A gas works is located at NGR 520750,101700.

### 3.2.3 Reach 3

Reach 3A(i) - A saw mill is located at NGR 502750,101800

Reach 3A (ii), 3A (iii), 3A (iv), 3A (v), 3A (vi) – Norfolk, Country Wharfs, Baltic and Arc wharfs. Mixture of uses including timber, coal and ballast yards

Reach 3b and 3A(vii) – historical uses include wharfs, warehouses, small boatbuilding yards.

#### 3.2.4 Reach 4

Ironworks to north of site. Most of reach is historically small wharfs.

#### 3.2.5 Reach 5

Reach 5A – No significant contaminative uses – has been a public house since at least 1970, previously a wharf probably associated with ferry (prior to bridge crossing)

Reach 5B(i) – Large wharf and coal yard. Large gasworks to north of study area (other side of railway)

Reach 5B(ii) – Large wharf with conveyors and hoppers shown. Probably linked to asphalt works to the north.

#### 3.2.6 Reach 6

Reach 6A(i) – Large wharf with conveyors and hoppers shown. Probably linked to asphalt works to the north. Site on infilled ancient creek (infilled after 1876).

Reach 6A (ii) and 6A (iii) – historical use as a coal yard.

Reach 6A (iv) – Precast concrete works from approximately 1970.

Reach 6A (v) – no significant use

Reach 6B (i) – Sewage works (small) from at least 1974.

Reach 6B (ii) – Infilled pond (filled between 1932 and 1970)

Reach 6B (iii) – no significant uses

Reach 6B (iv) – no significant previous contaminating uses.

Reach 6B (v) - Pond 1932-1976, now infilled. “Old” Limekiln – 1876-1898.

### 3.3 Site Walkover Survey

A site walkover was carried out on the 10<sup>th</sup> November 2009 and was attended by Peter Johnston (Halcrow Hydrogeologist), Jon Denner (Halcrow Project Engineer), Simon Deacon (Environment Agency) and Matthew Kennett (Local Authority). One area of particular concern that was discussed with regard to potential contamination was the current gas works site of which detail is given as follows.

#### **Gas Works** (NGR 102500, 502150) Reach 5B(i)

The EA have no information regarding this site. However, the EA were consulted as part of Network Rail's replacement of a transformer which lies between the main road and the gasworks. Shallow boreholes on the rail track land identified gasworks type contaminants in groundwater. It is likely that the sheet pile along the river bank is preventing the contamination from entering the river. The EA are concerned that no additional pathways from the aquifer to the river are created during construction.

Other sites considered to be of less significance include:



**East bank redevelopment - Wharfs converted to residential (Reach 3A (ii), 3A (iii), 3A (iv), 3A (v), 3A (vi))** - The following areas were re-developed: Baltic and Norfolk Wharfs and Surrey Street Car Parks. Jubb & Partners Consulting Engineers Ltd acted on behalf of Bellway Urban Renewal (possibly now Bellway Homes Ltd) as principle Environmental Consultants. Various investigations and reports were submitted during 2000 [See Table 5.1].

Former uses include:

- Baltic Wharf - Timber Wharf and old Town Quay, timber yards, docks and other yard uses;
- Norfolk Wharf - (including Dukes Wharf) - reclaimed land, coal yard, docks, timber yards;
- Surrey Street Car Parks - housing, gardens, ammunition storage (WWII), small sheet metal workings, plastic mouldings works, car parking.

Made ground was identified up to 2m in depth but possibly up to 5m in some areas of the docks. This was underlain by alluvium by 3m to 4m as detailed in Section 3.2.2.

Baltic and Norfolk Wharf: Chemical analysis from 20 trial pits indicates no hydrocarbon impact but elevated heavy metals in shallower samples. Lead and phenols were identified to be elevated. All other contaminants were deemed to be below relevant guidelines (ICRCL). Some contaminants were identified in groundwater.

County Wharf: The top 1.1m of soil at County Wharf was contaminated with heavy metals, PAH and petrol range hydrocarbons. The top 0.5m of soil was dug out and replaced before construction.

Arun Wharf: Some hotspots of contamination were removed due to heavy metals.

**Gas Works (Former) - (Reach 2).** NGR 520750, 101700 The former small scale gas works has been developed into a cadet's hall and repairs garage. An investigation undertaken indicated that the groundwater has been impacted by hydrocarbons.

**Travis Perkins (Reach 3A(i))** – opposite side of Pier Road - The EA have been consulted on the redevelopment of this site through the planning regime. No significant concerns regarding contamination were identified. According to the EA the site is deemed to be of such a distance from the River as not to pose a significant risk to controlled water.

**Riverside Autos (Listed Building) PCL308 (Reach 4B(i))** - There is a planning application to demolish the existing building, retaining the existing facades on River Road, the north west boundary flank and party wall on the south east boundary and construct three storey building containing nine 2 bedroom and three 1 bedroom apartments with open parking at ground floor. LU/407/07/ and LU/223/0//DOC. A desk study was submitted with the application, which concludes that there is the potential for heavy metals and organic contaminants to be present beneath the site.

**Iron Works PCL242 (Reach 4B(i))** - that became Dando Drilling and then was re-developed into residential flats has no mention of any remediation or contamination on the planning application that was approved in 1991. No reports are available.

**Hanson Aggregates (Reach 5B(ii) and Reach 6A (i))** - PCL099 Environmental Regulations Permitted facility that stores and coats road stone with bitumen. No reports are available.

**Riverside Industrial Estate (Reach 4B(i))** - PCL030 contains various industrial units on hardstanding. The three closest units to the river bank are Arun Grinders, TWS who manufacture thermocouples and Concept Bathrooms. None of these are likely to have had an effect on the river bank. Previous to the development of the industrial estate the site was a precast concrete works.

**Littlehampton Welding (Reach 4B(i))** - PCL074 is adjacent to Riverside Industrial Estate and a raised area of the river bank - Welding cutting and painting of architectural and structural metalwork with a travelling crane. No reports are available.

**Tesco Petrol Station (Reach 6B(i))** - PCL029 current petrol station developed around 1994. No reports are available. Opposite side of A259.

**Former Sewage Works (Reach 6B(i))** - PCL072 is now derelict. No reports are available.

**Landfill (Reach 6B(v))** - PCL210 Environment Agency information: Dry pond, inert waste, soil etc, possible horticultural waste.

## 4 Preliminary Conceptual Site Model

### 4.1 Introduction

Risk assessment is usually carried out to determine the presence and the significance of concentrations of substances measured at a site. The commonly accepted approach to risk assessment is to examine the contaminant in relation to the receptor (which might be a human, sensitive environmental feature or building) and determine whether there is a link (pathway) between them (contaminant linkages). If any of these elements (contaminant source, pathway or receptor) are absent or removed the contaminant linkage is broken and site poses no risk.

### 4.2 Source-Pathway-Receptor Model

The proposed works are assessed with regard to the potential impact on existing contaminant linkages. Potential sources have been identified and the condition of soil and groundwater in the vicinity of the works assessed. If the proposed works create a new or exacerbate an existing contaminant linkage, then remediation may be required to mitigate negative impacts on controlled waters or human health receptors. Identified potential contaminant linkages are summarised in Table 4.1.

Where sources are identified but the works do not increase the potential risk to receptors, then no action is proposed. It is however, important to identify areas with high concentrations of contaminants to inform the preparation of soil management plans and construction risk assessments and contingency plans for encountering contamination.

	Source	Pathway	Receptor
Human Health	Historical data from Ordnance Survey maps dating from 1876 to 2009, previous studies, walk over surveys and communication from the Environment Agency identified several potential sources of contamination across the scheme. These are identified in Table 5.2 and include various historical industrial land uses, historical landfill sites, sewage treatment works and railways.	Ingestion of soil and soil-derived dust Dermal contact with contaminated soil and spillages Inhalation of airborne soil dust Inhalation of vapours	Construction staff
			Local visitors after the works are completed.
Controlled Waters			Infiltration and dissolution of soil sources to shallow groundwater. Vertical migration to deeper groundwater receptors (potentially along sheet piles)
		Migration in shallow groundwater to surface waters	River Arun

Table 4.1: Potential Sources, Pathways and Receptors

Possible Sources of Contamination from current and historical land use	Possible Contaminants Associated with these Sources
Made Ground	The most likely sources of contamination associated with Made Ground can be metals (e.g. arsenic, cadmium, chromium, copper, lead, mercury, nickel, zinc), inorganic chemicals (cyanide, sulphate), asbestos, and organics (oil/fuel hydrocarbons, PAHs)
Former Landfill	The most likely sources of contamination associated with landfills are metals (e.g. arsenic, cadmium, chromium, copper, lead, mercury, nickel, zinc), inorganic chemicals (cyanide, nitrate, sulphate, ammonia, chloride), asbestos, and organics (oil/fuel hydrocarbons, PAHs, solvents and PCBs).
Former Sewage Works	The most likely sources of contamination associated with sewage works are metals (e.g. arsenic, cadmium, chromium, copper, iron, lead, mercury, nickel, zinc), inorganic chemicals (cyanide, nitrate, sulphate, ammonia, chloride, fluorides, phosphates), asbestos, and organics (oil/fuel hydrocarbons, , pesticides, chlorinated solvents and PCBs).

Possible Sources of Contamination from current and historical land use	Possible Contaminants Associated with these Sources
Wharfs and associated works	The most likely sources of contamination associated with wharfs and associated works comprise spillage or leakage of materials such as metals (e.g. arsenic, cadmium, chromium, copper, lead, mercury, nickel, zinc), inorganic chemicals (cyanide, sulphate), asbestos, and organics (oil/fuel hydrocarbons, PAHs, solvents, lubricants, PCBs).
Gasworks	Groundwater contaminated with hydrocarbons.
Concrete Works/ Hanson Aggregates	The most likely sources of contamination associated with concrete works and aggregate works comprise spillage or leakage of materials such as metals (e.g. arsenic, cadmium, chromium, copper, lead, manganese, mercury, nickel, zinc), inorganic chemicals (sulphate), asbestos, and organics (oil/fuel hydrocarbons, PAHs, solvents, lubricants, PCBs).

Table 4.2 – Contaminants associated with sources of contamination

The Environment Agency do not own the land on which the proposed defences are to be built and as such will not be liable for remediating existing contaminant linkages. There will however be a requirement not to create new linkages, by for example driving contamination within the made ground into the underlying alluvium during piling or creating preferential migration pathways.

## 5 Ground Conditions

### 5.1 Archived Ground Investigation Reports

Six ground investigation reports have been made available to Halcrow that are of help in establishing the ground conditions along the length of the site. Those boreholes within each report drilled closest to the existing flood defence wall have been selected and illustrated on Drawings 463457-SI-001 to 004. A summary of the six reports is presented in Table 5.1 as follows;

Ref	Report Author	Date of report	Reach	Sub division	Title of Report
20	Harry Stanger	02/1989	3A	ii, iii, iv, v	Report on ground investigations – Littlehampton ( <i>referenced Cala Report in Ref 28</i> )
30	Terratec Services	04/1998	4A	i	Site Investigation at 49 River Road, Littlehampton, West Sussex
28	Posford Duvivier	10/1996	3A	ii	East Bank Development Littlehampton, Report on Ground and Structural Investigation at Norfolk and Baltic Wharves

27	Posford Duvivier	05/1996	3A	vi	East Bank Development, Littlehampton, Report on Ground and Structural Investigation at Arc Wharf
21	Jubb and Partners	06/2000	3A	ii, iii, v	East Bank Littlehampton, Report on Ground Investigation
2	Ashdown Site Investigation	06/1997	5B	i	Railway Wharf, Quayside, Littlehampton, West Sussex. Factual Report on the Site Investigation (8171L)

*Table 5.1 – Summary of archived site investigations (prior to 2010 site investigation)*

These investigations have been undertaken within Reaches 3a, 4a and 5b and the reported ground conditions encountered within each of these reaches are presented as follows.

#### Reach 3A (ii – v)

Three of the six archived ground investigations reports relate to works undertaken within Reach 3a between sub divisions (ii) and (v).

The first of these ground investigations was reported in 1989 and comprised twenty boreholes and nine trial pits [Ref 20]. Six of the boreholes (1 – 6) are shown in Drawing DCARUN-GI 4 and 5.

The results of the ground investigation indicate that the Made Ground was variable with a thickness of between 2m and 2.5m overlying generally very soft to soft silty alluvial clay up to 6m thick underlain by chalk. The report states that granular material (the Blown Sand and Raised Beach Deposits) and the Brickearth must have been removed, or were present in very small quantities, as no consistent or significant thicknesses of granular material and Brickearth were found in the boreholes or trial pits. The soft clay is thickest towards the river to a maximum depth of 8.4m (BH6) where it is understood that some filling was carried out prior to the construction of the sheet pile retaining wall. Some of the soft clay, especially near the wall, may therefore be “fill”. The thickness of the clay reduces to the north east of the site, away from the flood defence wall, where the fill directly overlies the Chalk.

A second ground investigation was undertaken in 1996 within the same local area comprising four boreholes and seven trial pits at the Norfolk (sub division ii) and Baltic wharfs (sub division v) [Ref 28]. One of these boreholes (BHX2) is shown on Drawing DCARUN-GI 4. The ground conditions encountered were of a similar nature to that discovered during the ground investigation described above in 1989 whereby there was no evidence of drift deposits. The chalk was shown to be slightly weathered.

A third ground investigation was undertaken in June 2000 [Ref 21] within the same area comprising six percussive boreholes and seventeen window sample and dynamic probe holes within sub divisions (ii, iii and v). Three boreholes (1, 4 and 13) and two window samples (1 and 9) from this investigation are shown on Drawings DCARUN-GI 3 and 4. In general the investigations showed that the site is underlain

by a variable thickness of Made Ground typically between 1m and 2m thick, possibly up to 5m in areas of the former wharves. The Made Ground was of variable composition including clays, gravels, and brick and concrete rubble and was underlain by some 3m to 4m of soft clay. The presence of sands and gravels underlying the soft clay however was identified over the Upper Chalk. The Upper Chalk underlies this granular alluvium at depths varying from some 4m below ground level (mbgl) in the western end of Baltic wharf (sub division v) to in excess of 9mbgl in Norfolk Wharf (sub division ii).

The Upper Chalk was encountered in all boreholes as a very weak to weak friable limestone with abundant flint nodules.

#### Reach 3A (vi)

Two boreholes and 3 trial pits [Ref 27] were drilled within Reach 3a sub division (vi), just to the north of the site investigation discussed previously. Boreholes BH1 and BH2 encountered Made Ground overlying flint gravels overlying the Upper Chalk. The thickness of the Made Ground is greater in BH2 which is located immediately behind the existing flood defence wall as shown on Drawing DCARUN-GI 3.

#### Reach 4A

A ground investigation was undertaken at 49 River Road [Ref 30] to determine the underlying ground conditions and existing foundations of the property at this location. The works comprised but were not limited to five boreholes between depths of 1.50 and 3m. The ground conditions generally comprised Made Ground over Alluvium over Chalk. The top of the Chalk was encountered at 1.20mbgl furthest away from the river wall increasing in depth to 2.55mbgl closest to the river wall. One borehole (BH4) was drilled in the river bed at 3.6m below the wharf level and encountered the chalk at 1.80 below bed level, 5.4mbgl. This borehole is shown on Drawing DCARUN - GI 3.

#### Reach 5B (i)

A site investigation comprising one borehole to a depth of 15mbgl was undertaken to assess the soil profile to realign the existing sheet pile flood defence wall. The location of the borehole is very close (<10m) to borehole position CP1103 undertaken for the recent ground investigation. This report only became available to Halcrow after the completion of the recent investigation. The ground profile encountered within CP1103 is very similar to that obtained within the borehole presented in the Ashdown Site Investigation Report [Ref 2].

## 5.2 Summary of Made Ground

This section is based mainly upon the 2010 and 2012 ground investigation data. All analysis data summarised for each reach is presented in Appendix A.

### 5.2.1 Reach 1

Borehole locations and interpreted long sections for Reach 1 are shown on Drawing 463457-SI-004.

#### 5.2.1.1 Made Ground

The Made Ground typically comprised white to grey-brown chalk gravel. It is generally described as being composed of fine to coarse gravel sized fragments of chalk, fragments of tarmac, charcoal, ceramic, glass, brick, clinker and occasional concrete with cobbles of flint and chalk. The thickness of the Made Ground varies along Reach 1a between approximately 0.80m and 5.30m.

Cohesive Made Ground was encountered in borehole CP-RCB6A only along this sub-reach. The thickness was recorded as 2.35m and was described as composed of fine to coarse gravel and rare cobble sized fragments of extremely weak to weak chalk in a comminuted chalk matrix.

The borehole log for CP203 recorded “many fragments tarmac between 1.20m and 1.65m” and a “strong creosote odour”. The borehole logs for CP201, CP 202, CP/RC-B2, CP/RC-B5 and CP/RCB6 (and B6A) did not record any evidence of notable contamination.

#### 5.2.1.2 Sampling

Table 5.2 summarises the soil sampling carried out in Reach 1. All sampling was undertaken during the 2010 ground investigation. No soil sampling was carried out during the 2012 investigation.

	Borehole Number		
	CP201	CP203	CP202
Depth of sample (m)	1.30	0.40	0.30
	2.30	1.40	1.00
	4.30	3.40	2.00
		4.40	4.00
		5.40	5.00

Table 5.2 Summary of soil samples taken in Reach 1

Table 5.3 shows the borehole locations and year of sampling, from which groundwater samples were taken for analysis in reach 1.

Borehole	Year monitoring carried out
CP201	2010
CP202	2010
CPRCB2	2012
CPRCB5	2012
CP203	2010
CPRCB6A	2012

Table 5.3 Groundwater quality monitoring locations in Reach 1

### 5.2.1.3 Results

Previous investigations have shown an exceedance of the adopted assessment criterion for petroleum hydrocarbons in groundwater within Reach 1, although this is at 0.25 mg/l compared to an EQS for benzene of 0.03mg/l (which are not directly comparable). For soil samples there were exceedances of soil screening criteria for lead (CP203, 550mg/kg and CP202, 530mg/kg compared to a GAC of 450 mg/kg) and some PAH's (CP202 and CP203, several exceedances of individual PAHs, for example benzo(a)pyrene (GAC 1.0mg/kg) CP202 68 mg/kg at 0.3m depth, and CP203 55mg/kg at 1.4m depth). CP203 recorded elevated PAHs and TPH at depths where tarmac and a strong creosote odour were noted. The PAHs in CP202 may be due to tarmac found at the surface.

### 5.2.2 Reach 2

Borehole locations and interpreted long sections for Reach 2 are shown on Drawing 463457-SI-004.

#### 5.2.2.1 Made ground

The Made Ground was only encountered in the inspection pits (<1.20mbgl) of boreholes CP/RC9A and CP501. The strata comprised a relatively thin layer of granular Made Ground which was described as being composed of yellow brown slightly silty sandy angular and subangular fine to coarse flint gravel. Sand is fine to coarse. The thickness of the Made Ground varies along Reach 2 between approximately 0.80m and 0.60m. CP/RC9A was positioned on the opposite side of the road to the old gasworks. None of the borehole logs recorded contamination.

#### 5.2.2.2 Sampling

Table 5.4 summarises the soil sampling carried out in reach 2 in 2010. No sampling was undertaken in reach 2 during the 2012 investigation.



	Borehole number
	CP501
Depth of sample (m)	1.70
	2.70
	3.70

Table 5.4 Summary of soil samples taken in Reach 2

Table 5.5 shows the borehole locations and year of sampling, from which groundwater samples were taken for analysis in Reach 2.

Borehole	Year monitoring carried out
CP301A(WS)	2010
CPRCB9	2012

Table 5.5 Groundwater quality monitoring locations in Reach 2

#### 5.2.2.3 Results

Environmental sampling carried out during the previous investigation (Halcrow 2010) showed no exceedances of assessment criteria.

#### 5.2.3 Reach 3

Borehole locations and interpreted long sections for Reach 3 are shown on Drawings 463457-SI-003 and 463457-SI-004.

##### 5.2.3.1 Made ground

The granular Made Ground was encountered in all exploratory holes along this Section comprising a variable thickness of granular material described as off-white to dark grey, brown clayey silty sandy fine to coarse gravel of crystalline rock, chalk, brick, flint and glass. The recorded thickness of this granular Made Ground varies along Reach 3 between 0.40m and 2.80m.

##### 5.2.3.2 Sampling

Various investigations have been undertaken, mostly associated with the redevelopment of the wharves to housing. The following areas were re-developed: Baltic and Norfolk Wharves and Surrey Street Car Parks. Jubb & Partners Consulting Engineers Ltd acted on behalf of Bellway Urban Renewal (possibly now Bellway Homes Ltd) as principle Environmental Consultants. Various investigations and reports were submitted during 2000.

### 5.2.3.3 Results

Baltic and Norfolk Wharf: Chemical analysis from 20 trial pits indicates no hydrocarbon impact but elevated heavy metals in shallower samples. Concentrations of lead and phenols were considered to be elevated above relevant assessment criteria. All other contaminants were deemed to be below relevant guidelines (ICRCL). Some contaminants were identified in groundwater.

County Wharf: The top 1.1m of soil at County Wharf was contaminated with heavy metals, PAH compounds and petrol range hydrocarbons. The top 0.5m of soil was dug out and replaced before construction.

Arun Wharf: Some hotspots of heavy metal contamination were removed.

### 5.2.4 Reach 4

Borehole locations and interpreted long sections for Reach 4 are shown on Drawing 463457-SI-003.

#### 5.2.4.1 Made ground

Made Ground was encountered in all exploratory holes along this Reach. The strata comprised a layer of Made Ground of variable thickness which was described as being composed of off-white to dark grey, brown clayey silty sandy fine to coarse gravel of crystalline rock, chalk, brick, flint and glass. The thickness of the Made Ground varies along Reach 4 between approximately 0.40m and 2.80m.

Cohesive Made Ground was encountered within borehole CP1001 (FES, 2010) as a 2.90m thick layer beneath the granular Made Ground / concrete. It is described as very soft orange-brown, becoming brownish grey with depth, slightly sandy gravelly clay with a low cobble content, with rare to occasional pockets (<20mm) of very soft brown silty clay and very soft grey sandy silt. Sand is fine to coarse. Gravel is very angular to subangular fine to coarse of chalk and occasionally concrete.

None of the borehole logs recorded notable contamination.

#### 5.2.4.2 Sampling

Table 5.6 shows the borehole locations and year of sampling, from which groundwater samples were taken for analysis in reach 4.

Borehole	Year monitoring carried out
RCB10	2012
RCB11	2012
CP1001	2010

Table 5.6 Groundwater quality monitoring locations in Reach 4

Environmental sampling carried out during the site investigation (Halcrow 2010) showed no exceedances of assessment criteria for groundwater in borehole CP1001.

### 5.2.5 Reach 5

Borehole locations and interpreted long sections for Reach 5 are shown on Drawings 463457-SI-002 and 463457-SI-003.

#### 5.2.5.1 Made ground

Made Ground was encountered in all boreholes along this Reach comprising a variable thickness of slightly sandy gravelly clay with low cobble content. Sand is mainly medium and coarse, gravel is angular to subrounded fine to coarse of flint and chalk. Cobbles are mainly subangular of chalk and flint (<80mm). The thickness of the Made Ground varies between approximately 1.50m and 6.60m. Occasional clinker and wood fragments were noted.

CP1102 (FES, 2010) recorded a slight creosote odour at 0.40- 0.70m depth. CP1201B (FES, 2010) recorded a slight bituminous odour at 0.30m and 1.50m depth and a strong hydrogen sulphide odour within the alluvium (clay) below the made ground (6.60m depth) and a strong bitumen odour at 8.00m depth.

#### 5.2.5.2 Sampling

Table 5.7 summarises the soil sampling undertaken within Reach 5. All sampling was undertaken during the 2010 ground investigation.

	Borehole Number					
	CP1201B	CP1201A	CP1102	CP1101	WS1302(CP)	CP1103
Depth of sample (m)	2.2	0.2	0.2	0.4	1.2	0.2
	3.2	1.2	2.2	1.4	3.2	2.2
	5.2		4.2	2.4		4.2
	6.6			3.4		5.2
	9					
	10					

Table 5.7 Summary of soil samples taken in Reach 5

Table 5.87 shows the borehole locations and year of sampling, from which groundwater samples were taken for analysis in reach 5.

Borehole	Year monitoring carried out
CCP1101	2010
CCP1103	2010

Table 5.8 Groundwater quality monitoring locations in Reach 5

#### 5.2.5.3 Results

Previous investigations have shown an exceedance of the adopted assessment criteria for benzo(a)pyrene in soil within borehole CP1103 (11mg/kg compared to a GAC of 1.0mg/kg); no exceedances were found within groundwater that was sampled. Borehole CP1103 is located adjacent to a gas works (although there is a railway line between the gasworks and the site). The petroleum hydrocarbon concentration in groundwater from CP1101 which is located down hydraulic gradient was below the laboratory method detection limit,

#### 5.2.6 Reach 6A

Borehole locations and interpreted long sections for Reach 6A are shown on Drawing 463457-SI-002.

##### 5.2.6.1 Made Ground

Material categorised as forming the flood bund or embankment fill were present in boreholes 1302, 1303 and 1501, from FES (2010), which were all drilled along the existing flood bund. The material is generally described as brown clayey gravelly fine to coarse sand with flint gravel and rare brick fragments (<7mm), occasional rootlets and roots (<1mm) and rare pockets (<20mm) of firm orange-brown/mottled brown silty clay. It varies in thickness from 1.20 to 1.90m.

The Made Ground was encountered in four of the eight exploratory holes along this section of the Reach. The strata comprised a variable thickness of dark greyish brown and white becoming light brown with depth slightly sandy gravelly clay with low cobble content. Sand is medium and coarse, gravel is angular to subrounded fine to coarse of flint and chalk. Cobbles are mainly subangular of chalk and flint (<80mm).

Cohesive Made Ground was encountered within borehole CPB12A as a 1.20m thick layer within the granular Made Ground. It is described as being composed of soft to firm dark greyish brown and white becoming light brown with depth slightly sandy gravelly clay with low cobble content. Sand is mainly medium and coarse, gravel is angular to subrounded fine to coarse of flint and chalk. Cobbles are mainly subangular of chalk and flint (<80mm).

CP/RC-B13 (2012) recorded a slight hydrocarbon odour at 0.90 to 1.50 m depth. CPB13C recorded crushed tarmac 0.40 to 0.70m depth.

##### 5.2.6.2 Sampling

Table 5.89 summarises the soil sampling undertaken in reach 6A. Samples WS1301 and WS1303 were taken as part of the 2010 investigation, CP/RC-B12A and CP-B13 samples were taken during the 2012 ground investigation.

	Borehole Number			
	CP/RC-B12A	CP-B13	WS1301	WS1303
Depth of sample (m)	1.00	1.00	1.20	0.50
	2.50		3.20	

Table 5.9 Summary of soil samples taken in Reach 6A

Table 5.10 shows the borehole locations and year of sampling, from which groundwater samples were taken for analysis in reach 6A.

Borehole	Year monitoring carried out
CPB13	2012
WS1301A(CP	2010

Table 5.10 Groundwater quality monitoring locations in Reach 6A

#### 5.2.6.3 Results

Site investigations have shown an exceedance of the adopted assessment criterion for petroleum hydrocarbons in groundwater in borehole WS1301A, located in the existing flood embankment. An exceedance of the soil screening criteria for benzo(a)pyrene was detected in borehole WS1301A CP1103 (11mg/kg compared to a GAC of 1.0mg/kg).

#### 5.2.7 Reach 6B

Borehole locations and interpreted long sections for Reach 6B are shown on Drawing 463457-SI-001.

##### 5.2.7.1 Made ground

Materials categorised as forming the flood bund or embankment fill were present in all the boreholes located along the existing flood bund. The material is generally described as soft to firm, brown, slightly sandy, slightly gravelly clay. Sand is mainly fine, gravel is subangular and subrounded, fine and medium of flint and chalk. It appeared to be layered towards its base and varies in thickness from 1.55 to 2.10m.

Cohesive Made Ground was encountered in all areas to the rear of the flood bund. It was encountered as a variable layer between 0.30m and 1.60m in thickness comprising orange brown and mottled blue grey slightly silty gravelly fine to coarse sand with rare pockets (<12mm x 8mm) of black organic fragments; with subangular to subrounded fine to coarse gravel of chalk, flint and rare clinker.

None of the borehole logs recorded notable contamination.

### 5.2.7.2 Sampling

Table 5.11 summarises the soil sampling undertaken in Reach 6B. Samples from boreholes WS1601, WS1602, WS1604 and WS1605 were taken during the 2010 ground investigation. Samples from boreholes WS20, WS22, WS23, WS24, WS25 and WS26 were taken during the 2012 ground investigation. During the course of the 2012 investigation three sediment samples were taken from former treatment tanks situated in an historic campsite located within Reach 6 for bacteriological analysis.

	Borehole Number					
	WS1601	WS1602	WS1604	WS1605	WS1616	WSB20
Depth of sample (m)	0.3	0.3	0	0.5	1.2	0.3
	0.8	0.8		1		
Depth of sample (m)	WSB22	WSB23	WSB24	WSB25	WSB26	
	0.3	0.7	0.3	0.5	0.5	
				1.6		

Table 5.11 Summary of soil samples taken in Reach 6B

Table 5.12 shows the borehole locations and year of sampling, from which groundwater samples were taken for analysis in reach 6B.

Borehole	Year monitoring carried out
WS1504	2010
WS1601	2010
WS1602	2010
WS1605	2010
WSB16	2012
WSB23	2012
WSB26	2012

Table 5.12 Groundwater quality monitoring locations in Reach 6B

#### 5.2.7.3 Results

Previous investigations have shown an exceedance of the adopted assessment criterion for petroleum hydrocarbons in groundwater in boreholes WS1504 and WS1601; located in the existing flood embankment. It should be noted that bacteriological pathogens were also detected in borehole WS1504.

### 5.3 Superficial deposits

#### Reach 1a

Reach 1a is underlain by superficial deposits classed as 'blown sand'. They are described as typically comprising well sorted medium grained sands with a proportion of fine grained shell debris, blown from intertidal sand flats.

#### Reaches 1b to 5

Reaches 1b to 5 are underlain by superficial deposits classed as 'raised beach deposits'. The raised beach deposits (younger) occur widely on the lower coastal plain, but are generally concealed by Aeolian deposits and head gravel, and dissected by river channels. The thickness of the deposits is variable. The younger raised beach deposits comprise a complex sequence of sand, silt, and pebbly sand, with some sandy gravel and clean flint shingle. The greater part of the deposit is of thinly bedded calcareous silty fine to medium grained sand containing a few flint or chalk pebbles.

#### Reaches 5 to 6

Reaches 5 and 6 are underlain by tidal river deposits (formally known as marine and estuarine alluvium) includes the deposits adjacent to tidal rivers that were previously liable to tidal inundation but which now lie at up to 3m above present high water mark, having been artificially reclaimed for agriculture. The deposits consist of soft, brown and grey mottled, laminated silty clay, silt and fine sand with a sparse shelly fauna. Boreholes indicate that some 36m of alluvial sediment infill a buried valley beneath the floodplain near the mouth of the River Arun.

### 5.4 Solid Geology

All reaches are underlain by the White Chalk Subgroup comprising undifferentiated Lewes Nodular Chalk, Seaford Chalk, Newhaven Chalk, Tarrant Chalk, Spetisbury Chalk and Portsdown Chalk.

## 6 Updated Risk Assessment

This section describes a generic risk assessment for the whole scheme. Further risk assessment for each reach is detailed in the updated conceptual model section.

### 6.1 Human Health

Potential risks to human health from long term chronic exposure are assessed using the CLEA methodology (Environment Agency 2009) which provides a framework for deriving assessment criteria protective of human health. The CLEA model can be used to derive assessment criteria protective of sensitive human receptors for a range

of pre-defined land uses. Once constructed the flood defences will comprise open land which is likely to be accessible by members of the public for informal recreation. As there is no predefined land use within the CLEA model covering this use a conservative assessment has been undertaken adopting the residential without plant uptake criteria. This will identify areas, which, dependant on the final finish of the flood defences may require further consideration if the generic assessment criteria are exceeded.

The CLEA methodology is based on a chronic long term exposure risk, and does not consider short term acute exposure which may be a factor for construction workers handling and excavating shallow soils. In order to mitigate potential risk from chronic short term exposure, the mitigation measures set out in the Environment Statement should be adopted and a site by site risk assessment undertaken by the construction contractor, considering the soil data obtained from this investigation.

### 6.1.1 Results

Halcrow Tier 1 Generic Assessment Criteria (generated using the CLEA model) are presented in Table 6.1 for soils with 2.5% soil organic matter and tables of results screened against these criteria are included in Appendix A.

Test	Units	GAC (mg/kg)
Arsenic	mg/kg	35
Cadmium	mg/kg	18
Chromium	mg/kg	627
Hexavalent Chromium	mg/kg	4.3
Copper	mg/kg	6200
Lead	mg/kg	450
Mercury	mg/kg	240
Nickel	mg/kg	130
Zinc	mg/kg	40000
Boron (water soluble)	mg/kg	10000
Cyanide total	mg/kg	12
Aliphatic C5-C6	mg/kg	55
Aliphatic C6-C8	mg/kg	160
Aliphatic C8-C10	mg/kg	46
Aliphatic C10-C12	mg/kg	230
Aliphatic C12-C16	mg/kg	1700



Test	Units	GAC (mg/kg)
Aliphatic C16-C21	mg/kg	64000
Aliphatic C21-C35	mg/kg	64000
Aromatic C5-C7	mg/kg	480
Aromatic C7-C8	mg/kg	1300
Aromatic C8-C10	mg/kg	81
Aromatic C10-C12	mg/kg	420
Aromatic C12-C16	mg/kg	1600
Aromatic C16-C21	mg/kg	1300
Aromatic C21-C35	mg/kg	1300
Aliphatic C5-C35	mg/kg	1300
TPH Ali/Aro	mg/kg	1300
Acenaphthene	mg/kg	3100
Acenaphthylene	mg/kg	3000
Anthracene	mg/kg	22000
Benzo(a)anthracene	mg/kg	5.2
Benzo(a)pyrene	mg/kg	1.0
Benzo(b)fluoranthene	mg/kg	7.3
Benzo(k)fluoranthene	mg/kg	10
Benzo(g,h,i)perylene	mg/kg	47
Chrysene	mg/kg	9.7
Dibenzo(a,h)anthracene	mg/kg	0.91
Fluoranthene	mg/kg	990
Fluorene	mg/kg	2500
Indeno(1,2,3-c,d)pyrene	mg/kg	4.4
Naphthalene	mg/kg	3.9
Phenanthrene	mg/kg	930
Pyrene	mg/kg	2400
Benzene	mg/kg	0.49

Test	Units	GAC (mg/kg)
Ethylbenzene	mg/kg	380
Toluene	mg/kg	1300
Xylene	mg/kg	140
Phenol - Monohydric	mg/kg	420

*Table 6.1 Halcrow Tier 1 Screening Criteria for Human Health*

The following exceedances of the screening criteria for Human Health are noted.

The concentration of benzo(a)pyrene exceeds its criterion of 1.0mg/kg in a number of samples with concentrations ranging from 0.1mg/kg to 68mg/kg.

Concentrations of lead were found to exceed the assessment criterion of 450mg/kg in two samples during the Halcrow 2010 investigation. No exceedances of heavy metals were detected during the 2012 investigation.

Asbestos minerals crocidolite and amosite was detected in borehole CPRCB12A (Reach 6A) at a depth of 1.0m. The laboratory reported that the sample, "Contains Clump & Bundles of Unbound Asbestos". No asbestos was detected in any other sample locations across the site.

Carbon dioxide was found in most boreholes (maximum concentration of 0.9%vol in CPRCB11). However this is not associated with elevated methane or a reduction in oxygen content. It is thought to be naturally occurring carbon dioxide as a result of the geological ground conditions, not as a result of any made ground.

A limited amount of bacteriological analysis was undertaken in areas associated with former sewage works (HPB17 and TP17). The results are orders of magnitude below the level of bacteriological contamination associated with fresh sewage waste, and are not considered to present a risk to construction workers.

## 6.2 Controlled Waters

Soil and groundwater data have been compared against environmental quality standards (EQS) for Coastal and Transitional Waters.

A generic assessment applies the EQS standard (which indicates the maximum acceptable concentration in the water body) to the concentration of that contaminant at the source. The distance from source (soil sample) to receptor (River Arun) has not been considered in the derivation of assessment criteria and no allowance is made for dilution, retardation or degradation of the contaminant between the source and receptor. This therefore represents a conservative assessment of potential risk and exceedance of the EQS does not necessarily indicate a risk to the receptor, but rather that further consideration of the potential for the proposed scheme to create a pathway between source and receptor is required.

Test	EQS for Coastal and transitional waters	EQS Saltwater
Arsenic, Dissolved	25	25
Cadmium, Dissolved	1.5	2.5
Chromium, Dissolved	32	15
Copper, Dissolved	5	5
Lead, Dissolved	7.2	25
Mercury, Dissolved	0.07	0.3
Nickel, Dissolved	20	30
Zinc, Dissolved	40	40
Boron, Dissolved	-	7000
Cyanide total	-	50
Cyanide free	-	50
Benzo(a)pyrene	0.05	0.1
Benzo(b)fluoranthene	0.03	0.025
Benzo(k)fluoranthene	0.03	0.025
Benzo(g,h,i)perylene	0.002	0.025
Indeno(1,2,3-c,d)pyrene		
Naphthalene	1.2	5
Phenol	7.7	

Table 6.2 Environment Quality Standards

Groundwater quality data has been obtained for 10 locations in Reaches 1, 2, 4, and 6 which gives an indication of the true potential for mobilisation of contamination into the River Arun and surrounding groundwaters.

Each Reach has been assessed individually to allow potential sources to be identified in each area of construction. The following summarises the controlled waters assessment.

## 6.2.1 Results

### 6.2.1.1 Heavy Metals

There are no exceedances of the EQS for heavy metals at any of the sampling locations from the 2012 investigation. During the 2010 investigation there were eleven exceedances for copper out of a total 12 samples taken across all reaches, and two exceedances of zinc in boreholes CP1101 and WS1605 located in reaches 5B and 6B respectively.

### 6.2.1.2 PAH's

There were no exceedances of EQS's for PAH's in any of the boreholes monitored during the 2012 investigation or the 2010 ground investigation. Both investigations did not identify any PAH's within the groundwater; all PAH's were recorded as below the limit of detection.

## 7 Updated Conceptual Model

### 7.1 Reach 1

The conceptual model for Reach 1 is shown in Drawing 463457-GEOENV-007.

The current flood defences in Reach 1 consists of reinforced concrete king-posts and planks (on top of vertical concrete sheet piles with an additional lower capping beam towards low tide level), and steel sheet pile walls.

The promenade consists of granular Made Ground typically comprised white to grey-brown chalk gravel. Fragments of charcoal, ceramic, glass, brick, clinker and occasional concrete with cobbles of flint and chalk were also noted. The made ground overlies a sand and gravel layer up 8.50mbgl, below which white chalk was encountered. Previous investigations have shown an exceedance of the assessment criterion for petroleum hydrocarbons in groundwater within Reach 1, along with exceedances of soil screening criteria for lead and some PAH compounds.

The proposed work in this area will include the construction of a new sheet pile wall in front of the existing flood defence, as well as works to the promenade.

Sheet piling has the potential to create preferential pathways through the alluvium for contaminants within the made ground to migrate down into the underlying granular alluvium and laterally towards the river. The alluvium in the area of sheet piling is approximately 5m thick and so any piling is unlikely to create vertical pathways as the alluvium should tend to seal against the piles. The contamination from hydrocarbons seen in borehole BH201 at 0.8m depth is on the landward side of the piling and so any potential for lateral migration of contaminants towards the river is likely to be further reduced once the sheet pile is in place.

The exceedances of lead and PAHs found in CP203 and CP202 are a potential risk if uncovered during construction. This can be mitigated against, should soils be exposed, during construction within the site health and safety plan. It is considered that risks to site visitors post construction are minimised due to the hardstanding covering the made ground in this area.

## 7.2 Reach 2

The conceptual model for Reach 2 is shown in Drawing 463457-GEOENV-006.

The current flood defences in Reach 2 include a flood wall structure consisting of a concrete piled wall fronting a sloping concrete revetment, with the piles submerged at mid and high tides. There is also a floating pontoon located 5m out from the river side of the wall, which protects the existing flood wall from vessel impact / floating debris damage.

The ground conditions with Reach 2 comprise a relatively thin layer of made ground, which was described as being composed of flint gravel. The depth of the Made Ground varies along Reach 2 between approximately 0.80m and 0.60mbgl. Underlying the made ground is granular alluvium described as sandy flint gravel over cohesive alluvium. White chalk was encountered beneath the alluvium at approximately 4mbgl. Environmental sampling carried out during the previous investigation (Halcrow 2010) showed no exceedances of the generic screening criteria, therefore posing no risk to human health or groundwater. It is considered that there are no sources of contamination within Reach 2.

The proposed work in this area will include the construction of a new sheet pile wall in front of the existing flood defence, as well as works to the promenade and resurfacing of the road.

It is considered that there are no contaminated land risks associated with the improvements in Reach 2.

## 7.3 Reach 3

The conceptual model for Reach 3 is shown in Drawing 463457-GEOENV-005.

Current flood defences along Reach 3 comprise sheet pile walls, a concrete ramp, a combi wall and reinforced concrete capping beams

The Made Ground was encountered in all exploratory holes along this Reach comprising clayey silty sandy fine to coarse gravel of crystalline rock, chalk, brick, flint and glass. The thickness of the Made Ground varies between approximately 0.40m and 2.80m.

Granular alluvium immediately underlies the Made Ground deposits, described as clayey very gravelly fine to coarse sand. Gravel was fine to coarse flint with occasional chalk. The alluvium is underlain by chalk comprising an upper weathered horizon which grades into competent chalk

Construction Evaluation Limited (2008) and other previous investigations found evidence of petroleum hydrocarbon contamination in groundwater, and some heavy metal and PAH contamination in soil samples taken. This can be mitigated, should soils be exposed, during construction within the site health and safety plan. It is considered that long term risks to site visitors are minimised by the existing hardstanding in this reach.

The proposed work in this area will include the construction of a new sheet pile wall in front of the existing flood defence.

It is considered that there are no significant contaminated land risks associated with the improvements in Reach 3.

#### **7.4 Reach 4**

The conceptual model for Reach 4 is showing in Drawing 463457-GEOENV-004.

Current flood defences include steel sheet pile wall and masonry.

Made Ground was encountered in all exploratory holes along this Reach comprising clayey silty and sandy gravel of crystalline rock, chalk, brick, flint and glass. The thickness of the Made Ground varies between approximately 0.40m and 2.80m.

Underlying the Made Ground was granular and cohesive alluvium underlain by weathered structureless chalk which grades into competent chalk.

There were no exceedances of the assessment criteria for soils or groundwaters during the 2010 or 2012 Halcrow investigations.

The proposed work in this area will include the construction of a new sheet pile wall in front of the existing flood defence.

It is considered that there is no contaminated land risks associated with the improvements in Reach 4.

#### **7.5 Reach 5**

The conceptual model for Reach 5 is showing in Drawing 463457-GEOENV-003.

The current flood defence comprises a steel pile wall of approximately 83m in length, connected into a deep reinforced concrete capping beam.

Reach 5 is underlain by Made Ground, up to approximately 6m deep generally described as cohesive with chalk and flint gravel and wood fragments. Tidal river deposits (formally marine and estuarine alluvium) were identified beneath the made ground including cohesive alluvium overlying granular alluvial sands. Structureless chalk was encountered at elevations varying from -0.93 to -5.71mOD.

Previous investigations have shown an exceedance of the assessment criteria for benzo(a)pyrene in soil within borehole CP1103; no exceedances were found within groundwater. Borehole 1103 is located adjacent to a gas works. TPH concentration in groundwater was below the detection limit in CP1101, which is located down hydraulic gradient.

The proposed work in this area will include the construction of a new sheet pile wall in front of the existing flood defence.

Primary pathways were identified as inhalation and ingestion of soil and dust, which can be controlled using standard good practice during construction.

#### **7.6 Reach 6**

The conceptual model for Reach 5 is showing in Drawing 463457-GEOENV-002 (6A) and 463457-GEOENV-001 (6B).

Current flood defences consist of an embankment with a variable concrete, sand and gravel slope with a gravel/concrete crest and part vegetated back slope, including a sloping embankment and steel sheet pile wall.

The existing flood embankment comprises gravelly clay. Underlying the bund the alluvial deposits vary considerably along the length of Reach 6; a significant thickness of both cohesive and granular alluvium is present. Below the alluvium lies structureless and structured chalk at varying elevations.

Previous investigations have shown an exceedance of the adopted assessment criterion for petroleum hydrocarbons in groundwater in boreholes WS1301A, WS1504 and WS1601; located in the existing flood embankment in reaches 6A and 6B. It should be noted that bacteriological pathogens were also detected in borehole WS1504. An exceedance of soil screening criteria for benzo(a)pyrene was detected in borehole WS1301A (Reach 6A).

The proposed work in this area will include raising the existing embankment, some piling and extend the adjacent road embankment and realignment

Primary pathways were identified as direct contact, inhalation, ingestion and windblown dust; which can be easily controlled using standard good practice during and after construction. Raising the embankment will require covering the existing materials, reducing any potential for exposure.

## 8 Waste Management

### 8.1 Discussion

The majority of the improvement works do not involve the generation of significant quantities of waste soils, apart from the improvements in Reach 6B. In Reach 6B some of the existing flood defences will be partially excavated and re-used to form re-profiled defences. The plans for Reach 6B are not fully formulated at the time of writing this report, so the exact soil movements are not known. The site investigation data from Reach 6B does not show significant concentrations of contaminants within the existing flood defences, so the re-use of the material should be acceptable.

The CL:AIRE Definition of Waste Code of Practice requires that either a remediation strategy or design statement be produced as part of the documentation; either of which must be approved by the Regulators (Environment Agency). A remediation strategy is required if significant soil contamination is present on the site; a design statement if no or insignificant contamination is present. Chapter 9 presents an outline Design Statement for this project.

Should there be no requirement for re-use of soils the soils will require off-site disposal. It is likely the excess soils will be classified as either inert or non-hazardous waste (depending on where they are excavated from). Disposal to licensed landfill for inert soils is likely to cost approximately £25/m<sup>3</sup>, and for non-hazardous waste £170/m<sup>3</sup> (note these costs do not include excavation costs or transport to landfill, they are also based on 2013 landfill tax rates – rates may increase in future years). There are other options for dealing with excess soils which do not incur landfill tax, such as

using soils at nearby independent sites which have a requirement for soil materials. Local waste contractors should be contacted to explore this re-use/disposal route.

## **9 Design Statement**

### **9.1 Introduction**

The re-use of fill materials will follow the CL:AIRE Definition of Waste: Development Industry Code of Practice (CL:AIRE CoP). This CoP provides a framework to enable the re-use of fill materials within the current waste management legislation and guidance. This design statement is for Reach 6B, and is in draft form awaiting completion of the design.

The CL:AIRE CoP has three main elements:

- Suitable for use – fill materials must be suitable for use, i.e. geotechnically suitable, and not present a risk to humans or the environment.
- Certainty of use – it must be shown that the re-use is a certainty and not just a possibility
- Quantity – only the required quantity required for the scheme must be used.

It is acceptable for fill materials to undergo treatment, including remediation prior to re-use. On this project material will not undergo treatment as it is considered suitable for re-use without treatment.

Currently the plans for Reach 6B are not fully formulated so this design statement will need revision once plans are finalised.

### **9.2 Condition of Excess Soils**

The exact location of soils to be excavated are not known. However, site investigation for Reach 6B has not shown significant contamination (although there are occasional exceedances of the relevant CLEA guideline values and EQS). Once the plans for the Reach are finalised, the site investigation data for the exact area of soils to be excavated and re-used should be examined.

### **9.3 Deposition Site**

#### **9.3.1 Conceptual Model**

The conceptual model for Reach 6B is shown on Drawing 463457-GEOENV-001, and described in Section 7.6.

#### **9.3.2 Risk Assessment**

The area for re-use of soils is not finalised and the risk assessment should be reviewed once plans are finalised. The use of the site once works are complete will be open space, so the CLEA guideline values generated for the general risk assessment may be over protective. However, for the interim these guideline values are proposed for use as Environmental Acceptance Criteria. These are detailed in Section 9.3.3 below. For controlled waters it is currently assumed that soils will be in close proximity to controlled waters so leachate analysis should be directly compared to



Environmental Quality Standards. Once the final location for the re-use of soils is known, some refinement of this risk assessment may be possible, although, given the low concentrations of contaminants encountered, this may not be necessary.

### 9.3.3 Environmental Acceptance Criteria

#### 9.3.3.1 CLEA Derived Human Health Criteria

The CLEA guideline values generated for the generic risk assessment (residential without plant uptake criteria) are proposed for re-use criteria, subject to review once plans are finalised.

#### 9.3.3.2 Additional Derived Human Health Criteria

##### Asbestos

For asbestos in soils to present a risk to site users it must be capable of being mobilised into the air. This in turn is dependent on vegetation cover, how damp the soil is, and how much traffic (and type of traffic) etc the site gets. Obviously this could vary daily. There is very little risk if asbestos is present on a site at depth and unlikely to be disturbed. However, public perception is a key issue to consider along with client acceptability.

Asbestos is usually present on development sites in the form of asbestos cement board. This presents a low risk unless it is broken up or crushed as part of site works.

##### Existing asbestos guidance

ICRCL 64/85 Asbestos on contaminated sites 2<sup>nd</sup> ed, 1990, Defra. - this document stated that soils with concentrations of asbestos as low as 0.001% w/w of friable asbestos may give rise to measurable levels of airborne fibres if disturbed. Note that this relates to dry soils with free fibres of asbestos evenly distributed. (IOM Historical Research Report TM 88/14/1988, historically referred to in ICRCL 64/85)

Ministry of Housing (Netherlands), Spatial Planning and the Environment (VROM) - the Ministry has expressed a target level of 100 mg/kg or 0.01% weight (note target assumes activities such as digging, tipping and sifting of soil material are not systematically involved) and the soil is damp for a large part of the year.

The Hazardous Waste (England and Wales) Regulations 2005 - The Hazardous Waste threshold in the UK is 0.1% w/w. Note that this does not imply a soil with asbestos concentrations below 0.1% w/w is safe.

##### Material's re-use asbestos recommendations

It is proposed that the maximum level of free fibres acceptable in re-used soils is 0.001% w/w. This is based on the ICRCL research that soils with free fibres above this level may give rise to respirable fibres in air. There is a potential for small amounts of cement bound asbestos to be present in the fill material. This risk will be minimised by removal through hand picking during initial excavation, storage and final placing.

#### 9.3.3.3 Water Quality Criteria

The site is located next to the River Arun and this is considered the most sensitive water receptor. There is very little possibility for attenuation or dilution between the

deposition site and receptor and therefore it is considered that leachate test data should be compared to applicable Environmental Quality Standards.

#### 9.3.3.4 Environmental Acceptance Criteria

Table 9.1 shows the risk-based Environmental Acceptance Criteria (EACs) for soils reuse based on the CLEA model and the applicable Environmental Quality Standards.

Contaminant	Risk-based Environmental Acceptance Criteria				
	Human Health Protection (soil analysis)		Surface Water Protection (leachate analysis)		
			Conc.	Units	Notes
Asbestos	0.001 <sup>a</sup>	% w/w	Not applicable		
Arsenic	35	mg/kg	25	µg/l	EQS (coastal and transitional waters)
Boron	10000	mg/kg	7000	µg/l	EQS (saltwater)
Cadmium	18	mg/kg	1.5	µg/l	EQS (coastal and transitional waters)
Chromium	627	mg/kg	32	µg/l	EQS (coastal and transitional waters)
Chromium (hexavalent)	4.3	mg/kg	Not applicable		
Copper	6200	mg/kg	5	µg/l	EQS (coastal and transitional waters)
Iron	Not applicable		1000	µg/l	EQS (coastal and transitional waters)
Lead	450	mg/kg	7.2	µg/l	EQS (coastal and transitional waters)
Mercury (inorganic)	240	mg/kg	0.07	µg/l	EQS (coastal and transitional waters)
Nickel	130	mg/kg	20	µg/l	EQS (coastal and transitional waters)
Zinc	4000	mg/kg	40	µg/l	EQS (coastal and transitional waters)
Cyanide (total)	12	mg/kg	Not applicable		
pH	Not applicable		6 to 9		EQS (coastal and transitional waters))
Phenols	420	mg/kg	7.7	mg/l	EQS (coastal and transitional waters)
Benzene	0.49	mg/kg	8	µg/l	EQS (coastal and transitional waters)
Toluene	1300	mg/kg	40	µg/l	EQS (coastal and transitional waters)
Ethylbenzene	380	mg/kg	Not applicable		
m-xylene	140	mg/kg	30	µg/l	EQS (coastal and transitional waters)
o-xylene		mg/kg			
p-xylene		mg/kg			
TPH (total)	Not applicable		No visible sheen or staining		Freshwater Fish Directive / Surface Water (Fishlife) (Classification) Regulations 1997
Aliphatic C5-C6	55	mg/kg	Not applicable		
Aliphatic C6-C8	160	mg/kg	Not applicable		
Aliphatic C8-C10	46	mg/kg	Not applicable		
Aliphatic C10-C12	230	mg/kg	Not applicable		
Aliphatic C12-C16	1700	mg/kg	Not applicable		

Contaminant	Risk-based Environmental Acceptance Criteria				
	Human Health Protection (soil analysis)		Surface Water Protection (leachate analysis)		
			Conc.	Units	Notes
Aliphatic C16-C21	64000	mg/kg	Not applicable		
Aliphatic C21-C35	64000	mg/kg	Not applicable		
Aromatic C5-C7	480	mg/kg	Not applicable		
Aromatic C7-C8	1300	mg/kg	Not applicable		
Aromatic C8-C10	81	mg/kg	Not applicable		
Aromatic C10-C12	420	mg/kg	Not applicable		
Aromatic C12-C16	1600	mg/kg	Not applicable		
Aromatic C16-C21	1300	mg/kg	Not applicable		
Aromatic C21-C35	1300	mg/kg	Not applicable		
Aliphatic C5-C35	1300	mg/kg	Not applicable		
Acenaphthylene	3100	mg/kg	Not applicable		
Acenaphthene	3000	mg/kg	Not applicable		
Anthracene	220000	mg/kg	Not applicable		
Benzo(a)anthracene	5.2	mg/kg	Not applicable		
Benzo(a)pyrene	1.0	mg/kg	0.05	µg/l	EQS (coastal and transitional waters)
Benzo(b)fluoranthene	7.3	mg/kg	0.03	µg/l	EQS (coastal and transitional waters)
Benzo(k)fluoranthene	10	mg/kg			
Benzo(g,h,i)perylene	47	mg/kg	0.002	µg/l	EQS (coastal and transitional waters)
Indeno(1,2,3-c,d)pyrene	4.4	mg/kg			
Chrysene	9.7	mg/kg	Not applicable		
Dibenzo(ah)anthracene	0.91	mg/kg	Not applicable		
Fluoranthene	990	mg/kg	Not applicable		
Fluorene	2500	mg/kg	Not applicable		
Naphthalene	3.9	mg/kg	1.2	µg/l	EQS (coastal and transitional waters)
Phenanthrene	930	mg/kg	Not applicable		
Pyrene	2400	mg/kg	Not applicable		

Table 9.1 – Proposed Environmental Acceptance Criteria

## 9.4 Verification Reporting

### 9.4.1 Materials Management Plan

A Materials Management Plan will be required as part of the CL:AIRE Code of Practice declaration. The Materials Management Plan sets out the requirements for the contractor to develop and implement a tracking system to provide an auditable trail for excavation, disposal, treatment and/or reuse volumes throughout the scheme.

#### 9.4.2 Verification Reporting

The Cl:AIRE CoP requires a Verification Report to be produced to provide an audit trail demonstrating that materials have been correctly reused and wastes have been disposed of correctly. The report also shows how the reuse of materials meets the objectives of the Design Statement.

The contents of the Verification Report are as follows:

- 1 Introduction**
- 2 Background Information**
  - 2.1 Site Details
  - 2.2 Site Personal
  - 2.3 Background Information
  - 2.4 Previous Investigation
  - 2.5 Ground and Groundwater Conditions
- 3 Materials Management**
  - 3.1 General Description of Materials Management on Site
  - 3.2 Materials Management Procedure
  - 3.3 Verification of Materials Management
  - 3.4 Specification for Suitability
  - 3.5 Verification Methodology
  - 3.6 Health and Safety Issues
  - 3.7 Regulatory Licenses / Permits
  - 3.8 Site Preparation and Services
  - 3.9 Sequence of Activities
  - 3.10 Completion of Works
- 4 Verification Reporting**
  - 4.1 Materials Movements
  - 4.2 Volumes and Characteristic of remainder of fill material
- 5 Final Site Conditions**
  - 5.1 Final Extent of Material Movement
  - 5.2 Quality of Material
  - 5.3 Identification of post treatment management needs

The Verification Report will be produced on completion of site works at the Receiving Site.

#### 9.4.3 Validation Plan

A requirement of the verification exercise is to validate that the material re-used is suitable for its intended use.

It is recommended that all soils are tested and compared to environmental acceptance criteria based on the rate of 1 test per 500m<sup>3</sup>. This analysis is recommended to be done prior to excavation, once the plans for Reach 6 are finalised.

## 10 Conclusions and Recommendations

### 10.1 Conclusions

#### 10.1.1 Reach 1

The exceedances of lead and PAHs found in CP203 and CP202 are a potential risk if uncovered during construction. This can be mitigated against should soils be exposed during construction within the site health and safety plan. It is considered that risks to site visitors post construction are minimised due to the hardstanding covering the made ground in this area.

The potential for lateral migration of contaminants towards the river is likely to be reduced once the new sheet pile is in place.

#### 10.1.2 Reach 2

It is considered that there are no contaminated land risks associated with the improvements in Reach 2.

#### 10.1.3 Reach 3

It is considered that there are no contaminated land risks associated with the improvements in Reach 3.

#### 10.1.4 Reach 4

It is considered that there are no contaminated land risks associated with the improvements in Reach 4

#### 10.1.5 Reach 5

The exceedances PAHs found are a potential risk if uncovered during construction. This can be mitigated against should soils be exposed during construction within the site health and safety plan. It is considered that risks to site visitors post construction are minimised due to the hardstanding covering the made ground in this area.

#### 10.1.6 Reach 6

Some exceedances of the CLEA guideline values were noted, but it is considered that generally soils are suitable for re-use, subject to review once plans for Reach 6 are finalised.

### 10.2 Recommendations

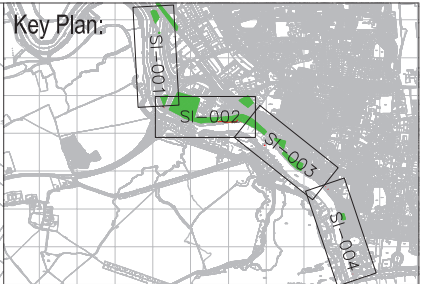
It is recommended that once plans are finalised for the scheme, the risk assessment is reviewed. It is also recommended that soils re-use in Reach 6 be facilitated by use of the CL:AIRE Definition of Waste Code of Practice.



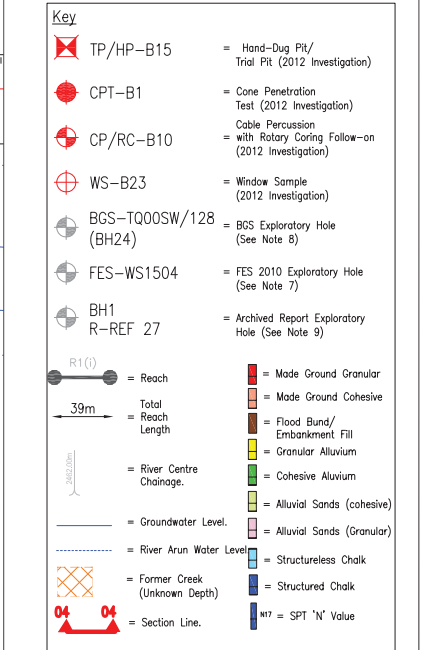
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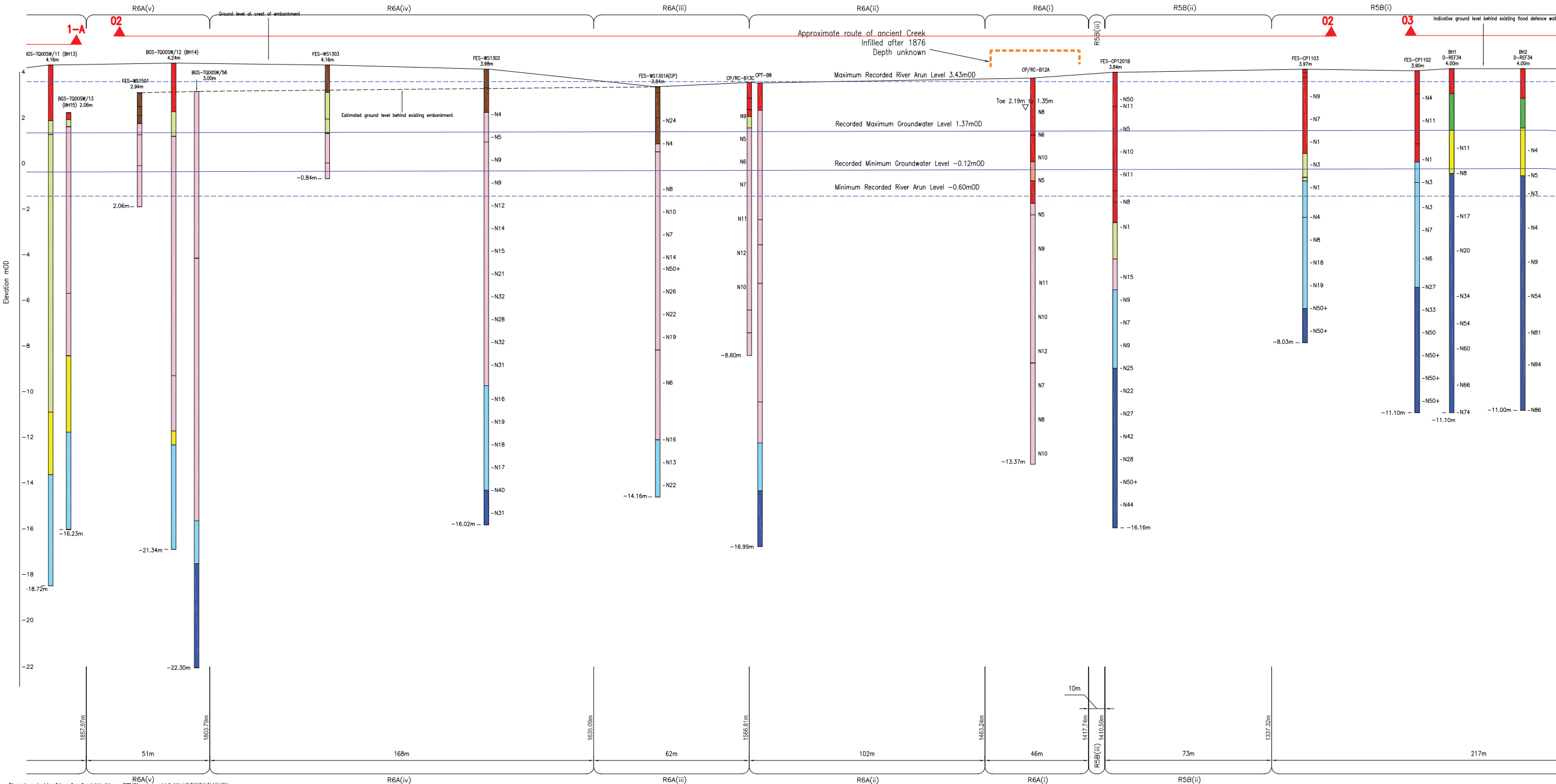
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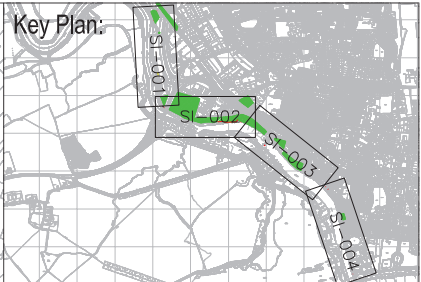
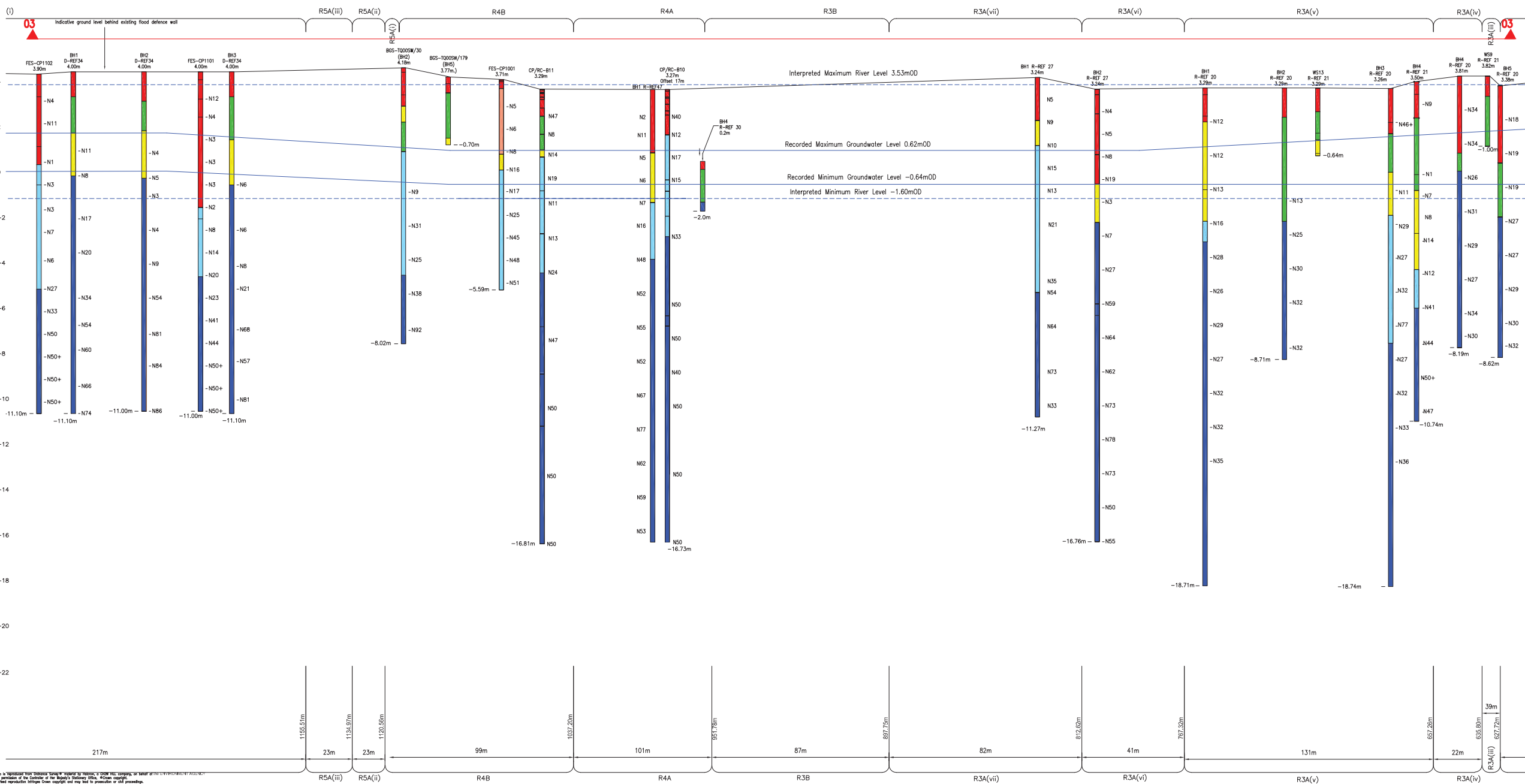
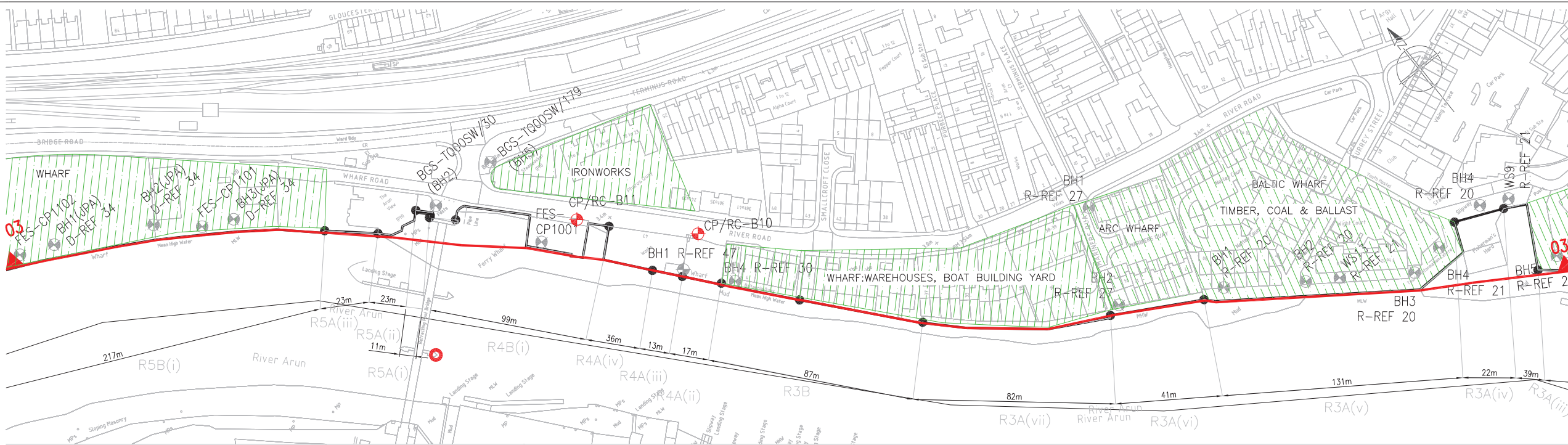
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User: andrew.patt



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  - RIVER ARUN WATER LEVEL DATA IS INTERPRETED FROM THE DIVER LOCATED AT THE RETRACTING FOOTBRIDGE IN REACH 3B.

**Key**

- TP/HP-B15 = Hand-Dug Pit/Trial Pit (2012 Investigation)
- CPT-B1 = Cone Penetration Test (2012 Investigation)
- CP/RC-B10 = Cable Percussion with Rotary Coring Follow-on (2012 Investigation)
- WS-B23 = Window Sample (2012 Investigation)
- BGS-TQ00SW/128 (BH24) = BGS Exploratory Hole (See Note 6)
- FES-WS1504 = FES 2010 Exploratory Hole (See Note 7)
- BH1 R-REF 27 = Archived Report Exploratory Hole (See Note 9)
- R1(i) = Reach
- 39m = Total Reach Length
- 39m = River Centre Chainage
- Groundwater Level
- River Arun Water Level
- Former Creek (Unknown Depth)
- Section Line
- Location of River Diver
- Made Ground Granular
- Made Ground Cohesive
- Flood Bund/Embankment Fill
- Granular Alluvium
- Cohesive Alluvium
- Alluvial Sands (cohesive)
- Alluvial Sands (Granular)
- Structureless Chalk
- Structured Chalk
- SPT 'N' Value

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**LITTLEHAMPTON ARUN TIDAL DEFENCES - EAST BANK**

Drawing

**2012 INTERPRETATIVE LONG SECTIONS**

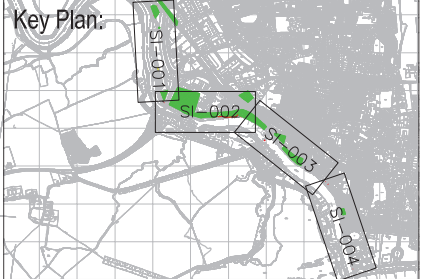
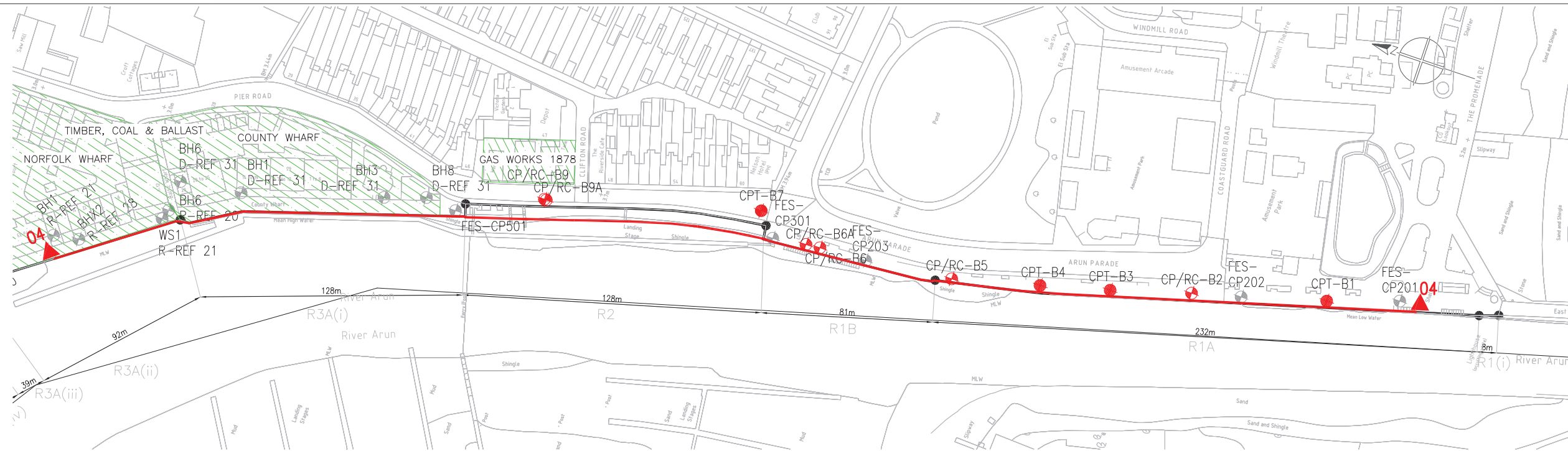
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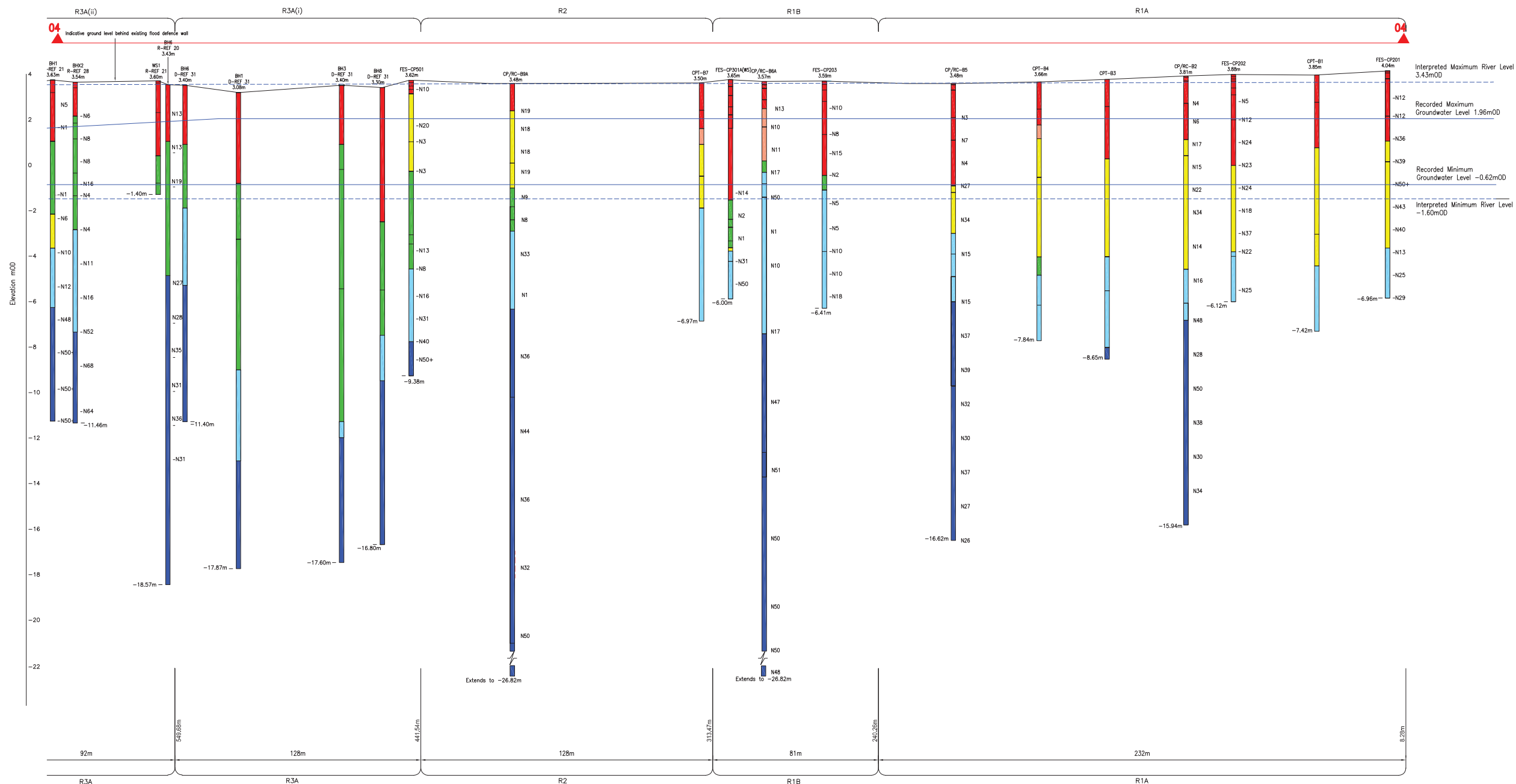
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- CPT-B1 = Cone Penetration Test (2012 Investigation)
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- WS-B23 = Window Sample (2012 Investigation)
- BGS-TQ00SW/128 (BH24) = BGS Exploratory Hole (See Note 8)
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- BH1 R-REF 27 = Archived Report Exploratory Hole (See Note 9)
- R1(i) = Reach
- 39m = Total Reach Length
- River Centre Channel
- Groundwater Level
- River Arun Water Level
- Former Creek (Unknown Depth)
- Section Line
- Made Ground Granular
- Made Ground Cohesive
- Flood Bund/Embankment Fill
- Granular Alluvium
- Cohesive Alluvium
- Alluvial Sands (cohesive)
- Alluvial Sands (granular)
- Structureless Chalk
- Structured Chalk
- SPT 'N' Value

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**SHEET 4 OF 4**

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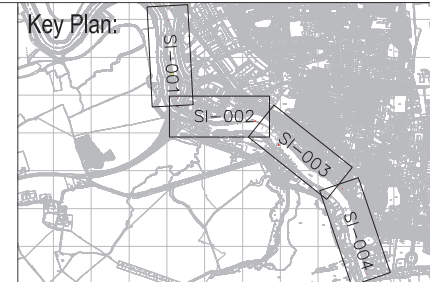
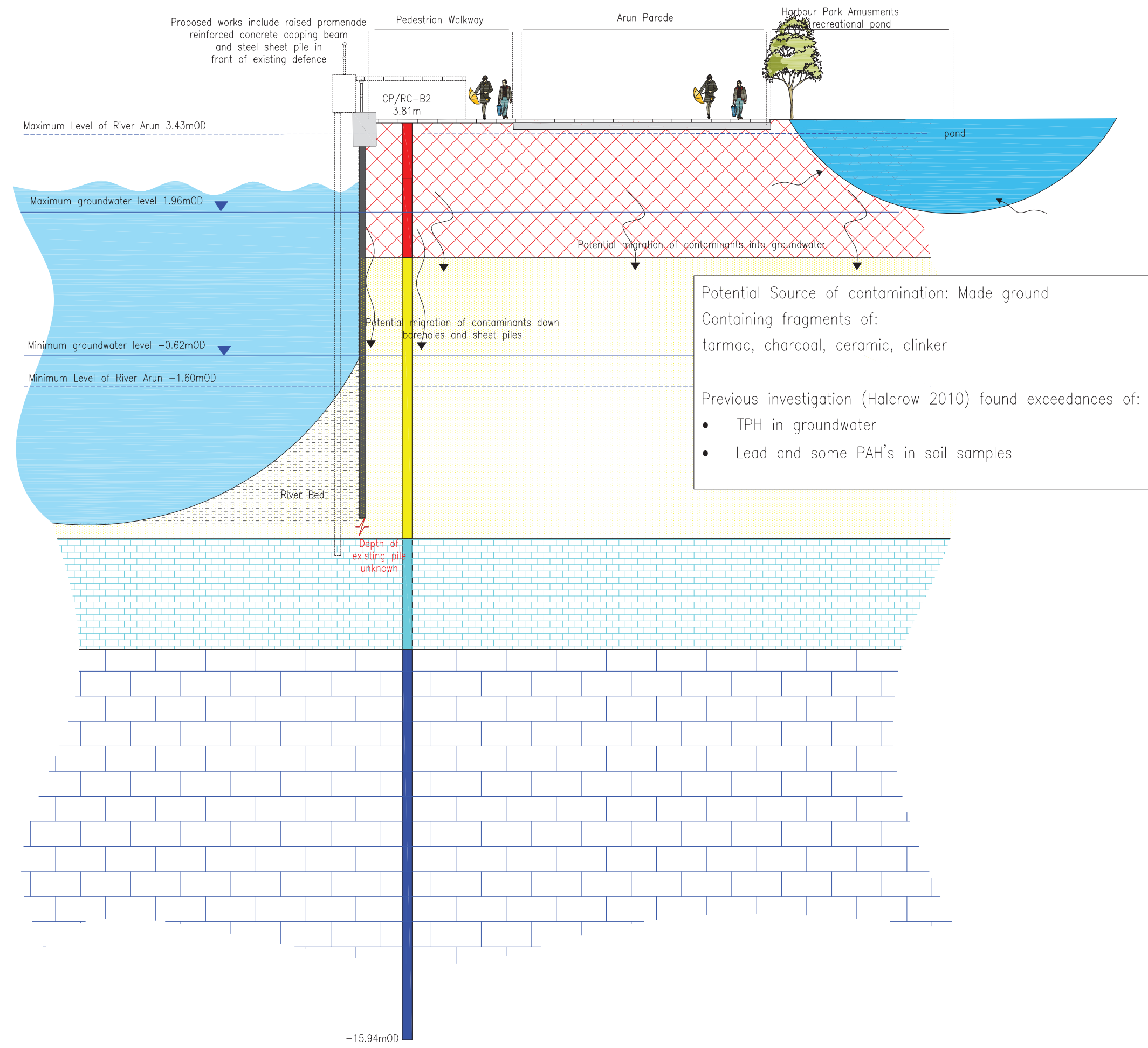
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## Appendix A

Appendix A Summary of site investigation data by reach



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  - RIVER ARUN WATER LEVEL DATA IS INTERPRETED FROM THE DIVER LOCATED AT THE RETRACTING FOOTBRIDGE IN REACH 3B
  - DEPTH OF EXISTING SHEET PILES IS UNKNOWN

Key

- Made Ground Granular
- Made Ground Cohesive
- Flood Bund/ Embankment Fill
- Granular Alluvium
- Cohesive Alluvium
- Alluvial Sands (cohesive)
- Alluvial Sands (Granular)
- Structureless Chalk
- Structured Chalk
- Groundwater Level
- River Arun Water Level
- Potential contamination pathway
- Proposed works
- Existing steel pile and concrete capping
- Mid and top handrail

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CONCEPTUAL MODEL  
REACH 1  
SHEET 7 OF 7

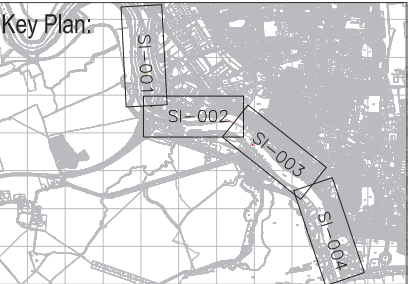
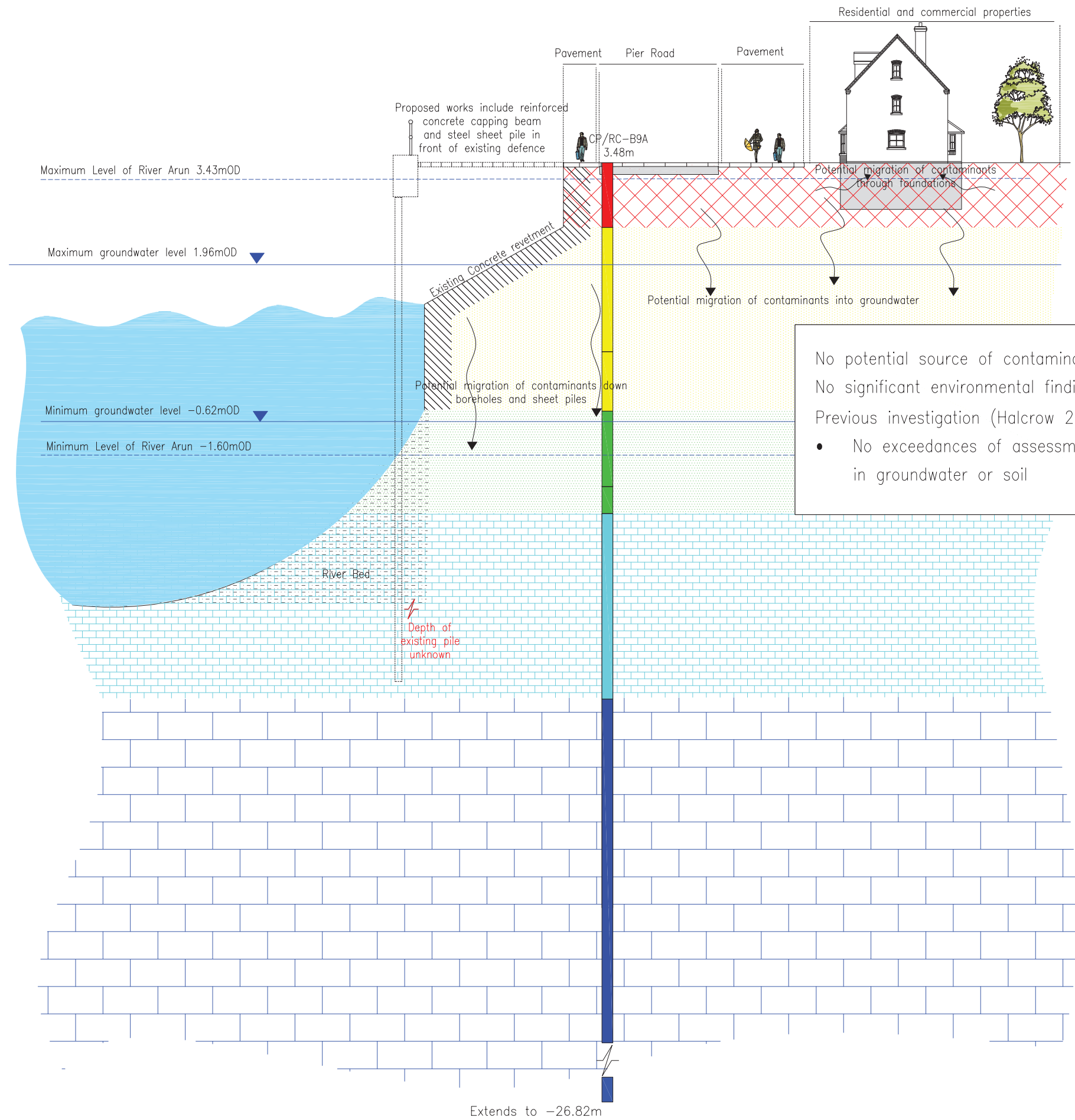
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  - DEPTH OF EXISTING SHEET PILES IS UNKNOWN

Key

- Made Ground Granular
- Made Ground Cohesive
- Flood Bund/ Embankment Fill
- Granular Alluvium
- Cohesive Alluvium
- Alluvial Sands (cohesive)
- Alluvial Sands (Granular)
- Structureless Chalk
- Structured Chalk
- Groundwater Level
- River Arun Water Level
- Potential contamination pathway
- Proposed works
- Mid and top handrail
- Foundations

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Drawing  
2012 INTERPRETATIVE REPORT  
CONCEPTUAL MODEL  
REACH 2  
SHEET 6 OF 7

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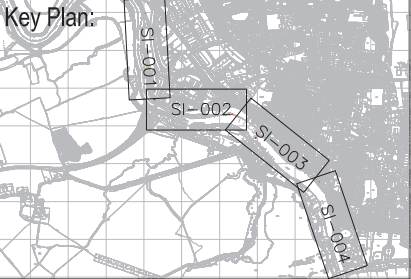
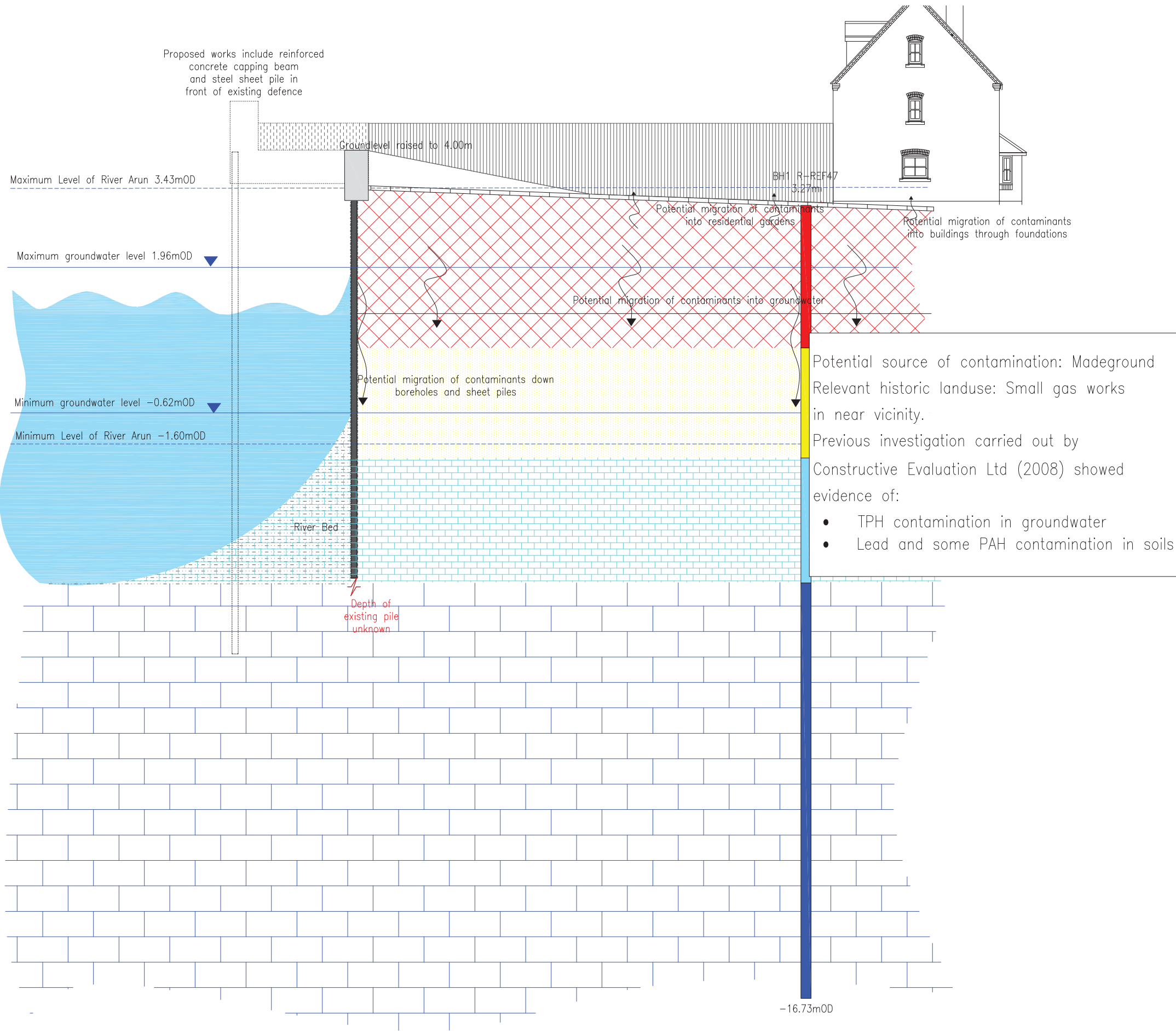
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Key

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- Made Ground Cohesive
- Flood Bund/ Embankment Fill
- Granular Alluvium
- Cohesive Alluvium
- Alluvial Sands (cohesive)
- Alluvial Sands (Granular)
- Structureless Chalk
- Structured Chalk

Groundwater Level.

River Arun Water Level.

Potential contamination pathway

Proposed works

Existing steel pile and concrete capping

Mid and top handrail

Garden Fencing

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**2012 INTERPRETATIVE REPORT  
CONCEPTUAL MODEL  
REACH 3B  
SHEET 5 OF 7**

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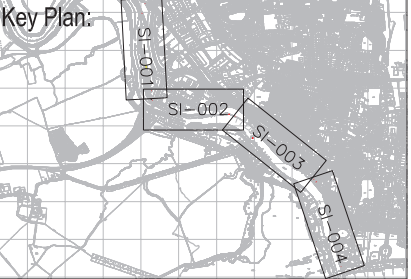
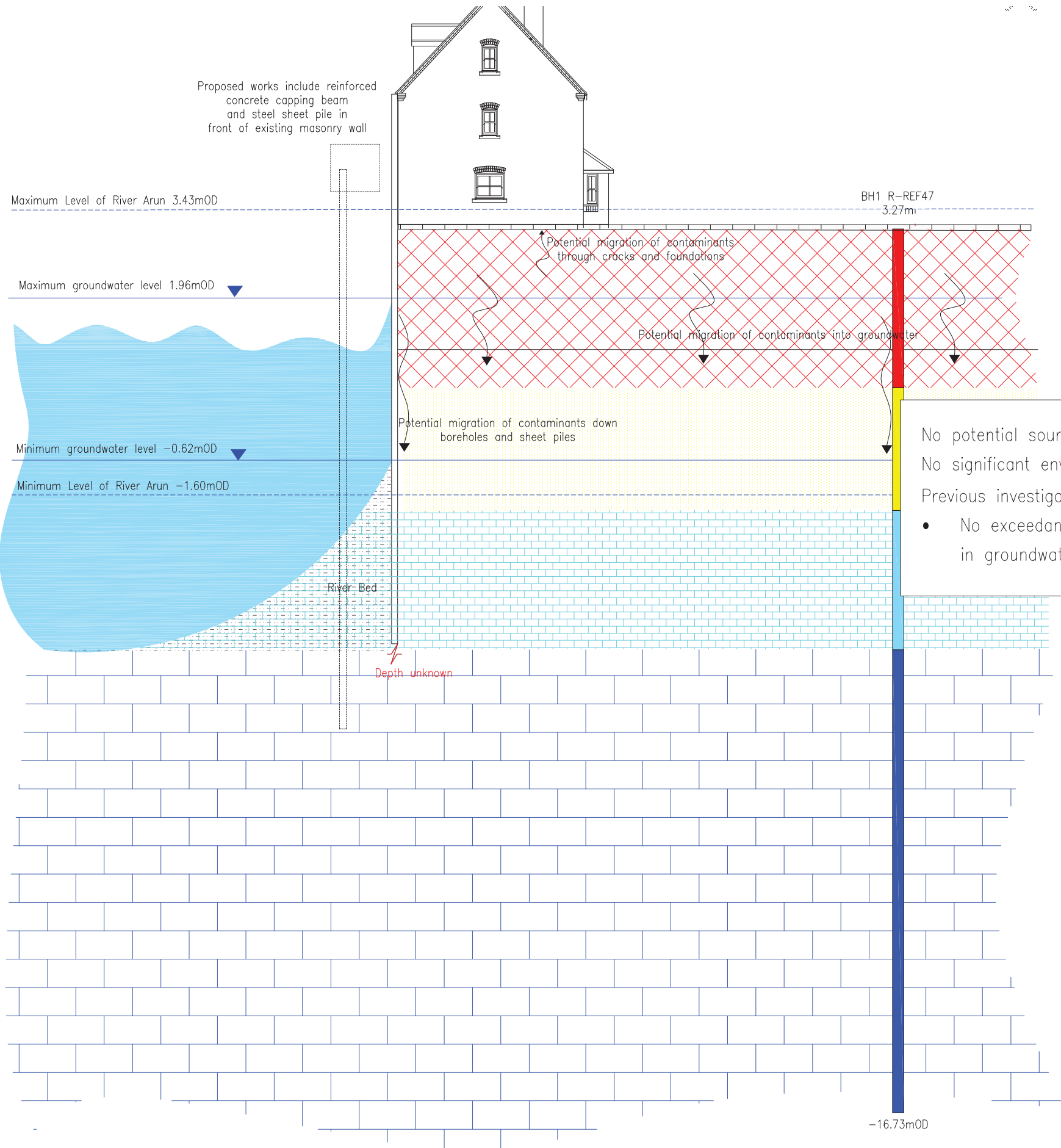
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Key

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- Flood Bund/Embankment Fill
- Granular Alluvium
- Cohesive Alluvium
- Alluvial Sands (cohesive)
- Alluvial Sands (Granular)
- Structureless Chalk
- Structured Chalk
- Groundwater Level.
- River Arun Water Level.
- Potential contamination pathway
- Proposed works
- Existing steel pile and concrete capping
- Mid and top handrail
- Garden Fencing

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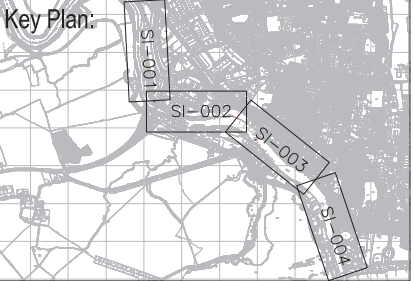
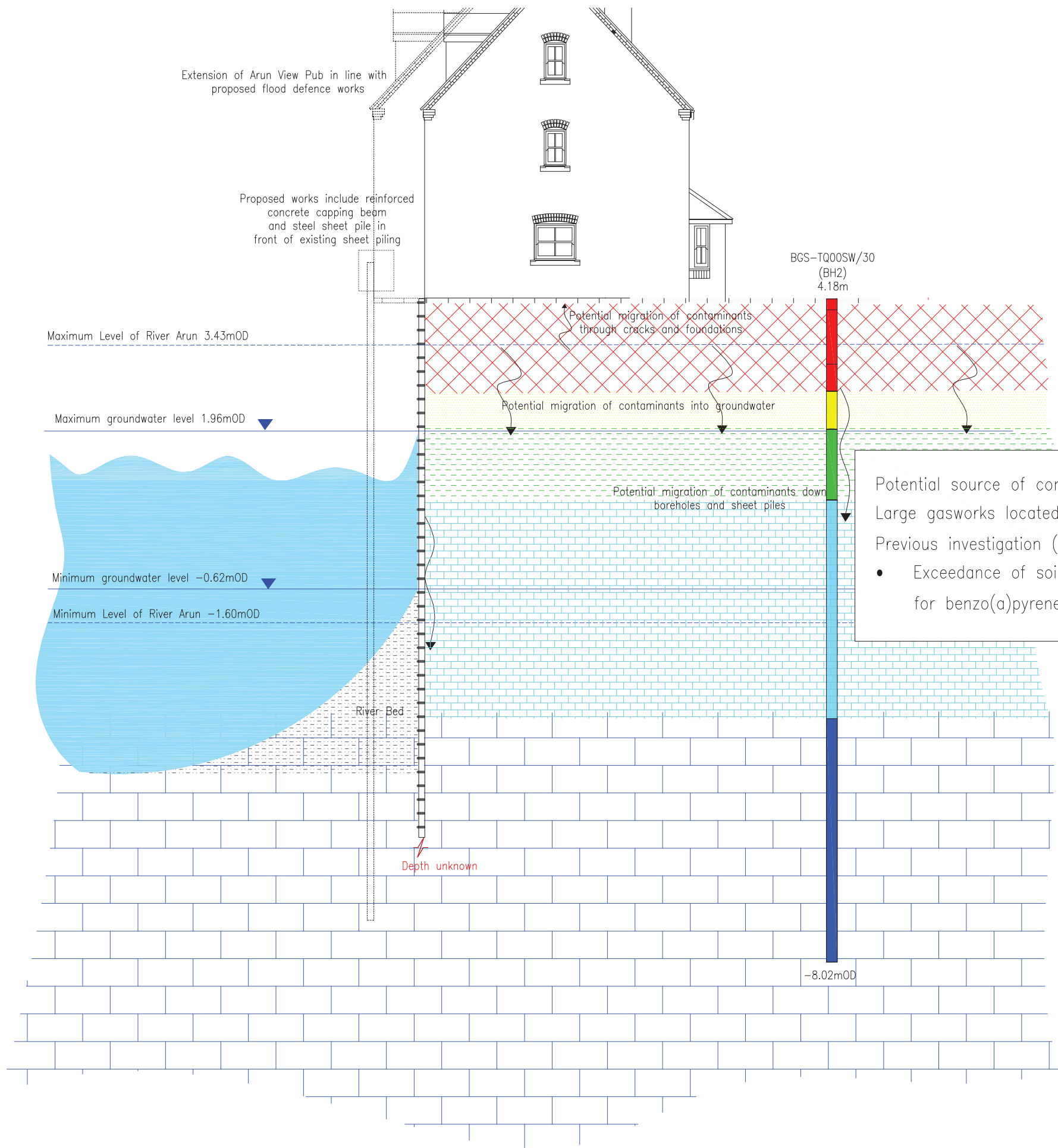
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CONCEPTUAL MODEL  
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Key

- = Made Ground Granular
- = Made Ground Cohesive
- = Flood Bund/Embankment Fill
- = Granular Alluvium
- = Cohesive Alluvium
- = Alluvial Sands (cohesive)
- = Alluvial Sands (granular)
- = Structureless Chalk
- = Structured Chalk
- = Groundwater Level.
- - - = River Arun Water Level.
- ~ = Potential contamination pathway
- - - = Proposed works
- = Existing steel pile and concrete capping

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REACH 5  
SHEET 3 OF 7**

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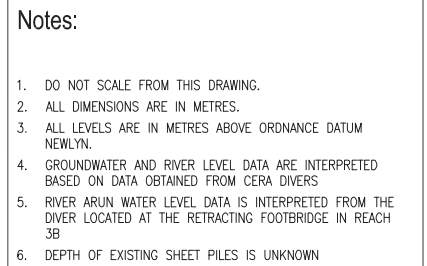
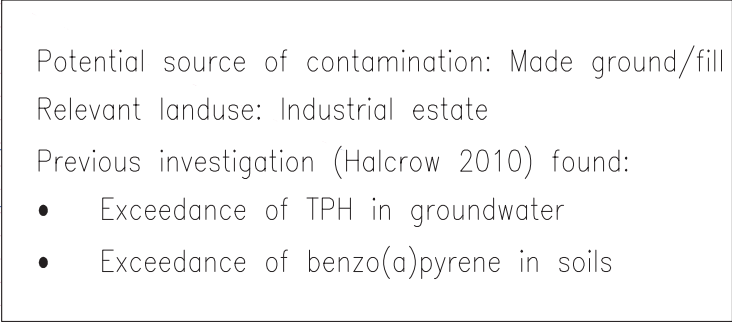
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|  | = Made Ground Cohesive           |
|  | = Flood Bund/<br>Embankment Fill |
|  | = Granular Alluvium              |
|  | = Cohesive Alluvium              |
|  | = Alluvial Sands (cohesive)      |
|  | = Alluvial Sands (Granular)      |
|  | = Structureless Chalk            |
|  | = Structured Chalk               |
- 
- |   |                                   |
|---|-----------------------------------|
|    | = Groundwater Level.              |
|    | = River Arun Water Level.         |
|   | = Potential contamination pathway |
|  | = Proposed works                  |

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2012 INTERPRETATIVE REPORT  
CONCEPTUAL MODEL  
REACH 6A  
SHEET 2 OF 7

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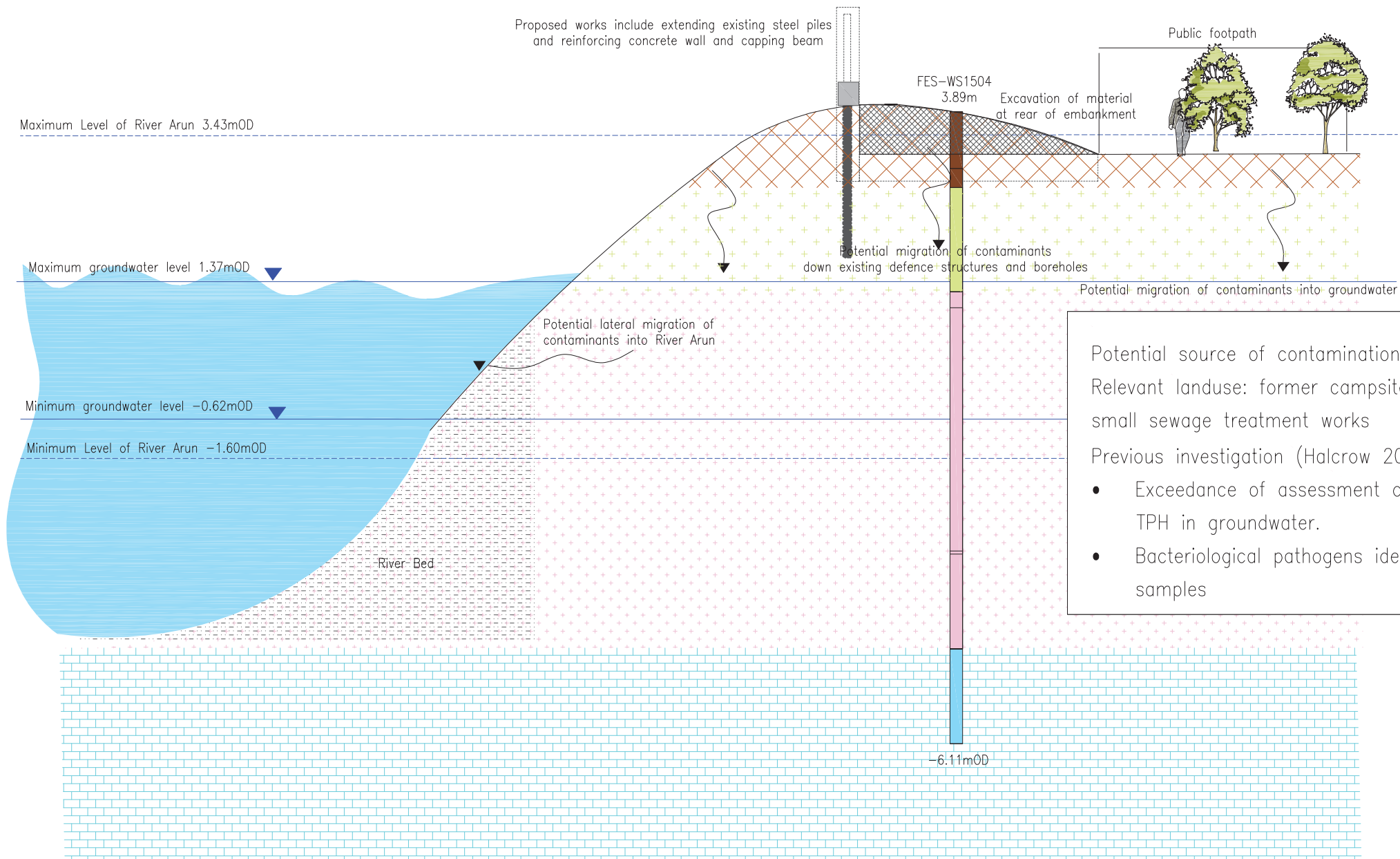
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- DEPTH OF EXISTING SHEET PILES IS UNKNOWN

Key

- Made Ground Granular
- Made Ground Cohesive
- Flood Bund/Embankment Fill
- Granular Alluvium
- Cohesive Alluvium
- Alluvial Sands (cohesive)
- Alluvial Sands (Granular)
- Structureless Chalk
- Structured Chalk
- Groundwater Level.
- River Arun Water Level.
- Potential contamination pathway
- Proposed works
- Existing steel pile and concrete capping
- Mid and top handrail

Rev	By	Chkd	Appvd	Date	Description

Client



**Halcrow Group Limited**  
Burdock Park, Swindon, Wiltshire, SN4 0DD  
Tel +44 (0)1793 812479 Fax +44 (0)1793 812089  
www.halcrow.com

A CH2M HILL COMPANY



Project

**LITTLEHAMPTON  
ARUN TIDAL DEFENCES  
- EAST BANK**

Drawing

**2012 INTERPRETATIVE REPORT  
CONCEPTUAL MODEL  
REACH 6B  
SHEET 1 OF 7**

Drawn by: CK Date: 07/03/13

Checked by: Date:

Approved by: Date:

Drawing No. Revision

**463457-GEOENV-001**

Drawing Scale: Not to Scale

# Appendix H – Landscape specifications and arboricultural report

This appendix contains two documents.

The first is a copy of the landscape specifications that will form part of the contract documents, and the second is a copy of the arboricultural survey undertaken during the detailed design stage of the scheme.

Both reports were used to inform the assessment, design and planting proposals, and the arboricultural survey is also required for planning purposes.

## East Bank River Arun, Littlehampton

Public Realm Outline Materials, Furniture and Planting Specification  
Reaches 1 and 2

V 1.4

3483\_PL\_901.

May 2013



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**East Bank River Arun, Littlehampton**

## East Bank River Arun, Littlehampton

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*This document has been prepared and checked in accordance with ISO 9001:2008.*

**East Bank River Arun, Littlehampton**



## **East Bank River Arun, Littlehampton**

### **Revision**

#### **1.2**

- Clause 3.4 omitted. Santa and Cole Comunitario bench omitted due to use of tropical hardwood and also to simplify design. These benches substituted with design to match clause 3.4.
- Additional images added for items to provide more information.
- Railings updated to reflect proprietary Marshalls Ferrocast Post and Wire system
- Suggested timber type added following supplier info and advice.
- Additional precast suppliers added for supplementary information (Thorpe and Evans)
- Edging to tie in existing/proposed surfaces substituted for aluminium in certain locations.
- Potential manufacturer for timber seating and steps added.
- Lighting number amended following initial Lighting design by manufacturer.
- Raised crossing to Pier Road removed.
- Slot drain to river wall interface removed.

#### **1.3**

### **Changes generally relate to value engineering exercise carried out 14.04.2013 and additional information received from manufacturers or sub-contractor contacts.**

- Page 2 Drawing numbers and references amended.
- Clause 2.1 Potential sub-contractors added.
- Clause 2.3. Geotextile to self-binding gravel omitted following advice from supplier (it is deemed only necessary when using urban tree soil which is not applicable in this instance).
- Clause 3.1 amended to update on the latest waterfront balustrade proposals (i.e. heights etc.)
- Clause 3.2 Balustrade to top of ramp walls, to front of ramp walls and handrails to steps and ramps - Minor addition of information. Lighting added to handrail to steps following additional funding allocation from ADC, as identified in a planning meeting (£10k).
- Clause 3.3 Bespoke Timber Seat – Type A (Forward facing with Backrests). Omitted trapezio for cost reasons, amended to bespoke to reflect budget price from Woodscape VS received. Number reduced from 7 to 6 for cost reasons.
- Clause 3.4 Bespoke Timber seating – Type B (Dual facing with backrests and arm rests). Sizes and number reduced for cost reasons.
- Clause 3.6 Proprietary Litter Bins – Amended to reflect the revised product information (increased capacity, locking mechanism).
- Clause 3.10 Proprietary Lighting Columns and lanterns – Potential manufacturer has recommended lighting column be amended in order to confirm with EU standards. Other additional information provided from manufacturer.
- Clause 4.2,4.3, 4.4 – Additional information provided.
- Clause 4.4 Timber Cladding to oversize Seating Steps – Additional information provided for manufacturers of branding irons to achieve pyrography effects.
- Clause 4.5 New clause added – Coping to River Wall

#### **1.4**

- Re-issue with document number for planning purposes.
- Drawing number references changed for planning purposes.
- Clause 3.1 and 3.2 Change to add in feature lighting to balustrade (still tbc).
- Clause 3.10 Lighting Column and Lantern Manufacturer Indicative Drawing incorporated

## East Bank River Arun, Littlehampton

### 1.0 Introduction

The materials, furniture and planting chosen are inspired by Littlehampton's surrounding natural context. They have been carefully selected to provide a unified, robust, simple and understated public realm which complement the surrounding natural context and will not compete visually with the more brightly coloured buildings along the waterfront. The character, simplicity and continuity of the materials will re-enforce the sense of place, improve legibility and place the emphasis on the surrounding natural assets of the river and beach. The materials have also been selected because they are robust, they are either durable enough to endure the exposed coastal conditions with minimal maintenance or will weather naturally adding richness to the scheme with time. It is anticipated that materials have been selected to achieve a minimum 20 year lifespan, typically 50+.

The materials follow the Environment Agency Landscape Specification for Works Implementation and Maintenance and the Environment Agency National Environmental Assessment Service Operational Guidance Volume 3: Landscape and Environmental Design Guidance. This will relate to things such as The Environment Agency's Timber Policy, use of pesticides, specification of hard and softworks generally etc.

#### Important to Note

At this stage of the Project (Stage D/E: Detailed Design) there are still a number of design decisions to be made. The suggested materials and furniture listed in this specification are intended to provide a broad indication. The final selection will be dependent on further detailed design, reviewing all product samples together (currently a process we are undertaking), client approval, engineering and buildability review, alongside cost review, this is an iterative process. Any sub-contractors/manufacturers proposed will need to show examples of similar projects undertaken and references to prove quality of workmanship aspired.

This outline specification relates to external finishes above ground only. All foundations, fixings, paving depths and drainage details to be provided by Engineer's.

At this stage the outline specification is to be read in conjunction with the following drawings:

- Landscape Masterplans 1 - 4 (Drawing 3483\_PL\_101 to 104)
- Visualisations (Drawing 3483\_PL\_105)
- Section Elevations (Drawing 3483\_PL\_106)
- Sections (Drawing DCARUN-SK-011, 012, 013, 014, 015 and 463457-CIVIL-103)

## East Bank River Arun, Littlehampton

### 2.0 Surfacing

#### 2.1. Upper and Lower Promenade Areas

##### 2.1.1. Location:

- Upper promenade
- Lower promenade/ pavement to the west of Arun Parade (including parking spaces)
- Surfacing of graded routes/ramps between upper and lower promenade
- Raised crossings (Arun Parade 2 No.)

##### 2.1.2. Material

Exposed Aggregate In-situ Decorative Concrete Paving

##### 2.1.3. Components of mix that determine appearance:

- Aggregate – to be determined from local supply, buff/silver colour, and aggregate size could be a mix of coarse and fine, suggest no bigger than 10mm at this stage. Resistant to freezing and thawing. Non-reactive.
- Buff Colour admixture/pigment – If necessary to achieve desired finish (options for both requested from potential suppliers)
- Washed sand
- The promenade is to have an exposed aggregate/micro etch finish to the surface. Different finishes to be reviewed for appearance. The mixture of aggregate (coarse and fine) in the surface of the concrete should have a minimum PSV (skid resistance) value of 33.

##### 2.1.4. Desired appearance

Colour and aggregate to compliment local beaches to Littlehampton, light buff colour (see images below of similar). Finish being consistent. Movement joints to match colour. To be smooth to enable children to cycle and scooter along the promenade (this will depend on aggregate size, level of retardation and % fines used). Movement joint colour to match paving and coincide with joints on adjacent walls, where possible (e.g. River Wall)



## East Bank River Arun, Littlehampton

### 2.1.5. Potential Suppliers

At this stage the following suppliers have been contacted to obtain samples:

- SLP Projects with Ed Lazenby  
Contact: Iain Christie – 07841 370109, iain.christie@slp-projects.com  
Jamie Anderson - 07500 190909 and 01935 700306, Jamie@lazenby.co.uk
- Lafarge (Tarmac)  
Contact: Steve Walton - 0870 336 8256, 07734 74 3052,  
steve.walton@UK.lafarge.com

### 2.1.6. Laying of In-situ Decorative Concrete Surfacing

Potential sub-contractors:

- Ed Lazenby  
Contact: Jamie Anderson - 07500 190909 and 01935 700306, Jamie@lazenby.co.uk
- Jon English Developments Ltd. Contact details to follow.
- Beton Tool Ltd (recommendation via Lafarge)  
Contact: Robert Pasqualotto, Tel: 07877 367 660

### 2.1.7. Further Information for Costing

Below is the extract from an email from Ed Lazenby:

*“You will appreciate without knowing the site or main contractor schedules it is difficult to give an exact price. Some guide lines for price will be as follows.*

1. *Labour only....this normally consists of main contractor supplying steel and concrete, we would set up, lay, supply and spray retarded, wash off and seal. Budget cost between £17 - £21 sqM*
2. *Supply and fix...we would supply and lay everything. Budget cost £ 60 - £75 sqM.*
3. *Supply only - supply of material cost to be - £145 p m3*

*Our price is loosely based on 150mm C40 coloured concrete (group one or two / Hatfields or SLP). Using local aggregate, surface not seeded. All surfaces sealed. The project could be installed in 5 weeks depending on time of year and how much ground the main contractor can give us”.*

We have also had a quote from Lafarge (Steve Walton)

*Supply of the mix only - £15 - £20/msq (assumes 100mm depth, colour pigment incorporated, local aggregate and concrete).*

## **East Bank River Arun, Littlehampton**

### **2.2. Upper Promenade, Interface with River Wall and upper promenade surfacing**

#### **2.2.1. Location**

Long term, there is a potential deflection of the sheet piles to the River Wall on the landward side. Therefore, we propose a 300 - 400mm wide strip of permeable paving in between the river wall and the in-situ decorative concrete paving that could be replaced in time, and also to allow drainage of water via the flood wall into the river via rectangular weep holes.

#### **2.2.2. Description**

- Reconstituted Stone Setts  
Assumes a row approximately 3 units wide (assuming setts 100 x 100mm plan)  
  
Potential Products:  
Charcon/ Marshalls Conservation Setts or Formpave 'Eco' Setts. To match kerbs and edgings.  
Bedded on a sand bed.

### **2.3. Self-binding gravel to planting areas**

#### **2.3.1. Location**

- All planting beds

#### **2.3.2. Explanation**

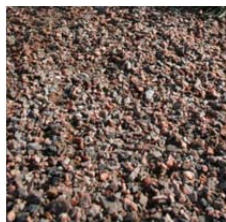
A self-binding gravel to be laid over topsoil over planting areas for a number of reasons:

- The gravel enables a random scattering of planting to mimic a 'spontaneous' coastal planting arrangement, where there is not a continuous cover of plants.
- To reduce maintenance requirements of weeding,
- To reduce potential plant theft,
- To ensure water and air permeability, and
- To reduce the potential for escape of an alternative loose material

#### **2.3.3. Details:**

- Potential Supplier of gravel: CED Ltd. Contact: Giles Heap. Tel: 0044(0)1708 867237. Fax: 0044(0)1708 867230. <http://www.ced.ltd.uk/footpath-gravels/CEDEC/index.htm>, or similar to be accepted.
- Surface course: specially graded decorative aggregates, chemically inert, porous and durable.
- Product Reference: CEDEC Red or CEDEC Gold (trial sample to ascertain). Size: 0-6mm. - Thickness: 50 mm.
- Compacted to produce a firm, regular surface, stable in use.

## East Bank River Arun, Littlehampton



Cedec Red

OR



Cedec Gold



### 2.4. Re-surfacing of Pier Road

Pier Road to be made good by re-surfacing to match existing finish.

### 2.5. Kerbs

#### 2.5.1. Location:

- To Arun Parade

#### 2.5.2. Details:

- Material: Reconstituted stone, silver grey colour.
- To include straights, drop kerbs, quadrant, internal and external angles, and radius kerbs. Square edge kerb. Typical size 145 x 255 x 915mm (laid upright).
- 10mm maximum mortar joint. Colour to match kerb. Flush joint.
- Potential Products/Manufacturers:  
Marshalls Conservation Kerb, Silver Grey. Marshalls. [www.marshalls.co.uk](http://www.marshalls.co.uk). 01422 312000



Typical finish of kerbs, edgings and tactile paving

### 2.6. Edging

#### 2.6.1. Location:

- To material interfaces, e.g. interface with proposed and existing surfaces to provide neat junctions/take up minor irregularities of levels. To provide delineation of parking bays (laid flush).

## **East Bank River Arun, Littlehampton**

### **2.6.2. Details:**

**To interface with existing and proposed surfaces (e.g. to lay insitu-decorative concrete up to at interface with existing tarmac)**

- 2.6.3. Material: Aluminium edging laid flush Potential Products/Manufacturers: Kinley Systems, Haywood Way, Hastings, East Sussex, TN35 4PL | UK Tel: +44 (0)1424 201 111 | Fax: +44 (0)1424 533 004 or Dural (Durosol) Unit 40, Monckton Road Industrial Estate, Wakefield West Yorkshire WF2 7AL United Kingdom Phone: 01924 360110

**To provide delineation of parking bays (flush and interface of existing road and new parking bay)**

- 2.6.4. Material: Reconstituted stone, silver grey colour. Potential Products/Manufacturers: Marshalls Conservation Edging, Silver Grey. Marshalls. [www.marshalls.co.uk](http://www.marshalls.co.uk). 01422 312000

## **2.7. Tactile Paving**

### **2.7.1. Location**

- Corduroy Paving to top and bottom of steps.
- Blister Paving at informal crossing points.
- To demarcate the cycleway route changing.

### **2.7.2. Details**

- Material: Reconstituted stone, silver grey colour (to contrast adjacent in-situ decorative concrete paving)
- Product in accordance with The Disabled Persons Act 1981 and DDA 2004 and to BS EN 1339: 2003.
- Potential Products/Manufacturers:  
Same manufacturer as other reconstituted stone products, to match kerbs and edging Marshalls Conservation Kerb, Silver Grey.

## **2.8. Recessed Service Covers**

All manholes, service/inspection covers for utilities etc. to have recessed covers in-filled with material and coursing to match adjacent paving. (likely to apply to lower footway only).

## East Bank River Arun, Littlehampton

### 3.0 Furniture and Lighting

#### 3.1. Waterfront Balustrade and Gates

##### 3.1.1. Location

Balustrade required at all areas of waterfront requiring edge protection and 4 No. gates required for controlled access to the river (via steps or pontoon).

##### 3.1.2. Details

- Design Intent - As well as providing a safe protection to the waterfront edge there is a desire to maintain a level of transparency, design quality, appropriate materials for a riverfront/coastal context (the sea is to the south) and ensure that crabbing can continue (children currently crab over the existing railing).
- Quantity - There is approximately 458m of waterfront balustrading required to protect the riverside edge. For flood defence reasons the river wall needs to generally come up above the promenade level, therefore the two components (wall and balustrade or balustrade only) provide a 1.1m edge protection to what we are assuming is a solely pedestrian promenade (with very occasional access for maintenance vehicles). Therefore, there are three scenarios for this edge condition:

- 900mm height railing on a 0.2m high river wall (approx. 149 metres)
- 600mm height railing on a 0.5m high river wall (approx. 258 metres).
- 1100 railing on a flush coping where the wall steps down to tie in to existing walls and levels (approx.. 48m). Potentially north and south.

Above dimensions of balustrade split approx.. only.

- Along the length of the waterfront there are a number of restricted access points that will require gates, two for the pontoon in the north and two for the access steps. The gates need to reflect the appearance of the waterfront balustrading as much as possible
- Product:
  - Torbay post and tension wire system featuring stainless steel cables.
  - The addition of feature-lighting in the balustrade is to be considered.
  - Baseplate to fix flush with the proposed river wall, fixing bolts likely to protrude.
  - Material – Ferrocast (an engineering grade polymer cast around a steel core).
  - Finish: Polyurethane paint (colour tbc).
  - It is suggested that to reduce maintenance the manufacturer can employ certain types of fixing and can use a locking adhesive for additional security.
  - Post spacing to be likely up to 2400mm. With this upper limit, the handrails can be set at 2,383mm centres on a 3574mm long precast river wall unit.
  - Special Details – In addition to the different railing heights the railing will need to accommodate changes in direction (typically 90 degrees) and also 'ends'.
  - Gates: There are gates required at each of the 2 river access steps. The manufacturer to develop a design for these that ties in to the waterfront balustrade in each location.



## East Bank River Arun, Littlehampton

### 3.1.3. **Manufacturer**

Marshalls  
Contact: Adrian Briggs  
Marshalls Street Furniture  
Tel: 01422 312374 or 0870 600 2425 or 07764 781615  
adrian.briggs@marshalls.co.uk  
www.marshalls.co.uk

Basis of Design: Manufacturer in liaison with designer, engineer and contractor to develop design and produce all shop drawings for construction.



Image: Marshalls Torbay post and tension wire system, Torquay (Design by LDA Design)

Full Height (1.1m shown, Littlehampton will use 1100mm, 900mm and 600mm high and will incorporate no lighting)

## East Bank River Arun, Littlehampton

### 3.2. Balustrade to top of ramp walls, to front/return of ramp walls and handrails to steps and ramps.

- Balustrade to reflect design and materials used in waterfront balustrade.
- Likely to be vertical angle opposed to providing an overhang because of the space available.
- Manufacturer to develop a design in conjunction with Landscape Architect and Engineer.
- The addition of feature-lighting in the balustrade is to be considered. At this stage assume lighting to be a linear LED spotlight. Such as Woodhouse Lec Belval, superwatt with a linear lens for a handrail section – Ref 5630 (see column lighting for contact details). Quantity to suit extra budget being made available by ADC for this component.

### 3.3. Bespoke Timber Seat – Type A (Forward facing with Backrests)

- Bespoke benches constructed from European Oak and marine grade stainless steel, ferrocast or anodised aluminium.
- Size: Approx. 5.4m x 0.81m (plan)
- Quantity: 6 No.
- All timber to meet EA timber policy. Contact with specialist external furniture manufacturer (Woodscape) suggests that European Oak with a minimum depth of 40mm will be fit for purpose (in lieu of tropical hardwood). Planed finish. Timber to have life length of 20 years min. All fixings to be countersunk and hidden.
- Basis of Design: Landscape Architect to develop to detail design stage and then external furniture designer/manufacturer to develop shop drawings for manufacture.

Potential Manufacturer: Woodscape

Contact: Ashley Tarry  
Woodscape Ltd  
1 Sett End Road West  
Shadsworth Business Park  
Blackburn  
Lancashire  
BB1 2QJ  
Tel: 01254 685185



## East Bank River Arun, Littlehampton

Similar timber benches

### 3.4. Bespoke Timber seating – Type B (Dual facing with backrests and arm rests)

Bespoke benches constructed from European Oak and marine grade stainless steel, ferrocast or anodised aluminium. With and without backrest.

- Assume:
- 3 No. 3m x 1m and 1 No. 1.0m x 1m
- All timber to meet EA timber policy. Contact with specialist external furniture manufacturer (Woodscape) suggests that European Oak with a minimum depth of 40mm will be fit for purpose (in lieu of tropical hardwood).
- Timber to have life length of 20 years min
- All fixings to be countersunk and hidden.
- Planed finish.
- Basis of Design: Landscape Architect to develop to detail design stage and then external furniture designer (such as Woodscape) to develop shop drawings for manufacture.
- Potential Manufacturer: Woodscape

Contact: Ashley Tarry, Woodscape Ltd, 1 Sett End Road West, Shadsworth Business Park, Blackburn, Lancashire, BB1 2QJ  
Tel: 01254 685185



Similar timber benches (although Littlehampton will likely incorporate a backrest and arm rest along part of the length).

## East Bank River Arun, Littlehampton

### 3.5. Bespoke 'pebble' seats

- Bespoke seats to reflect shape and aesthetic of shingles on the adjacent beach.
- Quantity: 5 No. 2 types.
- Size: Approximately 0.5m high x 2m long x 1m wide (but will vary because of nature of organic shape and dependent on type).
- Material: Precast Concrete. Mix design to be confirmed. Assume at this stage, white/Light grey/ silver colour with granite fines or reconstituted stone. To match/compliment river wall, pedestrian steps and ramp support walls. Refer to section 4.2 for description of likely mix appearance.
- Acid etch finish to all sides
- Gravity Fixed
- Basis of design:
  - Landscape Architect to develop design in 3D
  - Sample panels of finish to be provided for inspection to agree finish (different levels of acid etch). Preferred sample to be agreed prior to production.
  - Shop drawings produced by manufacturer, for comment by engineer and LA.
  - 1:1 MDF prototype made by manufacturer (CNC), for comment
  - 1:1 Fibreglass mould to be produced and inspected.
  - Seats poured and then retardant added to provide acid-etch finish.
  - 1No. precast production version of the seat is to be inspected and agreed with Landscape Architect and Engineer prior to production of successive seat units.
- Potential manufacturers:
  - SLP Precast & SLP Colourtone, 5 Holly Road, Red Marsh Industrial Estate, Thornton-Cleveleys, Lancashire, FY5 4HH. 01253 857784 F 01253 455248 or equivalent approved.
  - Cornish Concrete Products Ltd, Contact: Bill Dove - Tel: 01872 864808, Fax: 01872 863606.
  - Evans Concrete. Contact - Matt Perry, Tel: 01773 529214 or 01733 529200, Email: matt.perry@evansconcrete.co.uk. (<http://www.evansconcrete.co.uk/products/precast-concrete-hard-landscaping/>)
  - Thorp Precast Apedale Road. Chesterton, Newcastle-Under-Lyme. Staffordshire. ST5 6BN. Tel: 01782 561155 ([http://www.thorpprecast.co.uk/product/public\\_realm.html](http://www.thorpprecast.co.uk/product/public_realm.html) )

## East Bank River Arun, Littlehampton



(above: pebbles off the beach at Littlehampton that we are aiming to stylistically match)



(a similar scheme LDA Design built in Blackpool)

### 3.6. Proprietary Litter Bins

- Product Reference: WaterSide Standard Litter Bin MK 2
- Size: Height -1015mm, Width -850mm, Depth -450mm, Bin Capacity -130L, Weight -180Kg
- Material: Polyurethane (Ferrocast).
- Finish: Dark Grey matt to be specified to match waterfront balustrade, cycle stands and other furniture components (standard would be black gloss which we don't want)
- Tri-key lock as standard (tbc by Arun DC)

## **East Bank River Arun, Littlehampton**

- Quantity: As shown - 10 No. (tbc by Arun DC)
- Supplier:
  - Marshalls Plc
  - Landscape House
  - Premier Way
  - Lowfield Business Park
  - Elland
  - HX5 9HT



Finish shown in gloss. Actual finish would be matt dark grey.

### **3.7. Proprietary Cycle Stands**

- Product Reference: Sheffield Cycle Stand (Senior)
- Size: 950 x 770mm
- Material: Polyurethane (Ferrocast). Finish Dark Grey to match other furniture.
- To be submerged fixed.
- Quantity: 10 No.
- Supplier:
  - Marshalls Plc
  - Landscape House
  - Premier Way
  - Lowfield Business Park
  - Elland
  - HX5 9HT

## East Bank River Arun, Littlehampton



Finish shown lighter than actual finish required.

### 3.8. Proprietary Fingerpost Signage

- Product Reference: Campus Fingerpost Signage
- Quantity: 3 No.
- Finish: Anodised aluminium (dark grey to match ferrocast furniture).
- Supplier: WOODHØUSE  
Spa Park  
Leamington Spa  
Warwickshire  
CV31 3HL  
United Kingdom  
  
T +44 (0)1926 314313  
F +44 (0)1926 883778



### 3.9. Waterside Safety Signage/buoys

- Necessary waterside safety signage to be incorporated into new design. For costing assume a like for like replacement from existing. However, a review of this will need to be undertaken.

## East Bank River Arun, Littlehampton

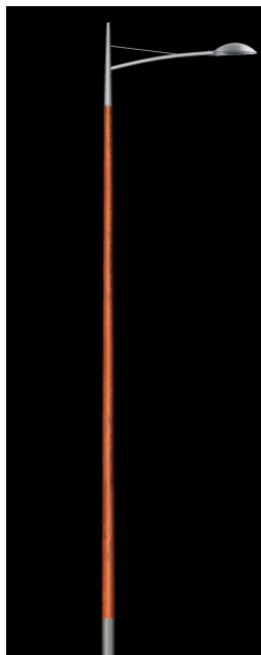
### 3.10. Proprietary Lighting Columns and Lanterns

#### 3.10.1. Location

Alongside Pier Road and Arun Parade in the lower promenade area and in the upper promenade area to the south.

#### 3.10.2. Description

- All proposed street lighting design and calculations shall be in accordance with BS5489-1 & BS EN13201-2: 2003 and satisfy highways standards.
- Column to be Woodhouse (now part of the Marshalls group) Aubrilam Dome XL, tapered cylindrical shaft in glued laminated Douglas Fir with GLULAM and FSC certification. Designed according to Aubrilam HTE-E process and conforming to EN 335, EN 350 and EN 386 standards. Page 67 Columns and Urban Furniture Catalogue ([http://www.woodhouse.co.uk/downloads/dl/file/id/669/dome\\_column\\_brochure.pdf](http://www.woodhouse.co.uk/downloads/dl/file/id/669/dome_column_brochure.pdf)).
- Lantern: Bussy Bracket – Eclatec Moana
- Outline lighting study by Woodhouse (02.04.2013) has determined a requirement for 13 No. 10m high double lanterns (to light road and promenade) and 2 No. 10m high single columns (to light promenade only).
- Finish – Naked.
- In addition to client team, lighting is subject to approval by SSE Contracting (Arun DC Lighting Contractors).

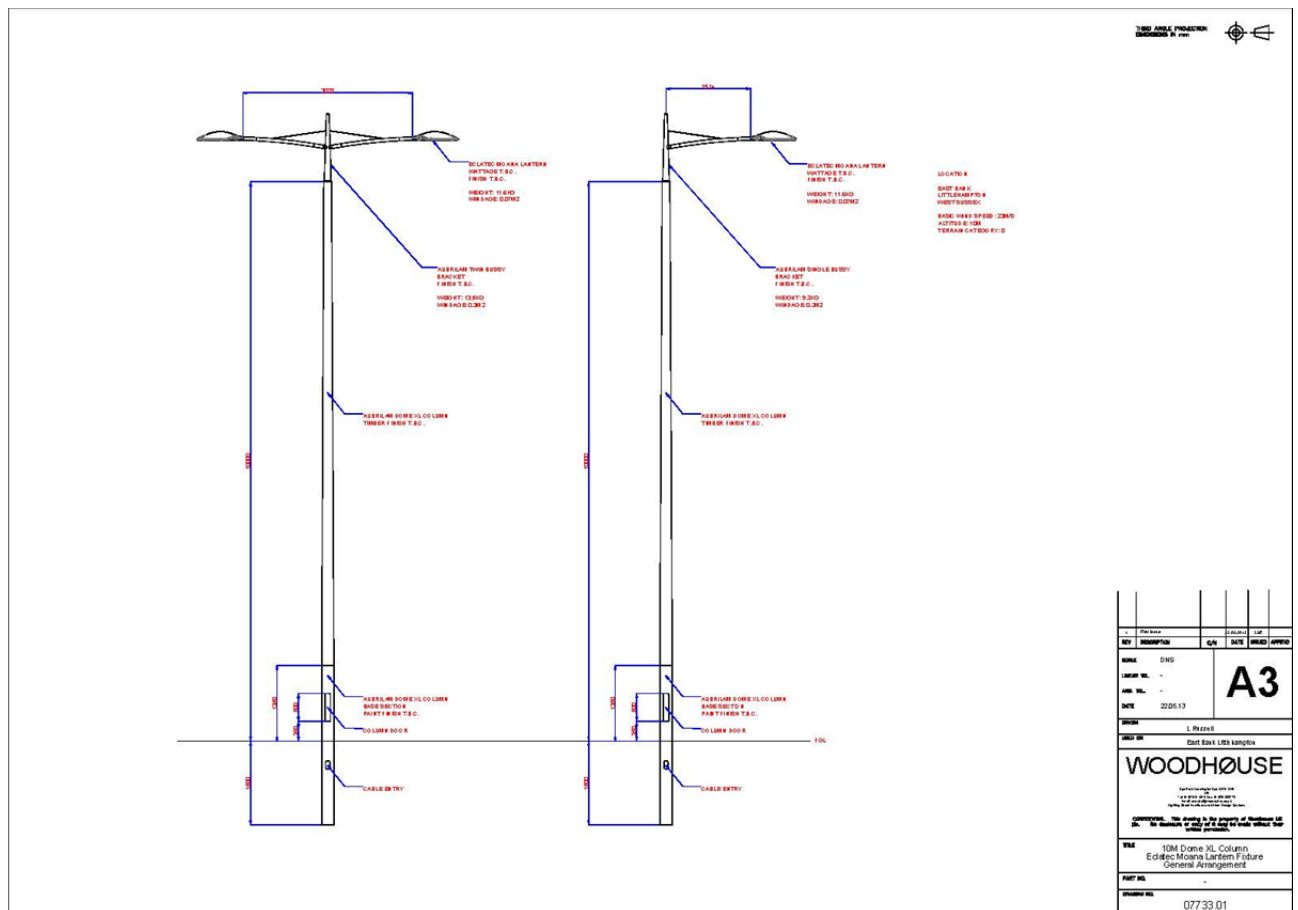


Single lantern shown

- Supplier:  
Woodhouse (now part of the Marshalls group):  
Contact: Simon Newcombe. Tel: 01926 314313.  
[snewcombe@woodhouse.co.uk](mailto:snewcombe@woodhouse.co.uk)



## East Bank River Arun, Littlehampton



Woodhouse Drawing – Indicative general arrangement of column and lantern.

## East Bank River Arun, Littlehampton

### 4.0 Walls and Steps

#### 4.1. Low steps to planting terraces

- Material: Corten steel up-stands or cladding. To create 3 tiers of planting (typically 3 x 500 high steps, to take up 1.5m).
- Thickness of Corten to be determined by Engineer/Contractor.



Image shown for typical appearance of wall, not for planting.

### Concrete Components

#### 4.2 Pedestrian Steps

#### 4.3 Support Walls to Promenade Ramps

#### 4.5 Coping to River Wall

### General

It is still to be confirmed if the steps and support walls to the ramps are to be precast or in-situ. For buildability and cost reasons the likelihood is that they will be cast in-situ; however pre-casters are reviewing the design to ascertain if concerns that have been raised can be addressed. The coping to the river wall will be pre-cast.

Desired appearance of all Concrete Components:

- Colour: To compliment in-situ decorative concrete surfacing.
- Finish: Light Acid etched to all visible faces (including step/wall sides, where appropriate). Smooth appearance to contrast exposed aggregate surfacing.
- Joints to match concrete colour and align with in-situ decorative concrete paving. Option to use aggregate fines in the mix.
- Mix design to be as sustainable as possible (local sand, aggregates etc.) to achieve desired finish.
- Desired Colour tone (options):



**East Bank River Arun, Littlehampton**

Precedent Photos:



(Ref: Cleveley's Promenade)



(Ref: Olympic Park, LDA Design)

## East Bank River Arun, Littlehampton

### 4.2. Pedestrian steps

#### 4.2.1. Location

- Standard: 7 No. sets of 7 steps picking up major desire lines. To take up 1.3m level change (typically, although landform at the top or bottom to take up any level differences, not the actual step unit). Aim to standardise mould for all 7 units.
- Straight and curved: 3 sets of steps of varying extent to take up level changes at tie-ins with existing typically. Running alongside ramps with landform effectively burying the steps to marry in the levels.

#### 4.2.2. Description

- In-situ or precast concrete (likely insitu). Refer to general note for finish.
- Size of individual step: Expect Riser: 170mm, Tread: 375mm
- To incorporate straight chamfer front edge to step and two 55mm recesses for create shadow or accommodate warning/slip resistance strip.
- To meet the necessary slip resistance standards for steps. Option for tread to have different finish to riser (only if necessary for slip resistance).
- To comply with Building regulations 2000, Part M, BS 8300:2009 +A1:2010 and Equality Act 2010.
- Appropriate finish to all visible faces (including sides, where applicable).
- Extent: Standard - One set of Steps 4m wide x 1.3m high.  
Straight and curved - Varies. Levels as per masterplan drawing.

#### 4.2.3. If Precast - Potential concrete manufacturers:

At this stage the following manufacturers have been contacted to obtain samples:

- Cornish Concrete Products Ltd, Contact: Bill Dove - Tel: 01872 864808, Fax: 01872 863606.
- Evans Concrete. Contact - Matt Perry, Tel: 01773 529214 or 01733 529200, Email : matt.perry@evansconcrete.co.uk. www.evansconcrete.co.uk

Other potential manufacturers:

- Thorp Precast Apedale Road. Chesterton, Newcastle-Under-Lyme. Staffordshire. ST5 6BN. Tel: 01782 561155
- Mooncrete Precast Concrete Ltd Contact Neville Moon, 43a Hardingham Road, Hingham, Norwich, Norfolk NR9 4LXl, Tel: 01953 850945, Fax: 01953 851834.
- SLP Precast Concrete, Contact Iain Christie, 5 Holly Road, Red marsh Industrial Estate, Thornton-Cleveleys, Lancashire FY5 4HH. iain.christie@slp-projects.com, Mobile No. +44 (0) 7841 370109.

Marshalls.

Contact: Roger Markham

## **East Bank River Arun, Littlehampton**

Marshalls Street Furniture  
Tel: 01422 312374 or 0870 600 2425 or 07764 781615  
adrian.briggs@marshalls.co.uk  
www.marshalls.co.uk

### **4.2.4. If Insitu - Potential Sub-Contractors**

- Beton Tool Ltd (recommendation via Lafarge)  
Contact: Robert Pasqualotto, Tel: 07877 367 660
- More to follow.

## **4.3. Walls to pedestrian ramps**

### **4.3.1. Location:**

- Visible walls to the 2 pedestrian ramps, rear wall and front/return wall.

### **4.3.2. Description:**

- In-situ or precast concrete (likely insitu). Refer to general note for finish.
- Typically to take up 1.4m level change max.
- Top of back wall to run horizontal flush with promenade.
- Top of front/return wall top of coping to follow consistent profile of the ramp.
- Both walls to run flush with ground level and balustrading to provide edge protection.
- Where a corner or end is visible to incorporate straight chamfer front to match river wall chamfer
- Contractors initial bill of quantities assumes 106 linear metres of walling
- Assume anti-graffiti/dirt protective coating to all visible faces.

### **4.3.3. Potential pre-cast concrete manufacturers:**

See 4.2 Pedestrian Steps

## **4.4. Timber Cladding to oversize Seating Steps**

### **4.4.1. Location**

- Sections of the concrete stepped terraces to be clad using timber. To create 3 tiers of terraces (typically 3 x 500 high steps, to take up 1.5m).

### **4.4.2. Description**

- Timber – European Oak to be supplied in accordance with the EA timber policy. Minimum of 40mm thick sections (NOT standard 28mm decking thickness, as per advice received from potential manufacturer).
- Potential to fabricate on steel panels off site. Hidden fasteners

## East Bank River Arun, Littlehampton

- Special features: Areas along the timber steps to have site specific narrative/ pattern inscriptions 'burnt' into the timber using a method of branding called Pyrography. Landscape Architect to supply location, size and details of this. For costing, assume coverage for an area 5msq.
  - Potential manufacturers of custom made branding irons.  
www.eyreandbaxter.co.uk, <http://www.equibrand.co.uk>, [www.tiranti.co.uk](http://www.tiranti.co.uk)
- Potential Manufacturers:
  - Woodscape

Contact: Ashley Tarry, Woodscape Ltd, 1 Sett End Road West, Shadsworth Business Park, Blackburn, Lancashire, BB1 2QJ. Tel: 01254 685185

LDA Design are currently working with Woodscape on the Phase II bleacher style seating illustrated below that was installed for the Olympic Park and now refined and proposed in additional areas for the legacy park. Therefore, they have benefitted from the lessons learnt on this project.

- Woodhouse (now part of the Marshalls group): Contact: Simon Newcombe. Tel: 01926 314313. [snewcombe@woodhouse.co.uk](mailto:snewcombe@woodhouse.co.uk)



Example of similar (LDA Design)



## East Bank River Arun, Littlehampton



Example: Patterns of local flora and fauna to be 'burnt' into the timber surface using custom made branding irons.

### 4.5. Coping To River Wall

#### 4.5.1. Location

Precast concrete coping unit is to be fixed to the underlying in-situ concrete/river flood defence piling. The coping will accommodate the waterfront balustrading to top.

#### 4.5.2. Description

- L-shaped coping units at a nominal length of  $2 \times 1787\text{mm} = 3574\text{mm} \times 450\text{mm}$  wide.
- Two basic sections (above ground visible height listed, engineer to confirm below ground required)  
: Approx. 149LM at 200mm high (dim above ground visible)  
: Approx. 306LM at 500mm high (dim above ground visible, although varies to south, see drawing)
- Two fixings (bolts) per unit to the underlying in-situ concrete.
- Assume straight vertical and horizontal profile with straight chamfered edge to top two visible edges (and ends where appropriate).
- Recess cast in to the top to receive balustrade baseplate, so baseplate will sit flush with top of wall (bolts however will be protruding). At this stage balustrading at 2,383mm centres on the 3574mm long unit, using a repeating pattern of unit.
- Unit to incorporate rectangular weep holes and drainage void to enable water to drain from landward to river side.
- Potential 'Specials' - Corner pieces/specials may be necessary where changes in direction/angle dictate, although intention is to minimise non-standard units and moulds generally. Special end pieces (with radii or chamfer to 3 top sides) required where walls

## **East Bank River Arun, Littlehampton**

finish or step down to accommodate levels. Flush access to pontoons and steps will be a precast 'paver' unit at finished ground level to match the river wall coping.

- Curves formed by a series of straights rather than large radius curves, nominal joint widths between units of 20mm to straight sections and tapering to joints to form curves.



**East Bank River Arun, Littlehampton**

**5.0 Planting**

**5.1. Topsoil**

**5.1.1. Location:**

- To all linear planting terraces running to the east of the Upper Promenade.

**5.1.2. Description**

- 450mm depth
- Topsoil to British Standard BS3882:2007 suitable for application.
- The soil shall have a defined granular or blocky structure and shall be free from non-soil material, brick and other building materials and wastes, hydrocarbons, plant matter, roots of perennial weeds and any other foreign matter or material or substance that would render the topsoil unsuitable for use.

**5.2. Subsoil**

**Location:**

- To all linear planting terraces running to the east of the Upper Promenade.

**Description**

- 200mm Depth
- Free draining. Layer under the subsoil.

**5.3. Plants**

**5.3.1. Location:**

- To all linear planting terraces running to the east of the Upper Promenade.

**5.3.2. Description:**

- Character of planting to mimic a 'spontaneous' coastal planting arrangement (naturalistic, not formal), where there is not a continuous cover of plants and plants appear sporadically as if they have naturally colonised. Coastal plant species, preferably indigenous to West Sussex coastline or suitability for coastal environment, attractiveness and low maintenance. Typical species: Biting stonecrop, Meadow Pipit, Yellow horned poppy, sea bindweed, Sea Thrift.
- Minimum size of plants to be 2L pot, container grown, although depends upon species.
- For the purpose of costing assume that 60% of all planting areas will be covered in plants at a density of 8 plants per m<sup>2</sup>.

**East Bank River Arun, Littlehampton**



Indicative character of planting



## **REACH 4 & 6 | LITTLEHAMPTON**

### **TREE SURVEY REPORT**

14th May 2013

**Our Ref: JSL2151\_770\_ Rev A**

**RPS**

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## QUALITY MANAGEMENT

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Prepared by:	<b>Chris Chambers</b>
Authorised by:	<b>David Cox</b>
Date:	<b>14th May 2013</b>
Project Number/Document Reference:	<b>JSL2151_770_ Rev A</b>
Status	<b>For Comment</b>

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## EXECUTIVE SUMMARY

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- This report documents the findings of Tree Surveys of two separate but closely located sites, the grounds of Reach 4 and Reach 6, both on the north-east shore of the River Arun at Littlehampton, West Sussex.
- The tree surveys were undertaken by RPS on the 9<sup>th</sup> of April 2013.
- This report has been produced in accordance with the BS 5837:2012 "Trees in Relation to Design, Demolition and Construction - Recommendations"
- Arun District Council confirmed that there are no Tree Preservation Orders currently in place on the site (08/05/2013). Trees covered by a Tree Preservation Order are protected under the Town and Country Planning Act 1990 (Trees Regulation 2012) and the local authority must be consulted and permission sought for any works that may affect them.
- The Reach 4 site is situated within the River Road Conservation Area, administered by Arun District Council. Trees in Conservation Areas are protected and no cutting, removal, wilful damage or destruction of any tree over 75mm in diameter at 1.5m above ground level is allowed without giving prior notification to the LPA (a section 211 notice).
- The tree cover on Reach 4 is limited, consisting of four immature Sycamore trees set in low brick planters, partially underplanted with amenity shrubs. The Reach 6 site is vegetated with areas of road-side structure planting, remnant outgrown hedge, scrub regeneration, and occasional larger trees of low to moderate amenity value.
- Trees can offer many benefits, including the provision of visual amenity, softening or complementing the effect of the built urban environment, and adding maturity to new developments by making places more comfortable in tangible ways by contributing screening and shade, reducing wind speed and turbulence, intercepting snow and rainfall, and reducing glare.
- All retained trees within close proximity of any proposed development will require protection in accordance with BS5837: 2012.

# 1 INTRODUCTION

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- 1.1 The Tree Survey was commissioned by Halcrow. The tree survey was undertaken by RPS on the 9<sup>th</sup> of April 2013. The weather conditions overcast with light rain.
- 1.2 This Tree Survey Report is a qualitative survey of the existing trees within and immediately adjacent to land at Reach 4 and Reach 6 Littlehampton in West Sussex.
- 1.3 The purpose of the survey is to assess the landscape and visual amenity value of the existing trees and to identify the constraints associated with the trees prior to any potential redevelopment of the site. An assessment of the quality of the trees has been made, with reference to the categories and sub-categories listed within Table 1 - BS5837:2012<sup>1</sup>.
- 1.4 The Tree Survey identifies plant species and size. The survey also involved a qualitative assessment of the life stage, general (apparent) physical condition and estimated remaining contribution (in years) of each individual tree or, where more appropriate, a group of trees. A visual inspection of the general health and condition of the trees was completed from the ground, further more detailed surveys may be required to completely detail the comprehensive condition of certain trees.
- 1.5 The survey information was recorded on the attached schedules JSL2151\_750 to 751 (Appendix 1) and RPS drawings JSL2151\_702 & 703 (Appendix 2). In addition to presenting the amenity value of the trees the root protection area (RPA) is also defined.
- 1.6 The Tree Survey were carried out in general accordance with the requirements set out in BS 5837:2012 "Trees in Relation to Design, Demolition and Construction – Recommendations".

## **Scope of the Survey and Limitations**

- 1.7 The findings of this survey are not valid in adverse or unpredictable weather conditions or for any failure due to 'force majeure' or unpredictable events.

<sup>1</sup> British Standards Institute, (2012); 'British Standard (BS5837) "Trees in Relation to Design, Demolition and Construction - Recommendations"

## 2 SITE LOCATION

---

- 2.1 The survey addresses two separate but closely located sites, the grounds of Reach 4 and Reach 6, both on the north-east shore of the River Arun at Littlehampton, West Sussex. The survey area of Reach 4 is approximately 0.14 Ha in size and is centred on Ordnance Survey Grid Reference TQ 023 021. Reach 6 is roughly 6.0 Ha in size, centred on OS Grid Reference TQ 015 028.
- 2.2 Reach 4 chiefly comprises paved hard-standing, amenity shrubs and trees in planters. Reach 6 consists of remnant structures, unmanaged waterside grassland, scrub and roadside tree and shrub groups.
- 2.3 Littlehampton, West Sussex is a seaside resort town and civil parish in the Arun District of West Sussex, England, on the east bank at the mouth of the River Arun, located approximately 50 miles south-south-west of London.



### 3 SURVEY METHODOLOGY

- 3.1 The tree survey involved a visual inspection from the ground of individual specimens and groups of trees in order to record their amenity value, management recommendations and dimensions. Where observed, the general condition of all the trees has been noted. The survey does not constitute a full arboricultural condition assessment involving the detailed inspection of trees in relation to their structural condition, decay, and any other physical and pathogenic defects.
- 3.2 Trees were not climbed or inspected below ground level and inaccessible trees will have best estimates made about the location, physical dimensions and characteristics.
- 3.3 The locations of the trees were based upon topographic survey supplied by Halcrow Group Ltd in Feb 2013 (called '30613\_River Arun Master Drawing-Original Topo' and '30613\_River Arun Reach 6 Topo 2D')
- 3.4 The survey assesses individual trees and groups of trees for quality and benefits within the context of proposed development. The quality of each tree or group of trees has been recorded by allocating it to one of four categories as described in paragraph 3.6. These categories have been differentiated on the tree survey plan (JSL2151\_701 - 703) by colours.
- 3.5 The survey information was recorded on the attached schedule (Appendix 1) in general accordance with the guidance contained within Section 4 of BS 5837:2012 "Trees in Relation to Design, Demolition and Construction - Recommendations". These should be read in conjunction with RPS drawings JSL2151\_701 - 703 in appendix of this document.
- 3.6 The information recorded includes the following: -
- 3.7

<b>Tree Ref No:</b>	Sequential reference number of trees or groups of trees. Avenues, woodlands and hedgerows were also recorded on the tree survey plan. # - denotes inaccessible trees (best estimates are made about the location, physical dimensions and characteristics.)				
<b>Species</b>	Species listed by common name, with scientific names.				
<b>Height (m)</b>	Estimated height of canopy to nearest metre.				
<b>Branch Spread</b>	branch spread, taken as a minimum at the four cardinal points, to derive an accurate representation of the crown				
<b>Stem diameter @ 1.5m (m)</b>	Estimated diameter of trunk at 1.5m above ground level in metres unless otherwise indicated, multi-stemmed trees being measured in accordance with Annex C: BS5837				
<b>Existing height above ground level</b>	To inform on ground clearance, crown/stem ratio and shading the estimated height of the canopy above ground level is noted. Where significant the height of first branch and direction of growth will be included.				
<b>Stem No.</b>	Number of stems (if necessary) of individual tree.				
<b>Life Stage</b>	Expressed as:-	Y SM EM M	(Young) (Semi-mature) (Early-mature) (Mature)	OM V D	(Over-mature) (Veteran) (Dead)

<b>Physical Condition</b>	Apparent condition expressed as the following categories, based upon a brief visual inspection from the ground only:-	Good Fair Poor Dead
<b>Comments / Management Recommendations</b>	General observations, particularly of structural and/or physiological condition (e.g. the presence of any decay and physical defect), and/or preliminary management recommendations and potential for wildlife habitats (not exhaustive).	
<b>Estimated remaining contribution (years)</b>	Estimated remaining contribution, in years (<10, 10+,20+,40+)	
<b>Tree Quality Assessment Value: <u>Category</u></b>	Criteria grading with regards to Table 1: BS 5837:2012, expressed as:-	<b>A</b> (Trees/Vegetation of high quality and value) <b>B</b> (Vegetation of moderate quality and value) <b>C</b> (Trees/Vegetation of low quality and value) <b>U*</b> (Those in such a condition that they cannot realistically be retained as living trees in the context of the current land use for longer than 10 years)
	* Category U trees can have existing or potential conservation value which might be desirable to preserve.	
<b>Tree Quality Assessment Value: <u>Sub - Category</u></b>	Criteria grading with regards to Table 1: BS 5837:2012, expressed as:-	<b>1</b> (Trees with mainly <i>arboricultural</i> value) <b>2</b> (Trees with mainly <i>landscape</i> value) <b>3</b> (Trees with mainly <i>cultural / conservation</i> value)

- 3.8 It is recommended that further arboricultural assessments be undertaken in order to assess the full health and safety of all trees which may possess structural or pathogenic conditions.

## 4 APPRAISAL AND RECOMMENDATIONS

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### Generally

- 4.1 The surveyed trees consist of a mix of both native and ornamental species of a young to early mature age range.
- 4.2 The trees and tree groups identified with moderate / high amenity value should, where possible, be integrated into any proposed layout of the site's redevelopment.

### Reach 4

- 4.3 The tree cover on Reach 4 is limited, consisting of four immature Sycamore trees set in low brick planters, partially underplanted with amenity shrubs. Sycamore is a non-native, vigorous species that could rapidly outgrow their current planting location within the raised planters. These trees have a limited useful life and are accordingly of low amenity value.

### Reach 6

- 4.4 The Reach 6 site is vegetated with areas of road-side structure planting, scrub regeneration, remnant outgrown hedge, and occasional larger trees of low to moderate amenity value.
- 4.5 The majority of the tree cover comprises of typical native highway structure planting approximately 15-25 years old.
- 4.6 The most remarkable vegetation on the site is a T5, a 20 metre high Lombardy Poplar with some skyline presence and the roadside embankment planting G3 comprising Common Ash, Austrian Pine, Sycamore, Willow, and Lombardy Poplar with value as a landscape buffer.
- 4.7 A number of native Ash are present on the site chiefly as multi-stemmed trees offering some skyline amenity.
- 4.8 Much of the remaining vegetation consists of typical scrub regeneration Bramble, Common Hawthorn, Field Maple, Sycamore of limited amenity value

### Planning Considerations

- 4.9 There are a number of trees that were identified with limited amenity value and some have a limited useful life expectancy. New tree planting opportunities should be considered as part of any potential redevelopment, this will help to broaden the age diversity of the tree cover within the area. Sufficient space should be provided for species with significant stature to grow out into maturity.
- 4.10 Given recent concerns about the potential spread of Ash dieback *Chalara fraxinea* infection in the UK and the current regulations regarding the movement of wood arisings all green and woody waste generated by the tree works should be chipped and larger material cut and neatly stacked in situ as deadwood habitat. Refer Forestry Commission | Ash Dieback Disease Factsheet <http://www.forestry.gov.uk>.

- 4.11 Arun District Council confirmed that there are no Tree Preservation Orders currently in place on the site (08/05/2013). Trees covered by a Tree Preservation Order are protected under the Town and Country Planning Act 1990 (Trees Regulation 2012) and the local authority must be consulted and permission sought for any works that may affect them.
- 4.12 The Reach 4 site is situated within the River Road Conservation Area. Trees in Conservation Areas are protected and no cutting, removal, wilful damage or destruction of any tree over 75mm in diameter at 1.5m above ground level is allowed without giving prior notification to the LPA (a section 211 notice).
- 4.13 Under the UK planning system, local authorities have a statutory duty to consider the protection and planting of trees when granting planning permission for proposed development. The potential effect of development of trees, whether statutorily protected (e.g. by a tree preservation order or by their inclusion within a conservation area) or not, is a material consideration that is taken into account in dealing with planning applications.
- 4.14 Trees can offer many benefits, including the provision of visual amenity, softening or complementing the effect of the built environment, and adding maturity to new developments by making places more comfortable in tangible ways by contributing screening and shade, reducing wind speed and turbulence, intercepting snow and rainfall, and reducing glare.
- 4.15 Trees may have the potential to provide valuable habitat for significant and/or protected species. It is recommended that consideration be given to the requirement for ecological surveys.

## **Design and Site Layout Considerations**

### **Root Protection Areas**

- 4.16 Where there are no significant constraints to root development present the Root Protection Areas (RPA) have been plotted onto the Tree Survey Plan as circles, with the tree located centrally, extending to encompass the area of ground, and thus the rootable soil volume, required for protection.
- 4.17 The Root Protection Area (RPA) can be adjusted where physical constraints or topographical features limit root activity in a particular area, however, the total area should remain the same. Prior to any adjustment of the trees RPA zones the changes should be assessed by an arboriculturalist. During any site planning exercises the current and future growth potential of the trees should be considered.
- 4.18 In accordance with BS83:2012, where the tree root spread is considered to have been significantly influenced by site conditions the trees RPA can be plotted as a polygon. The plotted polygon should be of the same area as it would be as a circle and its shape reflects an arboricultural assessment of likely root distribution.
- 4.19 The RPA for single stem trees broadly equates to a radius 12 times the stem diameter of the tree at 1.5m above ground level or the extent of canopy spread, whichever is the greater. For multi-stemmed, low branching trees or those with trunks with an irregular girth the point of stem diameter measurement is adjusted in consideration of these factors and in accordance with the illustrations in BS5837:2012 (Annex C).

- 4.20 The RPA should become an exclusion zone during construction works and for any development. It should be fenced-off and protected in accordance with BS5837:2012. The canopy is likewise susceptible to damage during construction work and requires similar protection.
- 4.21 No activities that result in excavations, changes in level or soil compaction should take place within the RPA of any retained trees, especially older mature trees. This would include the storage of materials, any construction work, trafficking by vehicles or even excessive trafficking by pedestrians.
- 4.22 If some form of construction has to take place within the RPA then certain measures need to be adopted to avoid disturbance or damage to the roots and to maintain moisture infiltration and gaseous diffusion into the soil.
- 4.23 Services likewise should be routed outside the existing or potential root zone of trees. Where it is unavoidable, then certain measures should be employed to avoid damage to the trees larger roots.
- 4.24 The location and siting of new facilities near trees should consider the potential impact on and conflict with both tree roots and canopy. This should take into account the ultimate size of existing young and middle-aged trees at maturity. Conversely the impact of the tree on the activities should also be considered with regard to obstruction, shading, leaf fall and root action. These are problems that can be managed provided sufficient space is allowed for.
- 4.25 New tree planting opportunities should be included as part of any redevelopment proposals, these designs should allow sufficient space for the ultimate height and crown spread of the trees at maturity.
- 4.26 The tree cover on the Reach 6 site comprises of closely planted native structure planting .Given that the tree structure is congested it is fair to assume that the root systems will be dense, fused, shallow, and likely located primarily in the upper 500mm of soil. Consequently, this vegetation is capable of significantly influencing the moisture content and volume of the surrounding soil and its removal may result in heave.
- 4.27 Heave is effectively the reverse of subsidence and is caused by the soil becoming 're-wetted' as a result of an increase in ground water that would have otherwise been taken up by the trees. This often results in expansion of the sub soil with the potential for resultant damage to structures above.
- 4.28 To allow as much time as possible for the ground to re-adjust we would recommend that, where practicable any construction proposed within the area previously occupied by the tree roots is carried out as late as possible within the construction programme. In addition to this it is recommended that any significant roots should be removed prior to commencing redevelopment to allow a natural rebalancing of the soil's moisture content and so reduce the potential for heave.

#### **Trees and Management of Health and Safety**

- 4.29 It is recommended that a programme of periodic arboricultural assessments be undertaken in order to regularly assess the full health and safety of all trees both in full leaf and bare stemmed. The assessments should prioritize areas based on levels of access and presence of target (i.e. exposure of people to hazard) and accord with arboricultural advice, taking account of relevant

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factors (where known) that affect safety such as the age class, condition, size and species of the trees.

# APPENDIX 1

---

Tree Survey Schedules JSL2151\_750 - 751

**Tree survey schedule**

Site: Reach 4, Littlehampton  
 Project / Schedule ref: JSL2151\_750  
 Survey dates: 09/04/13  
 Drawing reference: JSL2151\_701

Surveyor: David Cox  
 Status: For Comment  
 Revision:  
 Notes:



ref. no.	Species	height (m)	Crown spread (m)				Stem dia.(m)	Stem no. at 1.5m	Height of crown clearance (m)	Life stage	Structural Physiological condition	General observations Management recommendations	Estimated remaining contribution (years)	Tree Quality Category (BS5837)
			N	E	S	W								
1	Acer pseudoplatanus Sycamore	4.5	2.5	1.5	1.5	1.5	0.16	1.0	2.00	Y	Good	Young amenity planting set in narrow brick planter. Eleagnus / Grisilinia shrub planting around base, some minor snags / bark abrasions.	+ 20	C2
2	Acer pseudoplatanus Sycamore	4.5	2.5	2.5	2.5	2.5	0.20	1.0	2.00	Y	Good	Young amenity planting set in narrow brick planter. Eleagnus / Grisilinia shrub planting around base, some minor snags / bark abrasions.	+ 20	C2
3	Acer pseudoplatanus Sycamore	4.5	1.5	2.0	1.5	1.5	0.15	1.0	1.80	Y	Good/Fair	Young amenity planting set in narrow brick planter. Eleagnus / Grisilinia shrub planting around base, some minor snags / bark abrasions.	+ 20	C2
4 #	Acer pseudoplatanus Sycamore	5.0	3.5	3.0	3.0	3.0	0.18, 0.15 x 3	4.0	2.00	Y	Good/Fair	Unable to access tree directly, tree set in raised brick planter, multi stemmed from 0.5m. Few snags, lacks central leader.	+ 20	C2

Note: This survey is based on a brief visual inspection from the ground.  
 It is not intended as a full arboricultural inspection.  
 # - Indicates estimated / offsite tree



# Tree survey schedule

Site: Reach 6, Littlehampton  
 Project / Schedule ref: JSL2151\_751  
 Survey dates: 09/04/13  
 Drawing reference: JSL2151\_702 & 703

Surveyor: David Cox  
 Status: For Comment  
 Revision: A  
 Notes: \_\_\_\_\_



ref. no.	Species	height (m)	Crown spread (m)				Stem dia.(m)	Stem no. at 1.5m	Height of crown clearance (m)	Life stage	Structural Physiological condition	General observations Management recommendations	Estimated remaining contribution (years)	Tree Quality Category (BS5837)
			N	E	S	W								
1	Cupressocyparis leylandii Leyland Cypress	10.0	4.5	4.5	4.5	4.5	Ave 0.2	>10	1.50	M	Good	Tree at end of screen belt planting. Multi stem from 0.6m.	+ 20	C2
2	Sambucus nigra Elder	3.0	2.0	3.0	2.0	2.0	10.00	Ave 0.07	1.20	OM	Fair	Small scrubby tree.	+ 10	C3
3	Fraxinus excelsior Common Ash	Ave 10	5.0	5.0	5.0	5.0	Ave 0.5	-	-	M	Good	Series of more mature Ash at toe of road embankment, some multi/bifurcated stem. Some skyline amenity.	+ 20	C2
4	Fraxinus excelsior Common Ash	8.0	4.5	4.5	4.5	4.5	Ave 0.16	6.0	1.00	M	Good	Multi stem from ground level, adjacent to ditch / collapsed bridge.	+ 20	C2
5	Populus nigra 'Italica' Lombardy Poplar	20.0	3.5	3.5	3.5	3.5	0.45	1.0	3.00	M	Good	Road side tree, part of G3. Skyline presence.	+ 20	B2
6	Sambucus nigra Elder	3.0	Ave 2	Ave 2	Ave 2	Ave 2	Ave 0.15	> 10	0.00	OM	Fair	Series of individual, scrubby elder.	+ 10	C3
7	Crataegus monogyna Common Hawthorn	5.0	4.5	4.5	4.5	4.0	0.65	1.00	2.00	M	Good	Mature thorn, debris / fire camp around base. Some bark vandalism.	+ 20	C3
G1	Cupressocyparis leylandii Leyland Cypress	10.0	See plan				Ave 0.2	>10	1.50	M	Good	Continuation of T1, similar trees.	+ 20	C2
G2	Rubus fruticosus, Crataegus monogyna, Acer campestre, Acer pseudoplatanus Bramble, Common Hawthorn, Field Maple, Sycamore	Up to 8	See plan				-	-	0.00	M	Fair	Scrubby gaps on road embankment. Some larger Sycamore inland/eastwards.	+ 20	C3
G3	Fraxinus excelsior, Pinus nigra, Acer pseudoplatanus, Salix Sp, Populus nigra 'Italica' Common Ash, Austrian Pine, Sycamore, Willow, Lombardy Poplar	8-10	See plan				Ave 0.2	-	1.00	MA	Good/Fair	Road side embankment planting, approx 3m c/s. Etolated. Screen value.	+ 20	B2

Note: This survey is based on a brief visual inspection from the ground.  
 It is not intended as a full arboricultural inspection.  
 # - Indicates estimated / offsite tree

ref. no.	Species	height (m)	Crown spread (m)				Stem dia.(m)	Stem no. at 1.5m	Height of crown clearance (m)	Life stage	Structural Physiological condition	General observations Management recommendations	Estimated remaining contribution (years)	Tree Quality Category (BS5837)
			N	E	S	W								
G4	Crataegus monogyna, Fraxinus excelsior, Sambucus nigra Common Hawthorn, Common Ash, Elder	4.0	See plan				Ave 0.1	-	0.00	M	Good	Thicket / scrub. Mostly thorn.	+ 20	C3
G5	Sambucus nigra, Crataegus monogyna, Rubus fruticosus Elder, Common Hawthorn, Bramble	4.0	See plan				Ave 0.07	-	0.00	OM	Fair	Largely overmature elder, some better thorn, thicket.	+ 10	C3
G6	Acer campestre, Crataegus monogyna, Fraxinus excelsior Field Maple, Common Hawthorn, Common Ash	7.0	See plan				Ave 0.15	-	0.00	M	Good	Linear group / outgrown hedge, adjacent to post and rail fence. Some gaps.	+ 20	C2/3
G7	Quercus robur, Acer campestre, Crataegus monogyna, Prunus avium English Oak, Field Maple, Common Hawthorn, Wild Cherry	11.0	See plan				Ave 0.15	-	0.00	M	Good	Road side embankment planting, denser / more varied than G3, with occasional gaps.	+ 20	C2/3
G8	Quercus robur, Fraxinus excelsior, Acer campestre, Crataegus monogyna English Oak, Common Ash, Field Maple, Common Hawthorn	Up to 7	See plan				<0.2	-	0.00	MA	Good	Sparsely planted, embankment group. Includes thicket group of Aspen adjacent to gate. Some larger oak.	+ 20	C2
G9	Rubus fruticosus, Sambucus nigra, Crataegus monogyna Bramble, Elder, Common Hawthorn	Up to 3	See plan				<0.1	-	0.00	M	Fair	Bramble, occasional elder and thorn.	+ 20	C3
G10	Acer campestre, Crataegus monogyna Field Maple, Common Hawthorn	8.0	5.0	5.0	5.0	5.0	Ave 0.18	-	0.00	M	Good	Linear group / outgrown hedge beside post and rail fence. Predominately field maple. Screen value. Set at toe of bank (Continuation of G6).	+ 20	B2
G11	Prunus spinosa Blackthorn	3.0	See plan				-	-	0.00	M	Good	Sloe thicket.	+ 20	C3
G12	Crataegus monogyna, Prunus avium, Prunus spinosa, Fraxinus excelsior, Quercus robur Common Hawthorn, Wild Cherry, Blackthorn, Common Ash, Field Maple, English Oak	Up to 8	See plan				Up to 0.2	-	0.00	M	Good	Embankment planting area, 3m c/s. Some larger oak (0.2m diameter at chest height) and Aspen thicket, few sparse sections.	+ 40	C3

Note: This survey is based on a brief visual inspection from the ground.  
It is not intended as a full arboricultural inspection.  
# - Indicates estimated / offsite tree

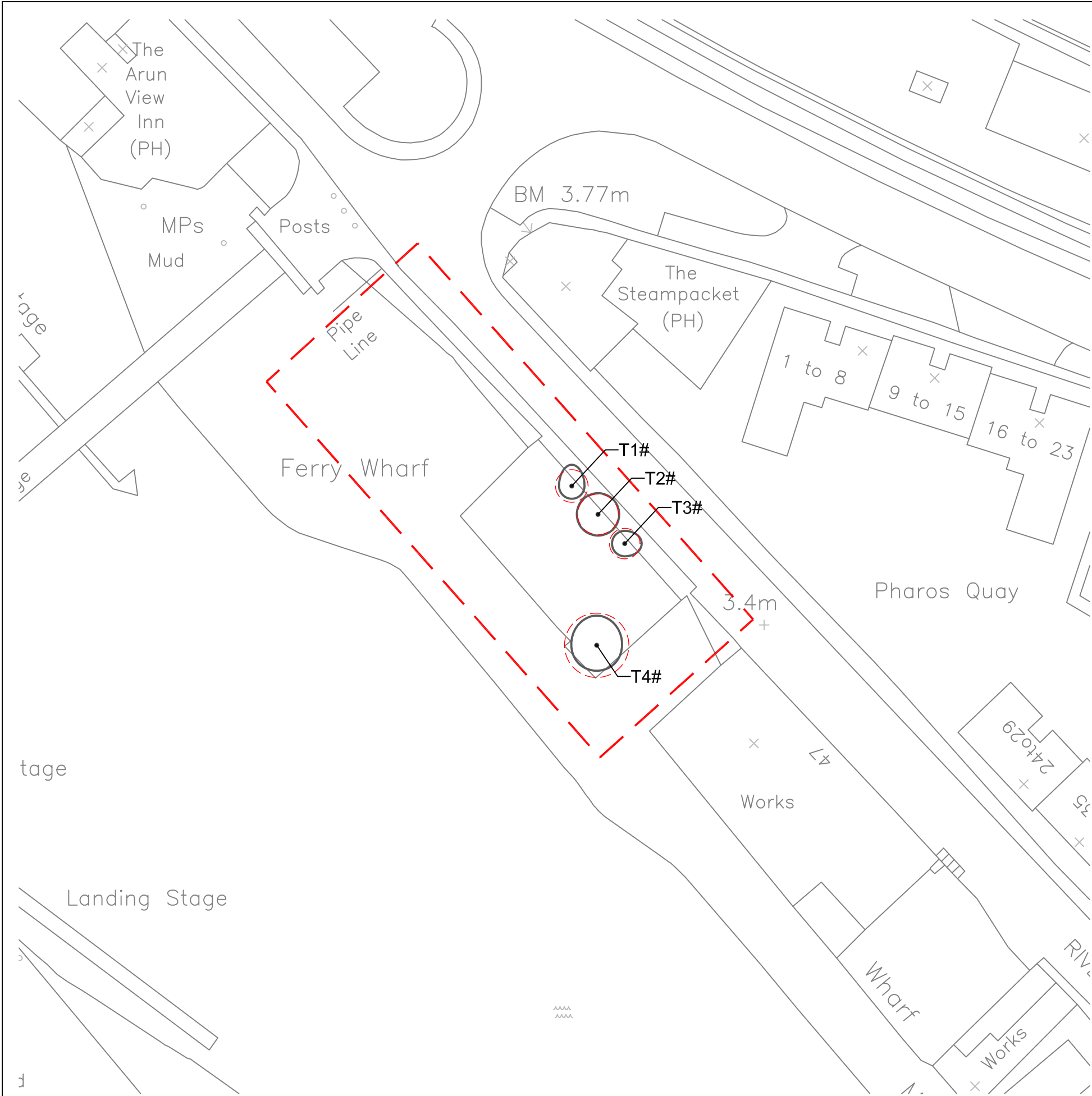
ref. no.	Species	height (m)	Crown spread (m)				Stem dia.(m)	Stem no. at 1.5m	Height of crown clearance (m)	Life stage	Structural Physiological condition	General observations Management recommendations	Estimated remaining contribution (years)	Tree Quality Category (BS5837)
			N	E	S	W								
G13	Alnus cordata, Populus tremula, Acer campestre, Crataegus monogyna, Betula pendula, Quercus robur, occasional Salix caprea Italian Alder, Aspen, Field Maple, Common Hawthorn, Silver Birch, English Oak, Goat Willow	Up to 12	See plan				Up to 0.3	-	0.00	MA	Good	Embankment planting area, 3m c/s. Some larger field maple, willow, oak, portions of Aspen thicket. Thicket. More stature than G12.	+ 40	C3
G14	Sambucus nigra, Crataegus monogyna Elder, Common Hawthorn	4.0	See plan				Ave 0.15	>10	0.00	M	Fair	Individual elder / thorn, elder declining.	+ 10	C3
G15	Crataegus monogyna, Sambucus nigra, Hedera helix Common Hawthorn, Elder, Common Ivy	3.5	See plan				Up to 0.18	-	0.00	M	Good	Mature / degraded hedgerow, collapsing sections. Mature feature none the less.	+ 20	C2/3

Note: This survey is based on a brief visual inspection from the ground.  
It is not intended as a full arboricultural inspection.  
# - Indicates estimated / offsite tree

# APPENDIX 2

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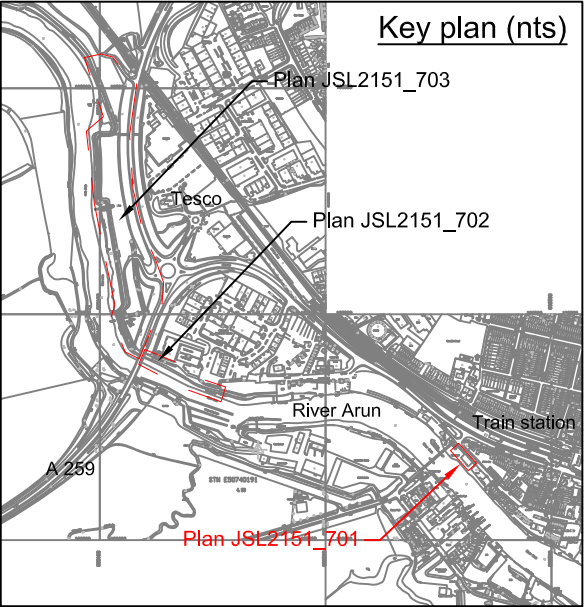
Tree Survey Drawings JSL2151\_701 - 703



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Notes

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Rev	Description	Date	Initial	Checked

Key

- Survey boundary.
- Tree with numbered reference. Canopy spread and BS5837:2012 tree quality category as shown below.
- Tree (in off-site or estimated location) with numbered reference. Canopy spread and BS5837:2012 tree quality category.
- Vegetation group with numbered reference. Canopy extents and BS5837:2012 tree quality category as shown below.

BS 5837:2012 Tree Quality Categories - Table 1

- Category A - High quality
- Category B - Moderate quality
- Category C - Low quality
- Category U - Unsuitable for retention

- Root protection area (RPA) Calculated in accordance with Section 4.6 - BS5837:2012

NOTES:

- Refer to RPS Tree Survey Report & Schedule for further details.
- Survey based on a visual inspection from the ground and is not intended as a full arboricultural inspection.
- Plan produced in accordance with recommendations set out in BS 5837:2012 - 'Trees in Relation to design, demolition and construction'.
- Due to the legal protection afforded to breeding birds vegetation removal should not take place during the bird nesting period; generally, although not restricted to, March - August inclusive.
- Survey based upon topographic survey supplied by Halcrow Group Ltd in Feb 2013 (called '30613\_River Arun Master Drawing-Original Topo' and '30613\_River Arun Reach 6 Topo 2D')

Refer to tree survey schedule JSL2151\_750 for further details



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Client Halcrow Group Ltd

Project Reach 4, River Arun Littlehampton

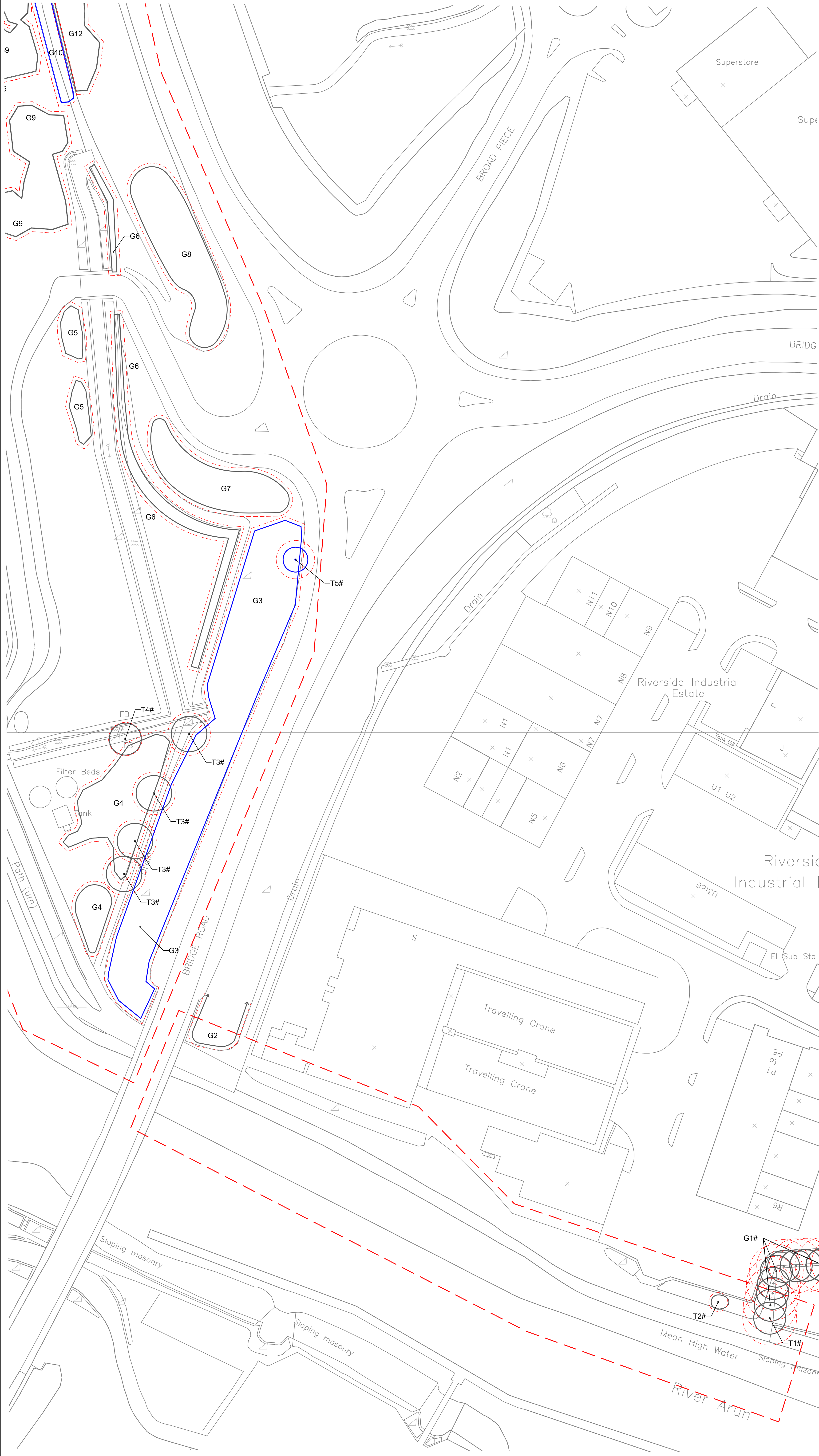
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For Comment	DC	DC
Job Ref	Scale @ A3	Date Created
JSL2151	1:500	15.04.2013

Drawing Number	Rev
701	-

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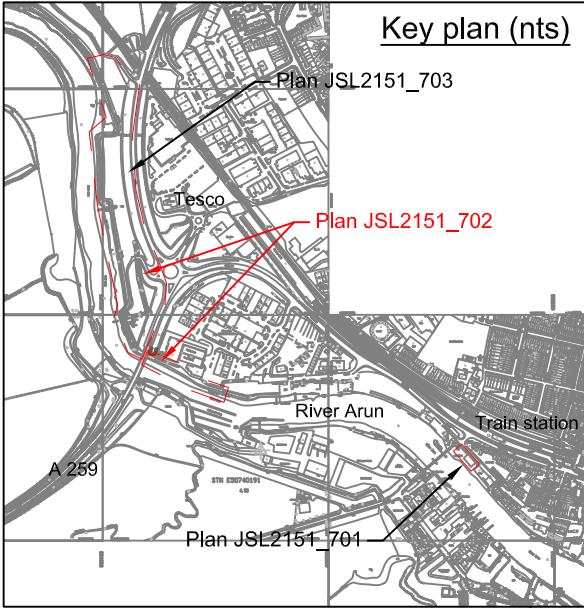


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**Key**

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- Tree (in off-site or estimated location) with numbered reference. Canopy spread and BS5837:2012 tree quality category.
- Vegetation group with numbered reference. Canopy extent and BS5837:2012 tree quality category as shown below.

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- Category C - Low quality
- Category U - Unsuitable for retention

Root protection area (RPA) Calculated in accordance with Section 4.6 - BS5837:2012

**NOTES:**

- Refer to RPS Tree Survey Report & Schedule for further details.
- Survey based on a visual inspection from the ground and is not intended as a full arboricultural inspection.
- Plans produced in accordance with recommendations set out in BS 5837:2012 - Trees in Relation to design, demolition and construction.
- Due to the legal protection afforded to breeding birds, vegetation removal should not take place during the bird nesting period generally, although not restricted to, March - August inclusive.
- Survey based upon topographic survey supplied by Halcrow Group Ltd in Feb 2013 (called 20613\_River Arun Master Drawing-Original Topo and 20613\_River Arun Reach 6 Topo-07)

Refer to tree survey schedule JSL2151\_751 for further details



Rev	Description	Date	Initial	Checked



Lakesbury House, Hillingbury Road, Chandlers Ford, Hampshire, SO53 5SS  
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Client **Halcrow Group Ltd**

Project **Reach 6, River Arun Littlehampton**

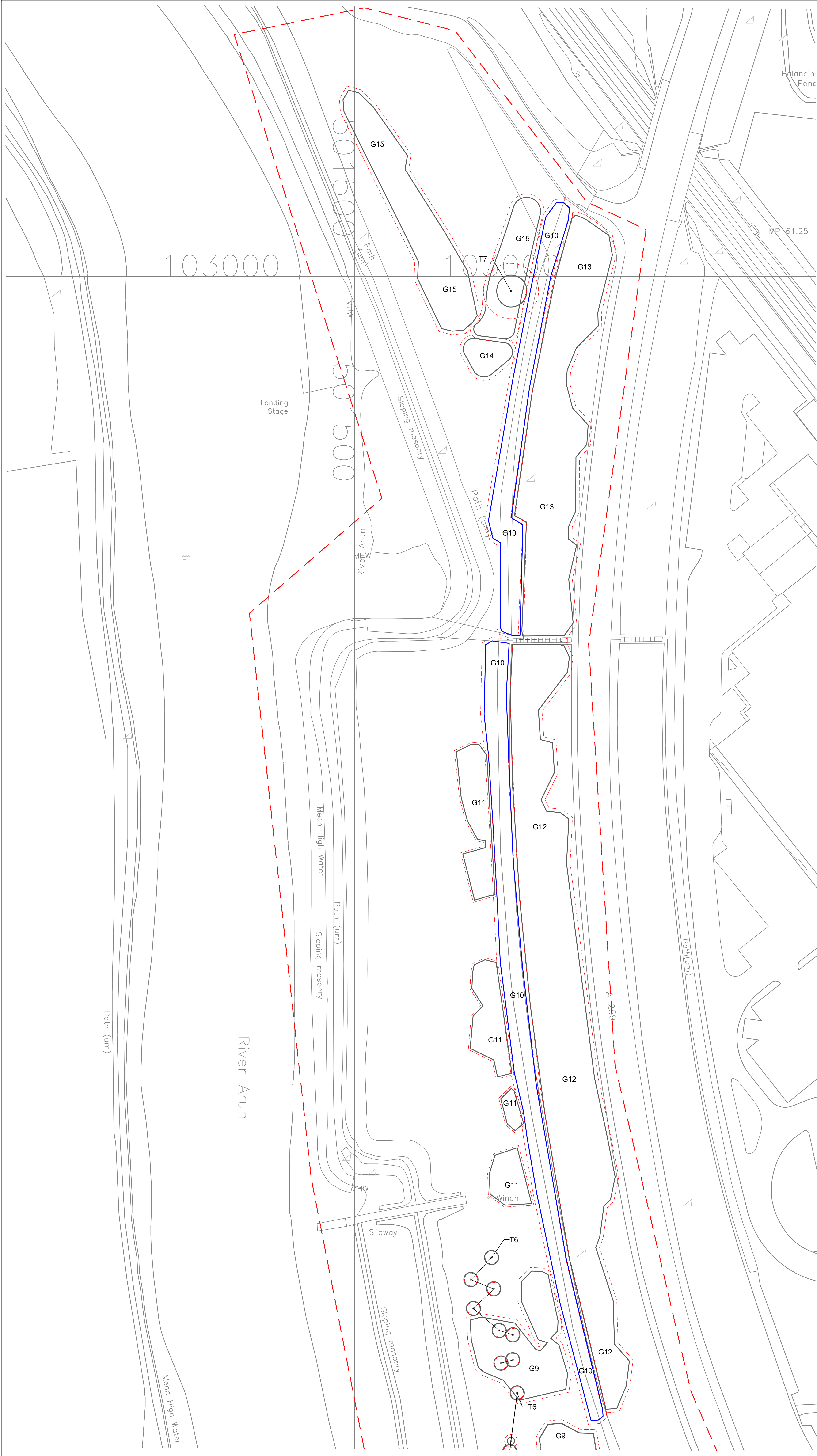
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For Comment	DC	DC
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JSL2151	1:500	15.04.2013

Drawing Number	Rev
702	-

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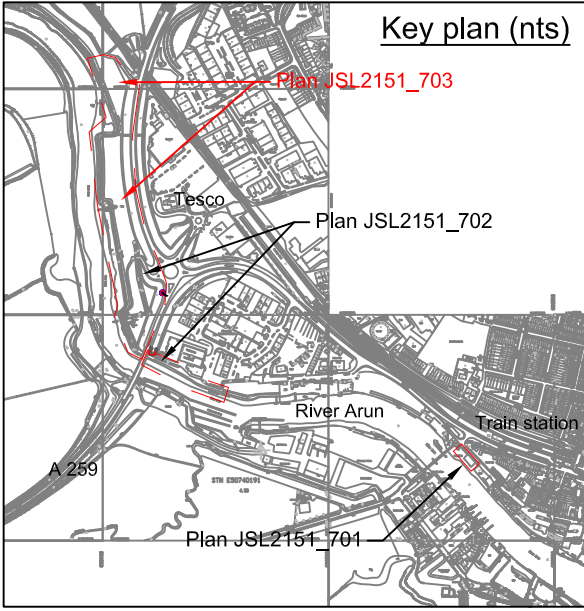


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- Category U - Unsuitable for retention

Root protection area (RPA) Calculated in accordance with Section 4.6 - BS5837:2012

**NOTES:**

- Refer to RPS Tree Survey Report & Schedule for further details.
- Survey based on a visual inspection from the ground and is not intended as a full arboricultural inspection.
- Plans produced in accordance with recommendations set out in BS 5837:2012 - Trees in relation to design, demolition and construction.
- Due to the legal protection afforded to breeding birds, vegetation removal should not take place during the bird nesting period generally, although not restricted to, March - August inclusive.
- Survey based upon topographic survey supplied by Halcrow Group Ltd in Feb 2013 (called 20613\_River Arun Master Drawing-Original Topo and 20613\_River Arun Reach 6 Topo-01)

Refer to tree survey schedule JSL2151\_751 for further details



Rev	Description	Date	Initial	Checked

Lakesbury House, Hillingbury Road, Chandlers Ford, Hampshire, SO53 5SS  
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**Client** Halcrow Group Ltd

**Project** Reach 6, River Arun Littlehampton

**Title** Tree Survey (Sheet 2 of 2)

Status	Drawn By	PM/Checked by
For Comment	DC	DC
Job Ref	Scale @ A1	Date Created
JSL2151	1:500	15.04.2013

Drawing Number	Rev
703	-

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## APPENDIX 3

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### Site Photographs



(1) The Reach 4 site is situated within the River Road Conservation Area. The tree cover is limited consisting four immature Sycamore trees of low amenity value.



(2) The Reach 6 site is vegetated with areas of road-side structure planting, scrub regeneration, remnant outgrown hedge, and occasional larger trees of low to moderate amenity value.

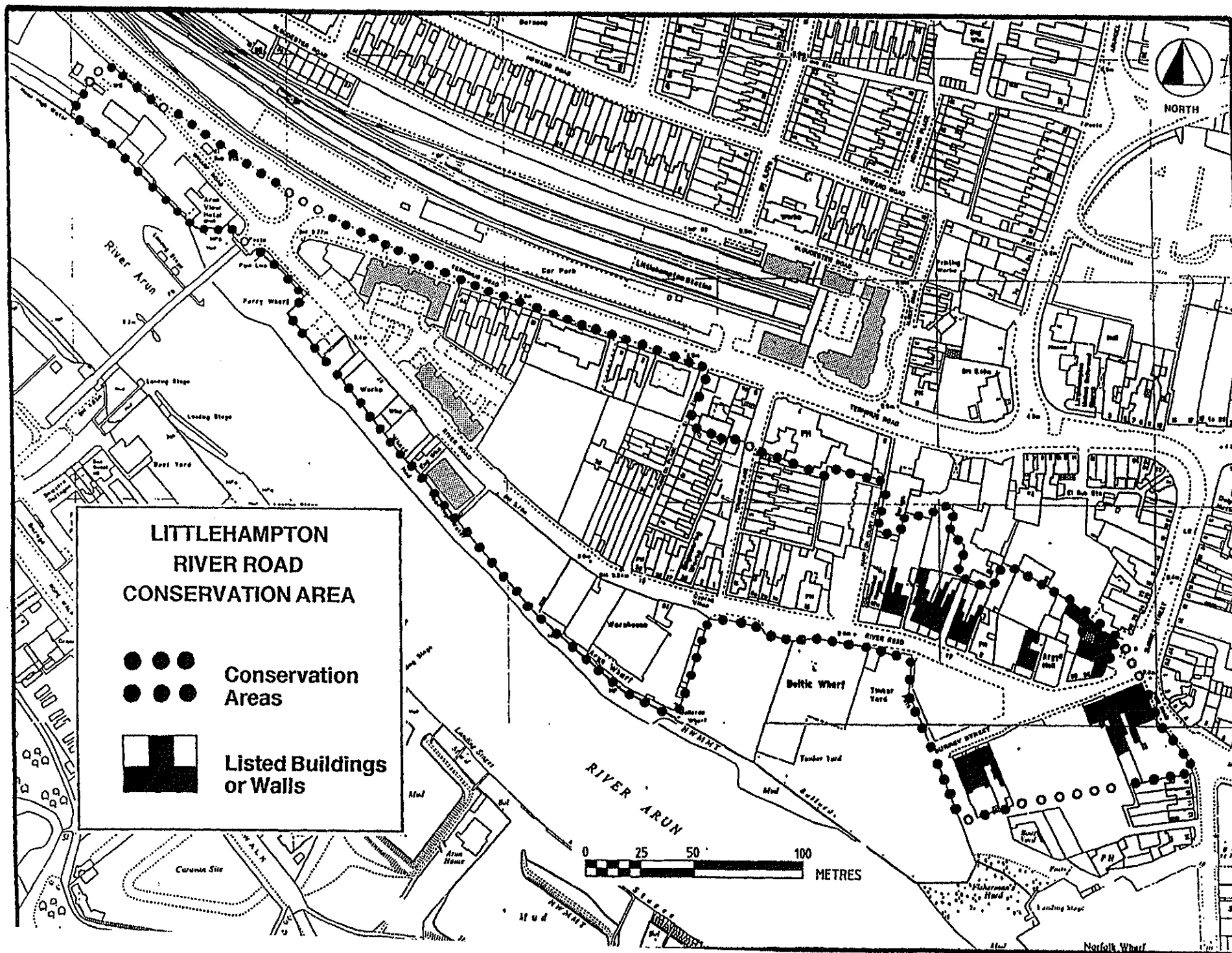


# APPENDIX 4

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## Conservation Area Plan

(Courtesy of Arun District Council)



# Appendix I – Traffic Management and Logistics Plan

This appendix contains a copy of the Traffic Management and Logistics Plan. This document is required for planning purposes and will be updated during the approval stage, prior to construction. In its final form it will form part of the contract documents and will be used to inform and control traffic management during construction.



**Title:** Traffic Management & Logistics Plan

**Employer:** Environment Agency

**Contract Title:** Littlehampton Arun Tidal River Walls

Rev:	Date:	Prepared by:	Reason for Issue:
0	02-04-13	WY	Draft
1	17-04-13	WY	Revised following comments from internal team
2	20-05-13	WY	Amendments to programme dates
3	22-05-13	WY	Reference to road closure for reach 5 deleted. Changes to reach 4 closure dates.

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## **Appendices**

## 1. Introduction

This plan has been produced by VolkerStevin Ltd (VSL), the principal contractor appointed by the Client, the Environment Agency (EA) to implement the Littlehampton Arun East Bank Tidal Walls project. The contents of this document are designed to manage impacts relating to traffic and logistics, to the satisfaction of the planning authority.

The proposed construction process will require quantities of materials to be transported both on and off site, though the majority of steel piles required for the project have already been delivered by sea and will be distributed through the site by river, so minimising traffic movements.

The main lorry movements that remain involve the transport of ready-mix concrete, some fill materials and the disposal of demolition arisings from the site. The plan outlines the management of the material and plant movements associated with the works and the interaction with the surrounding road network during the various stages of construction.

The VSL site management team will be based on site during the construction period to ensure that all contractors and material suppliers implement the controls set out within the Traffic Management & Logistics Plan.

## 2. Health & Safety Legislation and Guidance

The key legislation and guidance in respect to traffic management and logistics includes:

### Key Legislation

- CDM 2007 Regulations
- Traffic Management Act 2004
- Provision and Use of Work Equipment Regulations 1998
- Lifting Operations and Lifting Equipment Regulations 1998
- Health & Safety (Safety Signs & Signals) Regulations 1996

### Key Guidance used

- The Safe Use of Vehicles on Construction Sites [HS(G)114]
- Protecting the Public- Your Next Move [HS(G)151]
- Building a better future for freight: Construction Logistics Plans

### 3. Traffic Management and Logistics

#### 3.1 General

This document covers the scope of works associated with Littlehampton Arun East Bank Tidal Walls project. Streets within Littlehampton will not be used as holding areas for waiting vehicles in order to minimise site congestion, as this would inconvenience residents, road users, other trades and third parties, as well as potentially breach traffic regulations.

HGV deliveries to the main site compound at Railway Wharf, off Bridge Road shall be;

- Monday – Friday 08:00 – 18:00
- HGV deliveries to Arun Parade and Pier Road will be restricted to avoid disturbance to residents and potential conflict with schools
- Monday – Friday 09:30 – 15:00

All other deliveries to be made in accordance with the site working hours, namely;

- Monday – Friday 08:00 – 18:00

No deliveries shall be accepted at any other times without the prior written approval of the local authority.

The site team will liaise with the West Sussex and Arun District highway managers and other highway authorities as necessary. All members of the VSL supply chain, whose services are procured for the works, shall be briefed on the 'Traffic Management & Logistics Plan' plan prior to their arrival on site and a copy included within their order. Particular attention will be given to making suppliers aware of the approved access routes and delivery times.

VSL and WSCC Highway Department will share information regarding traffic hotspots etc during the works. The contact details are as follows;

VSL- Windsor Young Mob:07739 037445 Email: [windsor.young@volkerstevin.co.uk](mailto:windsor.young@volkerstevin.co.uk)

WSCC Highways- Tel TBC Email: TBC

## **4. Vehicle Movements**

### **4.1 Access Routes**

The primary access for all construction traffic will be the existing highway network. The Environment Agency project team shall arrange for all occupiers adjacent to the site to be notified in writing of the duration and nature of the works to be undertaken. This will be in the form of a newsletter delivered at least 28 days prior to the commencement of any site works.

#### **Anticipated programme of work:**

- Reach 1 & 2 – Arun Parade & Pier Road – approximately 25 weeks from November 2013 through to May 2014. This may extend in July 2014 depending on the final scope of work agreed with Arun DC.
- Reach 3 – Britannia Quay, River Road (main access by river from compound at Railway Wharf) – approximately 16 weeks from January to April 2014
- Reach 4 – River Road to south of footbridge - approximately 21 weeks January to April 2014
- Reach 5 – Arun View pub/Railway Wharf/Tarmac yard access via Bridge Road & Wharf Rd – approximately 18 weeks January to April 2014
- Reach 6 - access from roundabout at junction of Bridge Road and A259 – approximately 18 weeks March to August 2014

Site cabins and construction plant would also have to be delivered at the beginning and removed at the end of the project. This would amount to two or three moves a day for the first 2 or 3 weeks of the project. These vehicles would use the same access route and large loads would be pre-planned and movement orders agreed with the local police.

#### **Proposed routes**

To minimise construction traffic nuisance the following principal road routes and junctions will be used during the construction period for all deliveries. These routes have been proposed to try and avoid busy shopping streets in the town centre and the narrower surrounding residential streets.

#### **Reach 1 & 2 – Arun Parade & Pier Road (see plan appendix 1)**

The proposed route from the A27 is via A284 Lyminster Road, then on in to Wick Street and Arundel Road. Turn left into Franciscan Way (B2187), keeping left on to



East Street, then right at the roundabout in to Fitzalan Road. At the end of Fitzalan Road, turn right into South Terrace, then on to Pier Road / Arun Parade.

The total number of vehicle movements to this location amounts to about 1030 over a period from November 2013 to May 2014. This averages about 10 loads per day, though may peak at perhaps 2 or 3 loads per hour when importing back-fill materials in March to May 2014.

#### Reach 3 – Britannia Quay, River Road (see plan appendix 2)

From the A27 proceed along A284 Lyminster Road, turning right at the roundabout in to the A259. At the roundabout at the junction with the B2187 Bridge Road turn left down Bridge Road, then right in to River Road.

The anticipated number of road deliveries is much smaller to this reach, perhaps 50 in total between January and April 2014, averaging at 3 no per week.

#### Reach 4 & 5 – River Road & Railway Wharf (see plan appendix 3)

From the A27 proceed along A284 Lyminster Road, turning right at the roundabout in to the A259. At the roundabout at the junction with the B2187 Bridge Road turn left down Bridge Road, then right in to Quayside.

This is the proposed location of the main site compound at Railway Wharf, which is currently leased to Tarmac. The intention is to use the land to the east which at present is vacant. All steel piles for the project, amount to nearly 3000 tonnes, will be delivered into this site by sea, then transhipped to each of the sites by barge, thus avoiding road transport altogether.

Apart from materials required to construct reaches 4 and 5, this site will be used as a drop off location for materials shared between other sites, thus avoiding repeated journeys to Pier Road etc. The total number of road deliveries anticipated is 140 to 150 no, averaging at about 7 no per week and peaking at perhaps 2 or 3 loads per day.

#### Reach 6 – north of junction of Bridge Road and A259 (see plan appendix 4)

From the A27 proceed along A284 Lyminster Road, turning right at the roundabout in to the A259. At the roundabout at the junction with the B2187 Bridge Road turn right off the roundabout, using the existing slip road and temporary access down to the river side.

This section of work requires the import of considerable quantities of earthworks materials to form new flood embankments. Because of tidal constraints and flow

velocities it is not really feasible to delivery this by river, but we have proposed a route which we believe will minimise impact on residential property and uses routes currently adopted by other HGV traffic.

The total number of deliveries we anticipate here is 1550 in the period March to August 2014. This averages out at about 18 loads per day, but will reach a peak of perhaps 6 no per hour, or one every 10 mins for a 9 week period.

We will try and plan all deliveries in advance, with intervals of at least 10 minutes between loads, so there would be no 'stacking up' of vehicles in local roads.

The speed limit for HGV's accessing and leaving the site will be limited to 20 mph on all residential and access in to and out of the site will be controlled by vehicle marshals to ensure no disruption is caused to local traffic.

## **4.2 Site Access**

All of the working area and sites shall be secured with 2m high Heras-type temporary fencing around the perimeters. Lockable gates will be located in the fencing at vehicle and pedestrian access/egress points. A traffic marshal shall be located at the sites entrances during periods of frequent HGV movements. All gates are to be locked outside of the site working hours.

Where existing paved surfaces are unsuitable, site access routes, compounds and parking areas shall be formed with a geotextile separation membrane with a geogrid layer also being placed on the access routes. This will be covered with a temporary surfacing, designed to prevent rutting and minimise the amount of mud picked up by moving vehicles and plant.

All pedestrian and vehicular/plant access routes shall be segregated. In particular, pedestrian access to commercial premises on Pier Road will be maintained and adequate screening provided to protect members of the public from noise, dust and debris.

Similarly, provision will be made to permit access for the emergency services at all times, from either on end of Pier Road or the other. Signage to indicate this route will be agreed in advance with the highways authority and the emergency services.

### **4.3 Waiting, Turning & Parking Facilities**

Deliveries/site vehicles are not to block accesses or cause inconvenience to the public. Access routes will be arranged in such a way as to provide turning facilities for the largest expected vehicles on site. Vehicles shall not be allowed to reverse out of these sites and all reversing on site is to be controlled by a banksman/ traffic marshal.

If there is an issue while the previous vehicle is exiting the site preventing further deliveries, then vehicles will be directed to the main site compound where they will be held until access is available again. The traffic marshals on the site entrance will be in radio contact with the main site and in turn with vehicles. In this way we expect to prevent vehicles from queuing on the street and causing inconvenience.

Parking facilities shall be provided on site, which all site staff and visitors will be required to use. The exact extent of waiting restrictions will be subject to detailed survey & then statutory notices, to be undertaken when required. The locations illustrated on the attached plans are therefore indicative only.

### **4.4 Vehicle Loading/Unloading**

Under no circumstances are deliveries to be unloaded/loaded outside of the site perimeter or onto live public footpaths. Neither shall this take place on site boundaries where there is potential for materials to fall over the boundary fencing in to public space.

### **4.5 Temporary Signage**

All vehicles regularly accessing the site will carry a project sign with the contact number of the contractor's public liaison officer, so that complaints about vehicle movements or the condition of the road can be quickly addressed.

A copy of the agreed access/egress routes shall be displayed at the exit to each site. Any drivers found to disregard this instruction more than once, shall be removed from the project.

Temporary localised traffic management signage will be erected in accordance with the Traffic Signs Regulations and General Direction 2002 on the designated route to the site. It is proposed that signs to diagrams 7301 to 7305 be used. The location and types of site are illustrated on the following plans. The proposals have been drawn up by a competent traffic management provider appointed by VSL.

A plan detailing the exact proposals for traffic management measures will be produced by a competent traffic management contractor and agreed by the local authority prior to the main works commencing on site. The plan shall include but not limited to; information displayed on signs and their locations, parking restrictions, traffic lights etc.

#### **4.6 Road Closures and Traffic Regulation Orders**

##### Reach 1 and 2

In order to construct the planned work in reaches 1 and 2, road closures will be required to both Arun Parade and Pier Road (between South Terrace and the Littlehampton Harbour Board building). The approximate period for Arun Parade will be November 2013 until May 2014, depending on actual start dates agreed in the Planning consent and the final scope of work agreed. The equivalent period for Pier Road will be November 2013 until May 2014.

##### Reach 4

In order to construct the proposed works in this reach, which comprise the building of a new river wall, we will require the temporary closure of River Road, between the junction with Wharf Road and Pharos Quay. This would be for an estimated period of 4 weeks from January 2014, with a single lane traffic for a further 6 weeks.

#### **5. Vehicle Cleaning**

The site roads will be kept clean to avoid mud from unnecessarily being picked up. All vehicles will be inspected prior to leaving site to ensure that tyres and chassis are clear of debris and the load where necessary, suitably sheeted to prevent debris being dropped on surrounding roads. Wheels are to be cleaned before leaving site.

Automatic wheel washing systems will be positioned at the exit to reach 6 (slip road on to A259 roundabout), for the duration of the works to ensure wheels and chassis are clean prior to vehicles leaving site.

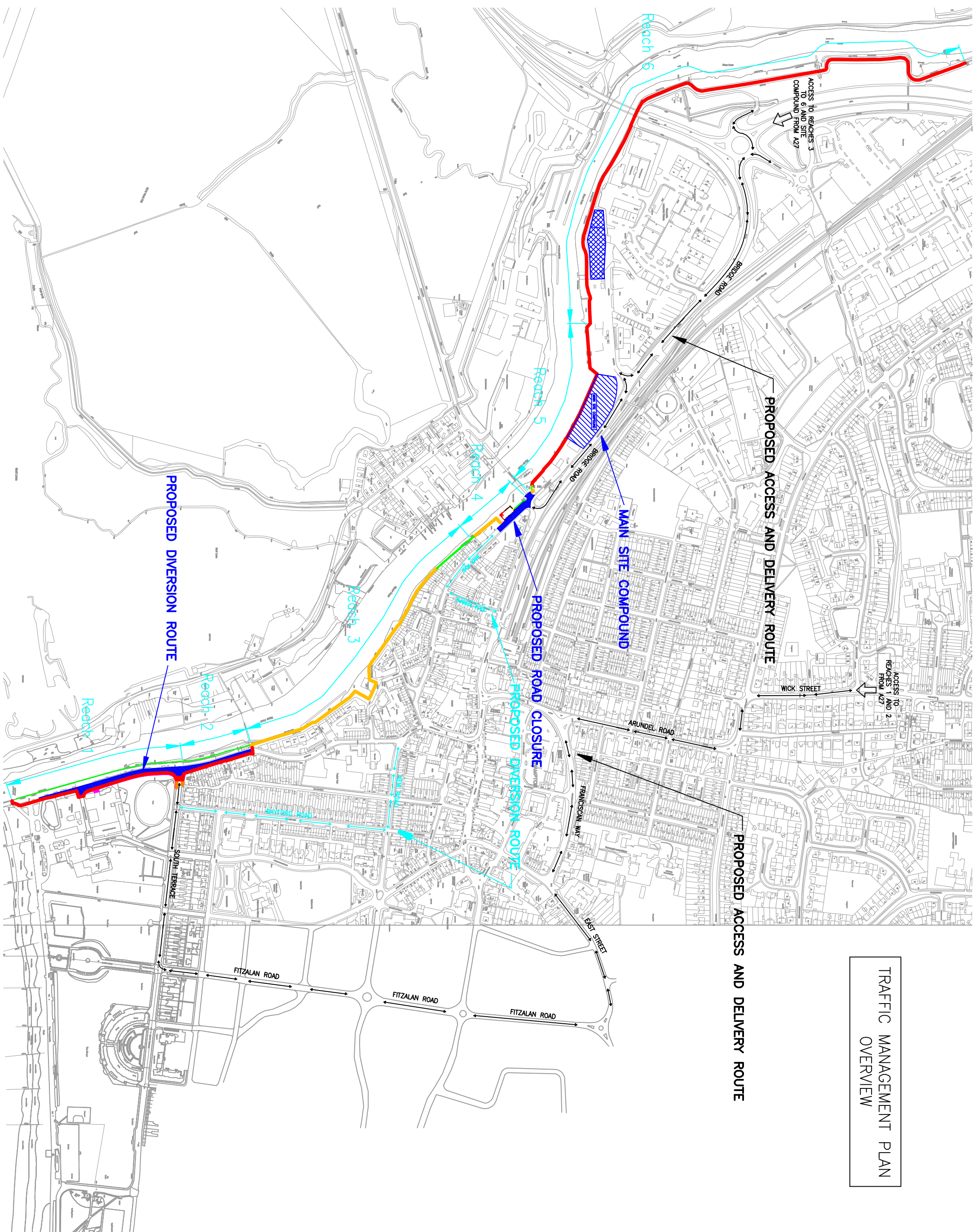
It is also envisaged that a road sweeper will be deployed as and when necessary, to ensure that local roads are kept clean.

#### **6. Highway Condition Survey**

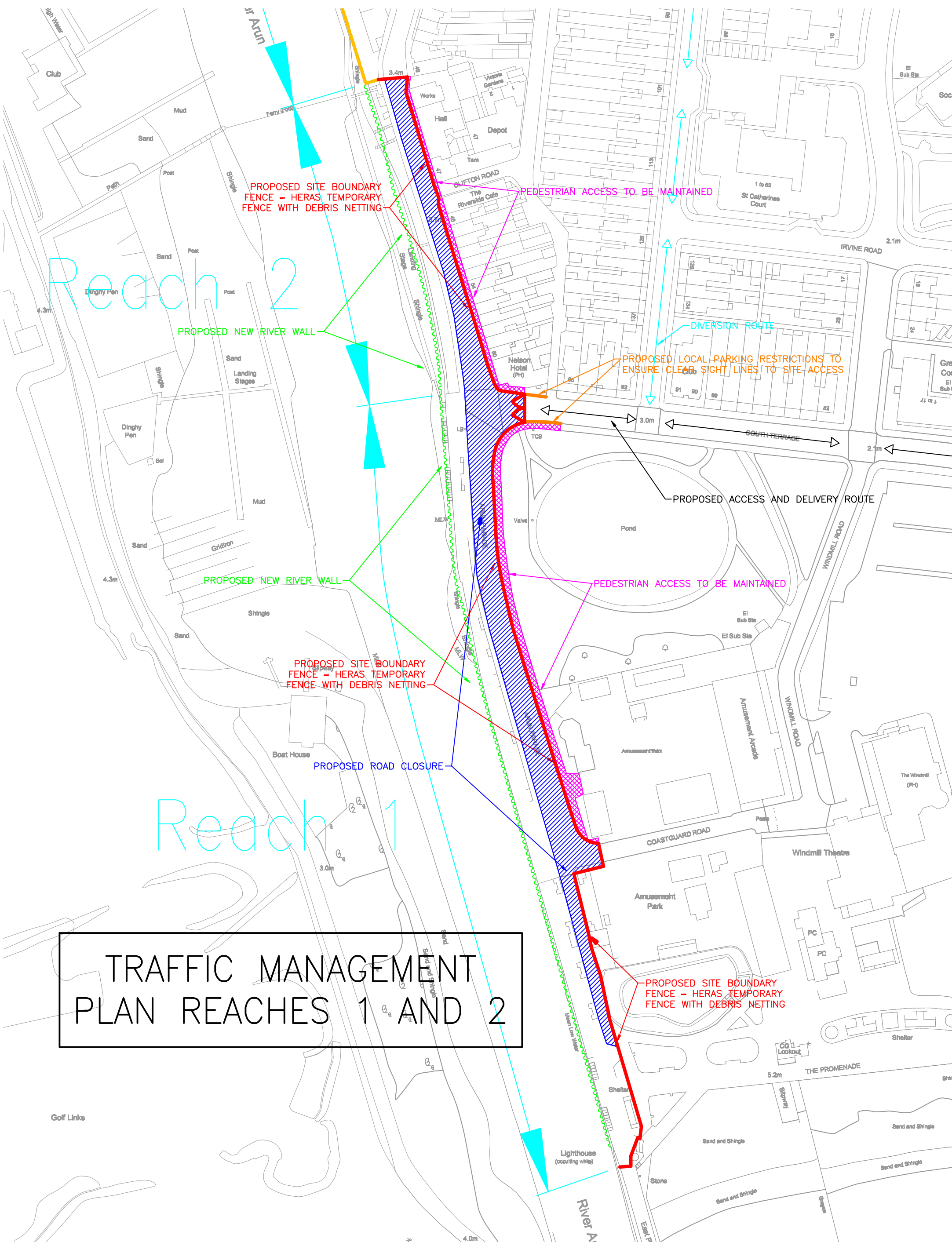
The main contractor will carry out a 'Highway Condition Survey' in liaison with a representative of the Highway Authority to determine and record the state of the existing highway. A photographic record must be produced and a post construction condition

survey must then be taken again as a joint inspection. This survey will provide evidence of the impact upon construction of the highway, by increased HGV flows arising from construction of the development, in accordance with Section 59 of the Highways Act 1980. Any construction activities within the local environment, but not associated with the scheme, will be registered and considered when allocating responsibility for any required maintenance works arising from HGVs.

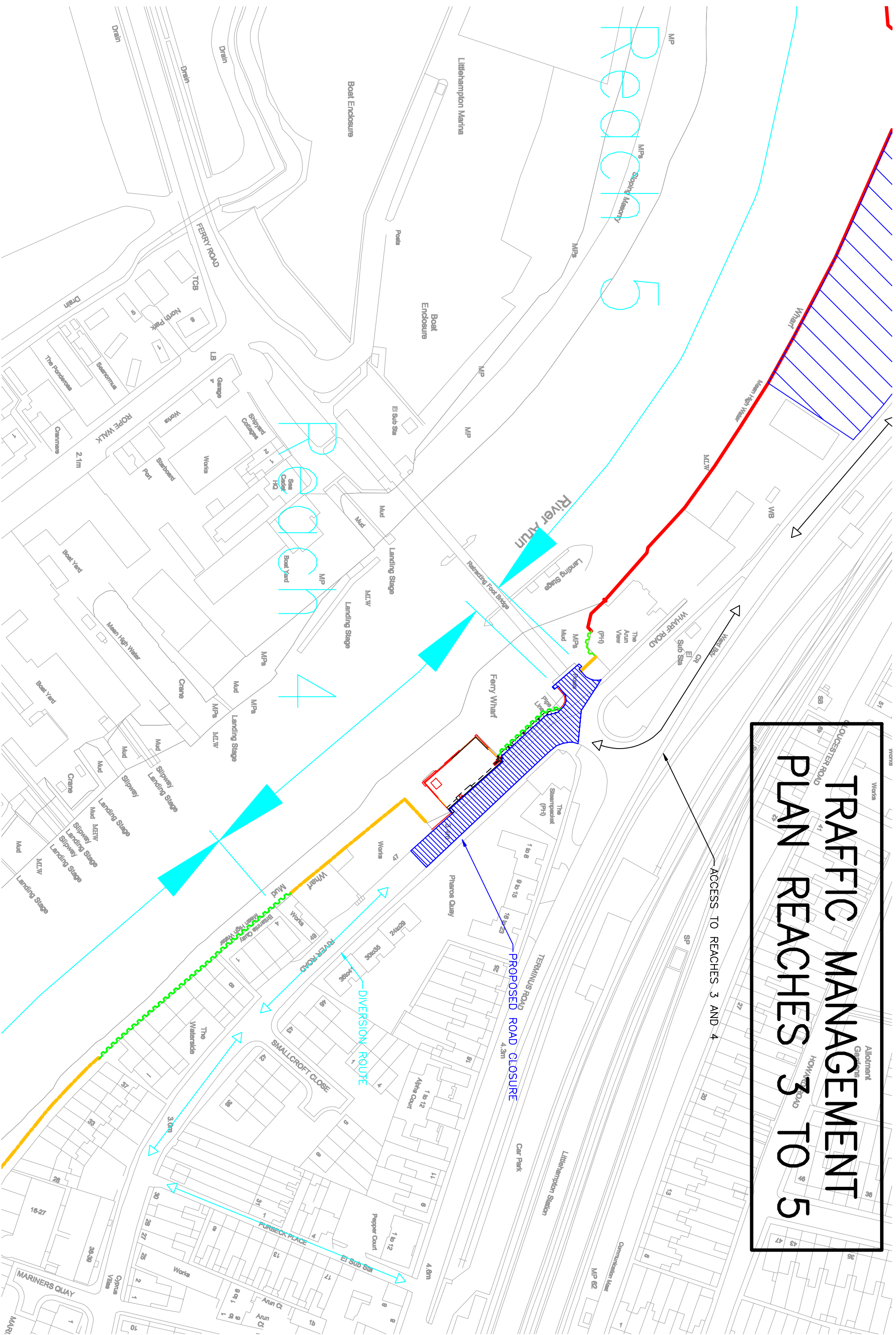








TRAFFIC MANAGEMENT  
PLAN REACHES 3 TO 5







# Appendix J – Water Framework Directive assessment

This appendix contains the Water Framework Directive assessment. This document has been approved by the Fisheries Department of the Environment Agency.

# Appendix J – Water Framework Directive Assessment

## 1 Introduction

This appendix presents the results of an assessment of the proposed Littlehampton Arun East Bank Tidal Walls scheme with respect to the Water Framework Directive (WFD), and specifically considers the potential for the scheme to have any long term effects on the hydromorphological, ecological or chemical quality of any water body. The assessment determines compatibility with the WFD, including any contributions to its environmental objectives, and draws conclusions on whether any additional measures are required.

## 2 Legislative background

The *Water Framework Directive (Directive 2000/60/EC)* (WFD), as implemented in England and Wales by the *Water Environment (WFD) (England & Wales) Regulations SI 3242/2003*, aims to protect and enhance the quality of our surface water and groundwater bodies.

The WFD requires the preparation of a River Basin Management Plan (RBMP) for each River Basin District (RBD), through which water bodies are assessed and designated, objectives are set, mitigation measures or actions for achieving the objectives are detailed and compliance with WFD is reported. Littlehampton falls within the South East RBD and the South East RBMP was published in December 2009 (*Water for Life and Livelihoods, River Basin Management Plan South East River Basin District*, Environment Agency).

The WFD has a number of key objectives, including:

- Preventing deterioration in and improving the status of aquatic ecosystems.
- Aiming to achieve good status (or good potential in the case of artificial and heavily modified water bodies; see below for further explanation) for all water bodies by 2015, or where justified, by 2012 or 2027.
- Promoting the sustainable use of water.
- Conserving habitats and species that depend on water.
- Reducing or eliminating the release of harmful pollutants.
- Reducing the effects of floods and droughts.

WFD stipulates that each water body should meet good ecological status (or good ecological potential; see below for further explanation) by the date set for that water body in the RBMP. Ecological status is determined by a set of biological, hydromorphological and physico-chemical quality elements. The overall status is determined by the lowest status element.

If a surface water body cannot achieve good ecological status because it has had substantial changes to its physical character resulting from human modifications, or because it is man-made, it is designated as a heavily modified or artificial water body (HMWB or AWB). For such water bodies the objective is to meet good ecological potential. For A/HMWBs which are not already at good ecological potential, the RBMP identifies the hydrological or morphological mitigation measures that are required for the water body to achieve its objective.

### 3 Assessment requirements

Article 4.7 of the WFD stipulates that any new modification which has the potential to alter the hydromorphology or other characteristics of the water body in which the scheme is located should not cause deterioration in the ecological status or potential of that water body, or prevent it from achieving its objectives as detailed in the relevant RBMP. If this cannot be achieved, the scheme must meet a set of conditions which are detailed in Article 4.7 for it to be exempt from the requirements of these objectives, and thus compliant with the WFD.

In addition, Article 4.8 of WFD requires that any scheme must not compromise the environmental objectives of any other water bodies within the same RBD, and Article 4.9 requires that the appropriate level of protection given by existing Community legislation (e.g. related to water abstraction, fisheries, nature conservation) must be maintained.

The following assessment has been undertaken to determine whether new modifications resulting from the proposed Littlehampton Arun East Bank Tidal Walls scheme:

- 1 Will meet the legal compliance requirements for 'no deterioration' in any water body.
- 2 Will not prevent the achievement of good ecological status or potential in any water body.
- 3 Will contribute to the delivery of the South East RBMP.

The assessment considers the hydromorphological and chemical consequences and associated ecological consequences associated with the proposed scheme. It has been informed by consultation with the Environment Agency Area Principal Environmental Planning Officer (Jo Simmons) during option appraisal and scoping and with the Geomorphology Technical Advisor (Rebecca Westlake) and Marine Advisor (Sigrun Schroeder) during assessment.

### 4 Baseline

#### 4.1 Scheme description and existing hydromorphological condition

The proposed scheme includes a range of flood defence works along a 2.5km stretch of the tidal defences on the east bank of the River Arun at Littlehampton between the harbour mouth and a point approximately 500m north of the A259 (Figure 1). The works within each of the defined scheme reaches are described in the main text of the Environmental Statement.

A brief consideration of these scheme elements is made here in order to scope this WFD assessment:

- Reaches 1 and 2: insertion of a steel sheet piled wall in front of the existing river defences (steel piles, concrete wall, concrete revetment, see Plate 1, 2), along a total frontage of 436m; the defence height will be raised to +5.4m AOD in Reach 1 and +4.9m in Reach 2; in Reach 1 the defence line will be advanced into the river by approximately 1.7-2.4m at the toe, and in Reach 2 by between 0 and approximately 7.7m.
- Reach 1 and 2: backfilling behind new defences will be completely land-based in an urban setting with no riparian habitat; a small section of riverside concrete revetment will be removed in Reach 2 where the new pile alignment will cross this.
- Reach 1: new floating pontoon (approximately 5m by 10m) to link to existing pontoon, and realignment of approximately 38m of existing pontoon by no more than 5m, to accommodate the new piled wall; relatively minor works required to insert new piles into the river bed.
- Reaches 3, 4 and a small extent of 5: similar to Reaches 1 and 2, discontinuous extents of new steel sheet piles will be inserted in front of the existing defences (variously concrete, masonry and timber walls, see Plates 3, 4), advancing approximately 1.2 to 1.7m into the river along a total frontage of approximately 200m (with a further 25m of land-based flood

wall); the sheet piles will be to a height of 3.8m AOD and topped with a concrete flood wall or glass flood panels to a defence height of 4.8m.

- Reach 3, 4: backfilling behind new defences will be completely land-based in an urban setting with no riparian habitat.
- Reach 5: most of the frontage will not change, with works limited to raising the existing steel sheet pile and concrete wall extents (Plate 5) using concrete capping or glass flood panels; these are land-based works with no consequences for the river.
- Reach 6 downstream and immediately upstream of the A259 road bridge: a new line of steel sheet piles (approximately 600m) will be inserted along the existing land-based defences. For the most part, the piles will be within the existing embankment, set back from the river's edge. Approximately 300m of existing pitched blockstone revetments will be replaced with open stone asphalt (OSA), and along the remainder OSA will be placed to riverside of the steel piles. The OSA will extend from 0m to 3.5m into the mudflat, resulting in a maximum loss of 0.12ha. Modelled flow velocities indicate that hard engineered protection is required as opposed to soft engineering at this location, and of the feasible engineering options OSA requires the least encroachment into the river. The entire length of OSA will be brushed over with sediment and soil material won from the riverside face of the existing embankment that is to be removed, in order to encourage colonisation by local vegetation and invertebrates. This will result in a net gain in vegetated bank compared to the existing situation which has large extents of blockstone revetment.
- Reach 6 under the A259 road bridge (approximately 42m): existing scour protection will be replaced with new OSA, and the existing steel sheet piles wall's capping beam will be raised; these are like-for-like or land-based works.
- Reach 6 north of A259 and filter beds: raise the existing embankment by approximately 1.1m along an extent of approximately 170m, but with the crest set landward of the existing crest, so no increase in the riverside footprint. This will be fronted by either a strip of new OSA or reinforced grass (e.g. Enkamat) (to be confirmed) approximately 8m wide along the riverside toe of the existing embankment (see Plate 7) for a length of approximately 170m, but neither option will encroach onto the existing saltmarsh habitat.
- Reach 6 upstream extent: managed realignment by removal of approximately 135m of riverside embankment (and sub-surface concrete slab revetment)(see Plate 8). The new defence line will use the A259 highway embankment and construction of a new bioengineered landward embankment. Additionally, ground levels will be modified to allow development of approximately 0.22ha of new mudflat and up to 0.7ha of new saltmarsh.

In Reaches 1 to 5, where space is currently restricted to construct new defences, there will be some encroachment into the river and consequent loss of a strip of sub-tidal and inter-tidal habitat (mud with areas of shingle/rubble). The majority of Reach 6, where replacement (and some new) scour protection is required, will be within the footprint of the existing engineered defences, or landward of these. However, in some locations the scour protection may impinge on a narrow strip of river habitat. Managed realignment works will be undertaken in the northern section of Reach 6 to allow establishment of new subtidal and intertidal mud areas and of new intertidal saltmarsh. The position of the realigned defences would be at the base of the A259 road embankment, i.e. as far from the river as is practicable. The existing flood embankment sections running perpendicular to the river channel will be left in place to protect the existing saltmarsh, to encourage additional saltmarsh colonisation and to prevent the migration of the River Arun into these areas.



**Plate 1 – Example Frontage Reach 1**



**Plate 2 – Example Frontage Reach 2 (high tide) showing area requiring backfilling**



**Plate 3 – Example Frontage Reach 3**



**Plate 4 – Example Frontage Reach 4**



**Plate 5 – Example Frontage Reach 5**



**Plate 6 – Example embankment frontage Reach 6**



**Plate 7 – Example embankment frontage requiring scour protection Reach 6**

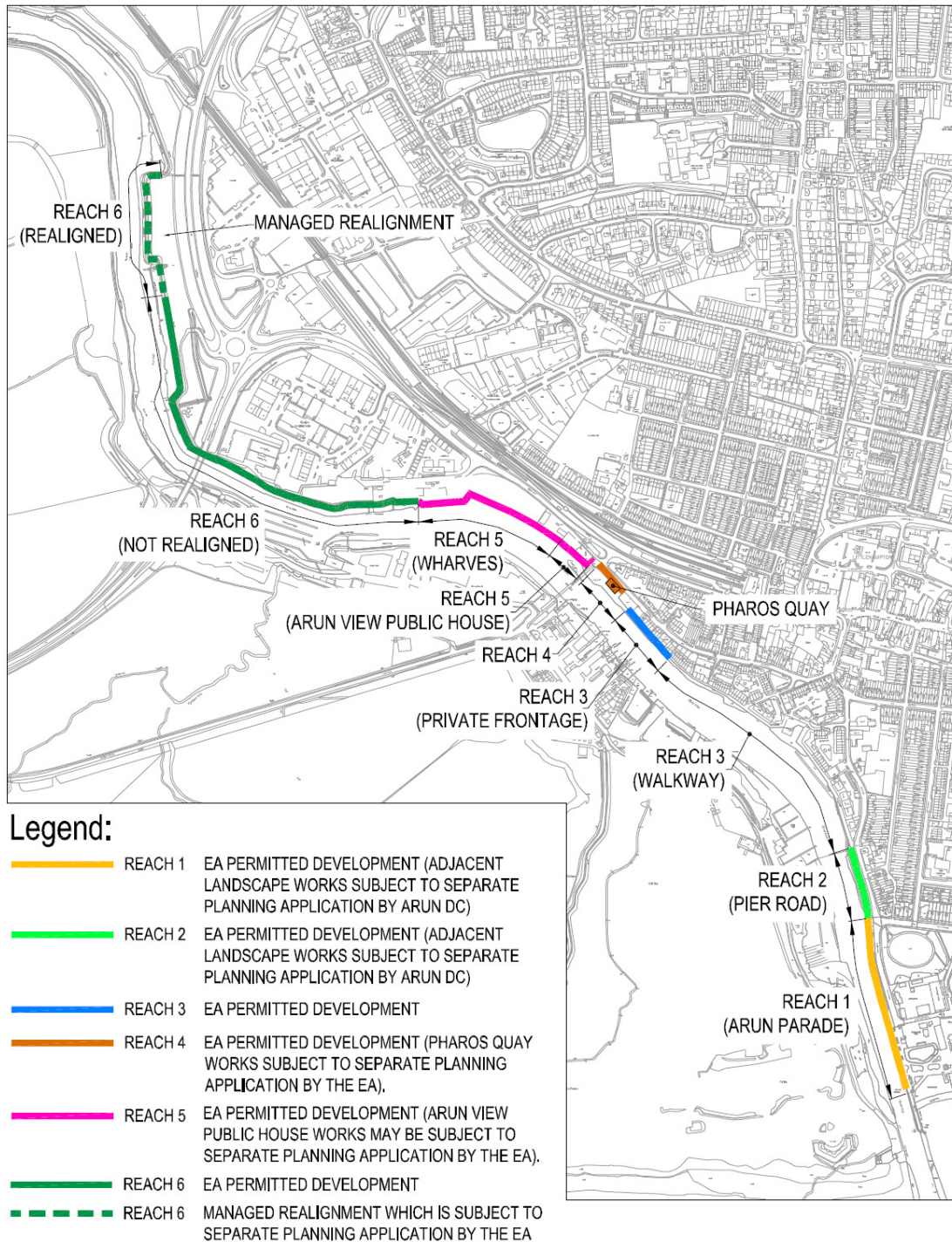


**Plate 8 – Embankment to be removed Reach 6**





**Figure 1 – The Scheme's Six Reach Locations**



## 4.2 Local aquatic ecological conditions

The east bank of the river comprises predominantly urban habitats with residential, industrial and public areas defended behind vertical pilings that form the water's edge. At low tide, there is a strip of inter-tidal mud along both sides of the river, with a foreshore of shingle, mud and sand at the river mouth.



Habitat types within the river include:

- Brackish water within the river, supporting coarse and sea fish.
- Intertidal mud in a narrow strip along both sides of the river, consisting of soft mud and sand and potentially supporting populations of marine invertebrates.
- Narrow strips of saltmarsh along the berms of the river at the northern end, typically no more than 3m wide and containing a typical range of saltmarsh species such as sea purslane, sea beet, common saltmarsh-grass and sea aster.
- Coastal floodplain grassland at the northern end, including slow-flowing drainage ditches flanked by common reed.

The river is known to support a variety of fish species associated with coastal, estuarine and brackish waters: common roach, European flounder, sand goby, grey mullet; European sea bass; European plaice; solenette; sea lamprey; and sea trout.

#### **4.3 Water bodies potentially affected by the scheme**

The Littlehampton Arun East Bank Tidal Walls scheme is associated with the following water bodies as identified in the South East RBMP:

- 1) Water body within which the scheme is located - *Arun* (GB540704105000) – transitional water body extending from the mouth of the River Arun in Littlehampton upstream through the scheme site and further past Arundel to Pulborough, approximately 17.5km in length in total.
- 2) Upstream water bodies – (a) *Ryebank Rife* (GB107041006620) – river water body discharging to the River Arun on the west bank opposite Reach 6 of the scheme; (b) *Ford Trib (Lower Arun)* (GB107041013020) – river water body discharging to the River Arun approximately 2.8km upstream of the limit of the scheme.
- 3) Downstream water body - *Sussex* (GB640704540003) – coastal water body at the mouth of the River Arun, directly downstream of the scheme.
- 4) Underlying groundwater body - *Littlehampton Anticline East* (GB40701G50340) – groundwater to east of River Arun.

The *Arun*, *Ryebank Rife*, *Sussex* and *Littlehampton Anticline East* water bodies are all included in this assessment. However, as the proposed scheme will have no consequences for tidal or fluvial flow in the channel upstream of the scheme's upper limit, the upstream water bodies (which are 2.5km or more away) are not considered further.

Baseline conditions for the in-scope water bodies are summarised in Tables 1a to 1c.

**Table 1a - WFD classifications for surface water bodies relevant to the scheme**

Category	Surface Water Body Assessment		
<b>Waterbody Name</b>	<i>Arun</i>	<i>Sussex</i>	<i>Ryebank Rife</i>
<b>Waterbody ID</b>	GB540704105000	GB640704540003	GB107041006620
<b>Type</b>	Transitional	Coastal	River
<b>Hydromorphological Status</b>	Heavily modified (cause not stated, but anticipated to be Flood protection, Urbanisation)	Heavily modified (by Coastal protection and Fisheries)	Not designated
<b>Current Overall Quality</b>	Moderate potential	Moderate potential	Moderate status
<b>Current Ecological Quality</b>	Moderate potential (Fish: moderate)	Moderate potential (Invertebrates: good)	Moderate status
<b>Supporting Elements</b>	Dissolved inorganic nitrogen: moderate Dissolved oxygen: high Tidal regime – freshwater flow: supports good	Arsenic, Copper, Dimethoate, Iron, Zinc: all high	Quantity & dynamics of flow: good Morphology: good
<b>Mitigation Measures Assessment</b>	Moderate (see Table 1c for measures not in place)	Moderate (see Table 1c for measures not in place)	n/a
<b>Overall Status Objective</b>	Good potential by 2027	Good potential by 2027	Good status by 2027
<b>Current Chemical Quality</b>	Does not require assessment	Good	Does not require assessment
<b>Protected Area</b>	No	Bathing Water Directive Natura 2000 (Habitats and/or Birds Directive), Nitrates Directive	Bathing Water Directive Nitrates Directive

**Table 1b - WFD classifications for groundwater bodies relevant to the scheme**

Category	Groundwater Body Assessment
<b>Waterbody Name</b>	Littlehampton Anticline East
<b>Waterbody ID</b>	GB40701G503400
<b>Current Overall Quality</b>	Poor status
<b>Current Quantitative Quality</b>	Poor (Impact on wetlands: good; Impact on surface waters: poor; Saline intrusion: good; Water balance: good)
<b>Current Chemical Quality</b>	Good
<b>Status Objective</b>	Good quantitative status by 2027 Good chemical status by 2015
<b>Protected Area</b>	Drinking Water Protected Area Nitrates Directive

**Table 1c – Morphological Mitigation Measures for HMWBs**

Water body	Mitigation Measure / Action	Status
<b>Arun</b>	<u>Annex B</u> <ul style="list-style-type: none"> <li>Indirect / offsite mitigation (offsetting measures)</li> <li>Retain marginal aquatic and riparian habitats (channel alteration)</li> <li>Preserve and where possible enhance ecological value of marginal aquatic habitat, banks and riparian zone</li> <li>Structures or other mechanisms in place and managed to enable fish to access waters upstream and downstream of impounding works</li> <li>Bank rehabilitation / reprofiling</li> <li>Removal of hard bank reinforcement / revetment or replacement with soft engineering solution</li> </ul>	Not in place (All)
	<u>Annex C</u> <ul style="list-style-type: none"> <li>SE0125 (Bank rehabilitation / reprofiling)</li> </ul>	n/a
<b>Sussex</b>	<u>Annex B</u> <ul style="list-style-type: none"> <li>Manage disturbance</li> <li>Site selection (dredged material disposal)</li> <li>Sediment management</li> <li>Operational and structural changes to locks, beach control, etc</li> <li>Preserve and where possible enhance ecological value of marginal aquatic habitat, banks and riparian zone</li> <li>Managed realignment of flood defence</li> <li>Bank rehabilitation / reprofiling</li> <li>Preserve and, where possible, restore historic aquatic habitats</li> <li>Removal of hard bank reinforcement / revetment, or replacement with soft engineering solution</li> </ul>	None in place

#### 4.4 Scope of WFD detailed assessment

Considering the water body baseline and the nature of the proposed flood alleviation scheme, the component elements of the scheme, and biological and supporting quality elements for each water body, have been scoped into or out of the WFD assessment as summarised below.

##### **Scheme Elements in Scope**

- Reaches 1 and 2: new sheet piled wall between 0m and approximately 7.7m in front of the existing river defences.
- Reaches 3, 4 and 5: new sheet piled walls between approximately 1.2 and 1.7m in front of the existing river defences.
- Reach 6: new and replacement scour protection.
- Reach 6: managed realignment and intertidal habitat creation.

##### **Scheme Elements Not in Scope**

- Reaches 1, 2, 3, 4, 5 and 6: increased height of defences and backfilling between old and new alignments have no consequences for the water body; there is no tidal floodplain potential as the entire area is urbanised.
- Reach 1: new and realigned existing, pontoons; supporting piles will result in inconsequential changes to water body bed habitat and water column shading.
- Reach 6: the short extent of new steel sheet piles and the larger extent of cut-off piles set back from water body's edge have no consequences for the water body; there is no tidal floodplain potential as the entire area is urbanised.

- Reach 6: embankment raising has no consequences for the water body; there is no tidal floodplain potential as the entire area is urbanised.

#### **Water Body Quality Elements in Scope**

- Surface water body biological quality elements – fish, invertebrates and plants.
- Surface water body supporting morphological (habitat) and hydrological (flow) elements (and HMWB hydromorphological mitigation measures).

#### **Water Body Quality Elements Not in Scope**

- Surface water body chemical quality – the proposed scheme entails physical works and will not introduce any new discharges or releases of potentially contaminating substances, and therefore can have no material effects on the levels of priority chemical substances (identified at EU level) or other specific chemical pollutants (identified by each EU member state) in any water body.
- Surface water body supporting elements, i.e. physico-chemical quality and freshwater flow. Any effects on physico-chemical quality, such as sediment disturbance and resuspension during piling operations, or localised dewatering to allow safe construction, could have localised and short-term effects on water quality and flow in the *Arun* water body only; sediment movement will be controlled by local use of silt curtains with only small quantities therefore dispersing and settling elsewhere; any effects on supporting elements will therefore be localised, will not persist beyond the construction period and do not present a risk of impacting on water body status.
- Surface water protected area status:
  - the scheme will have no effects on nutrients that could affect nitrate status in the *Sussex* coastal water body or the *Ryebank Rife* river water body;
  - the scheme will have no effect on microbial conditions that could affect bathing water status in the *Sussex* coastal water body (the designation approaches to approximately 600m east of the mouth of the *Arun*); small quantities of resuspended sediment in the *Arun* during construction will not be sufficient to have an aesthetic effect on the designated bathing water;
  - although the *Sussex* water body has associated Natura2000 designations there are none within 15km (the nearest being at Pagham Harbour) and there is no potential for the proposed tidal flood alleviation scheme to have any effects;
- Groundwater body chemical quality – the scheme will not entail the release of any priority substances or specific pollutants; although some local contamination has been identified within the shallow sand and gravel deposits, there will be no piling within contaminated land (that could theoretically increase the risk of chemical contamination of the underlying groundwater body) and existing piled river wall structures will be retained, ensuring no new contaminant pathways are created.
- Groundwater body quantitative status – the new piled walls replace existing walls and will not introduce a new barrier to connection between the *Arun* surface water body and the underlying groundwater body, not prevent lateral movement within the groundwater body; the new pile cut-off in the flood embankments is only intended to prevent lateral seepage during high tide/flow events and again will not effect the connectivity between or within water bodies.
- Groundwater protected area status – as indicated above, the scheme has no consequences for groundwater quality or quantity.

## 5 Impact Assessment

### 5.1 Relevant WFD objectives

The following generic environmental objectives (based on Article 4.1 of the WFD) have been considered for the WFD assessment of the scheme:

- Objective 1 - No changes affecting high status sites; does not apply as there are no high status sites associated with the scheme.
- Objective 2 - No changes that will cause failure to meet surface water good ecological status / potential or result in deterioration of surface water ecological status or potential; requires detailed assessment.
- Objective 3 - No changes which will permanently prevent or compromise the Environmental Objectives being met in other water bodies; considered below.
- Objective 4 - No changes that will cause failure to meet good groundwater status or result in deterioration in groundwater status; does not apply as described above in Section 4.4.

The upstream *Ryebank Rife* water body has its confluence with the *Adur* within the scheme area, but on the west bank. Since the proposals all relate to lateral defences on the opposite bank, and will not alter flow in the *Adur*, there are no risks of adverse effects on this water body. Other upstream water bodies are several kilometres distant and will be similarly unaffected.

Although the scheme extends almost to the boundary of the *Arun* with the downstream *Sussex* coastal water body the scheme will not change fluvial or tidal flow volumes, velocities, sediment transport etc sufficiently to affect the coastal water, and there are no identifiable risks for the water body's status. Potential impacts through sediment disturbance or flow alteration during construction of the scheme may lead to temporary and localised changes in water quality, but the small scale and short duration of any such changes mean that they will be inconsequential for the coastal water body's overall potential. None of the scheme's physical elements will contribute or detract from the morphological mitigation measures identified for the *Sussex* water body (Table 1c).

Thus WFD objective 3 is considered not to be at risk for either upstream or downstream water bodies.

Since objectives 1, 3 and 4 are not at risk, the remainder of this assessment focuses on Objective 2.

### 5.2 Objective 2 assessment methodology

The assessment process applied here has been broken down into a series of clearly defined steps, to provide a transparent and accountable assessment of the scheme. The following steps have been considered:

1. Scope the assessment through baseline data collection - already done in Sections 4.2 and 4.3. The data collection included a review of the South East RBMP to identify the relevant objectives and actions and the Environmental Statement for the scheme.
2. Define issues and features at a water body scale – already done in Section 4.3. The WFD 'features' that may be affected by a flood risk management scheme are the biological quality elements of the water bodies. Any effects may be direct, impacting on biological populations, or indirect, by changing the water body's chemical and physical parameters ('issues') upon which the biological elements are dependent.
3. Screen the preferred option against the relevant status objectives and elements to determine if the project has any impact on the criteria identified for those water bodies – already done in Sections 4.4 for scheme elements and 5.1 for water bodies.

4. Detailed assessment for those criteria where potential adverse effect had been identified to determine the effects on elements. Identified potential impacts are considered in Section 5.3 in relation to the ecological and supporting hydromorphological status objectives. As the *Arun* is a HMWB the preferred option is also assessed against the relevant morphological mitigation measures.
5. Article 4.7 test - if the preferred option is predicted to cause deterioration in water body status or prevent the water body from meeting its' objectives, then assessment is needed against the conditions listed in WFD Article 4.7.

### 5.3 Detailed assessment for the *Arun* water body (objective 2)

The potential consequences of the scheme that have the potential to affect the quality of the *Arun* surface water body and impinge on its status or WFD objectives:

- Any permanent change in the alignment of the watercourse or the floodplain.
- Any permanent change to the nature of the defences, particularly the form or nature of materials used, and any change to structures.
- Any long term change (damage) incurred during construction activities.

Potential effects resulting from any change in the above include:

- Changes in channel morphology and morphological diversity.
- Changes to tidal prism and wave energy.
- Changes to flow (including localised flow).
- Changes to water levels, river capacity and floodplain capacity.
- Changes to sediment balance.
- Changes to sedimentation/erosion.

Any change in these factors has, in turn, potential to affect river, riverbank or floodplain ecology, (including priority habitats habitat such as saltmarsh and mudflat) and fish, invertebrates, plants and algae, and thereby has potential to affect the actual or target ecological potential of the water body.

The scheme elements which need to be considered in terms of their potential consequences on water body quality elements can be summarised as follows:

- In the southern and middle sections of the scheme (Reaches 1, 2, 3, 4, 5) the proposed works will involve replacement of existing defences comprising a mix of materials with new steel sheet pile defences, encroaching into the river, which will affect approximately 0.1ha of riverbed immediately adjacent to the flood defences. An estimate of the effects of sea level rise without the scheme suggests this may result in the loss of approximately 0.05ha of intertidal habitat over the next century. Thus the scheme related loss is approximately 0.05ha.
- Towards the north of the scheme (Reach 6) new and replacement scour protection will modify the engineered nature of the river bank with some encroachment onto approximately 0.12ha of mudflat habitat. However, because the OSA scour protection will be brushed over with sediment and soil material won from the riverside face of the existing embankment that is to be removed, this will encourage colonisation by local vegetation and invertebrates with a net gain in vegetated bank compared to the existing situation which has large extents of blockstone revetment.
- At the northern end of the scheme, managed realignment of the flood embankment coupled with manipulation of ground levels will facilitate the formation of new mudflat (0.22ha) and new saltmarsh (0.7ha) in Reach 6B. The mudflat area will be formed at the opening to the saltmarsh, and there is therefore reasonably high confidence that this will remain as mudflat (rather than rapidly succeeding to saltmarsh). The saltmarsh will

significantly improve feeding and nursery opportunities for a number of species including flounder, sand goby and grey mullet.

The consequences of these components of the scheme for biological and hydromorphological quality elements are considered in Tables 2 and 3, respectively. A summary of potential effects of the scheme against the identified hydromorphological mitigation measures for the *Arun* water body is provided in Table 4.

As indicated in Table 2, the localised effect on invertebrates and phytobenthos resulting from advancing the flood defence line in Reaches 1 to 5 will be more than mitigated for by the creation of new mudflat habitat in Reach 6, and the additional new saltmarsh habitat will also benefit all biological quality elements.

Similarly, as indicated in Table 3 the loss of channel morphological diversity in Reaches 1 to 5 will also be more than mitigated for by the creation of new mudflat habitat in Reach 6, and the additional new saltmarsh habitat will also provide further diversity. Other hydromorphological elements will not be significantly affected.

As indicated in Table 4 the scheme makes overall a small contribution to the morphological mitigation measures for the *Arun* water body, specifically by managed realignment in Reach 6 which results in the replacement of an engineered hard bank flood defence with saltmarsh backed by a new embankment combined with the existing A259 road embankment.

**Table 2 – Assessment Against *Arun* Biological Quality Elements**

Scheme Component	Fish	Invertebrates	Macrophytes and Phytobenthos
New steel sheet pile defences encroaching into the river	<p><b>Impact:</b> Loss of subtidal and intertidal habitat for fish, potentially affecting feeding areas but quality considered to be low due to scour resulting from the adjacent engineered walls combined with boatwash. The total area lost (0.22ha) is not significant at the water body scale; within the scheme site alone the river bed is between approximately 36m (subtidal) and 110m (intertidal) wide and 2.3km long</p> <p><b>Mitigation:</b> None necessary.</p> <p><b>Impact:</b> Piling activities in the subtidal zone of the water body in Reaches 1 to 4 have potential to harm fish directly and to disrupt migration, at the most extreme resulting in a depleted year class for migratory species that are affected.</p> <p><b>Mitigation:</b> Works in Reaches 1, 2, and 4 will use vibro-piling and Reach 3 will be press piled. There is a possibility that local ground conditions encountered at any location may demand some impact hammering.</p> <p>The Area Fisheries Technical Officer has confirmed that the press piling technique will have no discernible effect on fish survival or migration.</p> <p>Hammer or vibro-piling during the daytime will not significantly impact on sea trout movement even during the winter migrating period (Nov-Mar), since</p>	<p><b>Impact:</b> Loss of subtidal and intertidal habitat for benthic invertebrates. Quality of this habitat is considered to be low due to scour resulting from the adjacent engineered walls combined with boatwash. The total area lost (0.22ha) is not significant at the water body scale; within the scheme site alone the river bed is between approximately 36m (subtidal) and 110m (intertidal) wide and 2.3km long.</p> <p><b>Mitigation:</b> None necessary.</p>	<p><b>Impact:</b> Strip of riverbed to be lost is not vegetated.</p> <p>Some scattered plant and seaweed growth on existing flood walls will be lost in the short term until new walls are colonised, and this will not impact on the water body's ecological potential.</p> <p>Potential long-term effect is limited to loss of the sparse macroalgae and pytobenthos communities of subtidal and intertidal habitat (considered to be low quality due to the adjacent engineered walls combined with boatwash). The total area lost (0.22ha) is not significant at the water body scale; within the scheme site alone the river bed is between approximately 36m (subtidal) and 110m (intertidal) wide and 2.3km long.</p> <p><b>Mitigation:</b> None necessary.</p>



	<p>their movement is primarily at night. Eels will migrate in the Spring and early Summer months once water temperature reaches 10-12°C, and if impact hammering or vibro-piling is essential this will require mitigation. A slow start method to impact piling will encourage fish to leave the area and avoid percussive shock. To reduce the risk of disrupting migration, impact and vibro-piling may also need cushioning or baffling to reduce disturbance of fish movement.</p>		
New and replacement scour protection	<p><b>Impact:</b> Scour protection will largely replace existing blockstone and concrete revetments / reinforced embankments. Some encroachment onto 0.12ha of mudflat is not significant for fish at the water body scale.</p> <p><b>Mitigation:</b> None necessary</p>	<p><b>Impact:</b> Vegetation and invertebrates on existing revetments / reinforced embankments will be lost in the short term only, as the new erosion protection will provide additional opportunities for colonisation by macrophytes, macroalgae and invertebrates. Locally sourced sediment/soil from the Reach 6 embankment to be removed will be brushed into the scour protection to promote colonisation.</p> <p><b>Mitigation:</b> None necessary.</p>	
Managed realignment of the flood embankment	<p><b>Impact:</b> New saltmarsh habitat presents alternative feeding opportunities on 0.22ha of new mudflats, and new feeding opportunities and potential spawning and nursery areas within the new area of channels, creeks and saltmarsh totalling 0.7ha. Species that may particularly benefit from the new saltmarsh include flounder, sand goby and grey mullet.</p> <p><b>Mitigation:</b> None necessary.</p>	<p><b>Impact:</b> Gain of 0.22ha subtidal and intertidal mudflat habitat for benthic invertebrates.</p> <p>New saltmarsh habitat (0.7ha) presents new invertebrate habitat opportunities.</p> <p><b>Mitigation:</b> None necessary.</p>	<p><b>Impact:</b> Gain of 0.22ha subtidal and intertidal mudflat habitat for phytobenthos.</p> <p>New saltmarsh habitat (0.7ha) presents opportunities for colonisation by macrophytes and better linkage of saltmarsh habitat in the area, which is currently present as discontinuous and narrow areas.</p> <p><b>Mitigation:</b> None necessary.</p>
Net effects for biological quality elements	<p><b>Net 0.05ha gain of subtidal and intertidal habitat mitigating for impacts on benthic invertebrates and phytobenthos</b></p> <p><b>Net 0.7ha gain of saltmarsh habitat benefitting fish, benthic invertebrates, macrophytes and potentially phytobenthos (if creeks form)</b></p>		

**Table 3 – Assessment Against *Arun* Hydromorphological Quality Elements**

Scheme Component	Channel Morphology & Morphological Diversity	Flow, Tidal Prism & Wave Energy	Water Levels, River Capacity & Floodplain Capacity	Sediment Balance & Sedimentation/Erosion
New steel sheet pile defences encroaching into the river	<p><b>Impact:</b> A narrow strip of intertidal mud is present along both banks of the <i>Arun</i>, but the new steel sheet pile wall will reduce this extent on the left bank, resulting in a reduction in morphological diversity.</p> <p><b>Mitigation:</b> Managed realignment in Reach 6: see below.</p>	<p><b>Impact:</b> The reduction in river bed width occurs within a channel that is between approximately 36m (subtidal) and 110m (intertidal) wide. The narrowest point of the channel is currently at the river mouth where the entrained channel is approximately 32m wide, and this will remain unchanged. Therefore, there will be no new constraint on fluvial or tidal flow.</p> <p>The decrease in channel cross section in Reaches 1 to 5 is small (&lt;21.6% at MLWS and &lt;6.2% at MHWS ) as is the increase in intertidal extent at Reach 6 (&lt;1ha) and will not decrease or increase the tidal prism in the channel.</p> <p>The new steel sheet pile walls will replace vertical walls fabricated from a mixture of hard engineering materials, and will not alter the flow characteristics or wave energy within the channel.</p> <p><b>Mitigation:</b> None necessary.</p>	<p><b>Impact:</b> The decrease in channel cross section in Reaches 1 to 5 is small (&lt;21.6% at MLWS and &lt;6.2% at MHWS) as is the increase in intertidal extent at Reach 6 (&lt;1ha) and will not significantly change the river's capacity or water levels.</p> <p>Floodplain capacity will not change (see separate Flood Risk Assessment).</p> <p><b>Mitigation:</b> None necessary.</p>	<p><b>Impact:</b> The new steel sheet piled wall will replace a similar engineered wall and will have no effect on sediment supply or significant sinks in the water body.</p> <p>As the river bed will be slightly narrowed, local deposition at the toe of the new wall may be slightly less than occurred at the toe of the existing wall as there will be slightly higher (&lt;5.2%) flow velocities than at present.</p> <p><b>Mitigation:</b> Managed realignment in Reach 6: see below.</p>
New and replacement scour protection	<p><b>Impact:</b> Hard engineering will be used to repair scour holes and prevent new scour in areas currently protected by</p>	<p><b>Impact:</b> No significant change compared to existing engineered revetments.</p>	<p><b>Impact:</b> No change.</p> <p><b>Mitigation:</b> None necessary.</p>	<p><b>Impact:</b> No change.</p> <p><b>Mitigation:</b> None necessary.</p>

Scheme Component	Channel Morphology & Morphological Diversity	Flow, Tidal Prism & Wave Energy	Water Levels, River Capacity & Floodplain Capacity	Sediment Balance & Sedimentation/Erosion
	<p>blockstone and concrete revetments (either exposed at the surface or buried under soil/sediment surface layers).</p> <p><b>Mitigation:</b> None necessary.</p>	<p><b>Mitigation:</b> None necessary.</p>		
Managed realignment of the flood embankment	<p><b>Impact:</b> Setting back the flood embankment will establish a short reach of more natural tidal river edge in what is largely a heavily modified reach of the water body. There will be a consequent increase in morphological diversity.</p> <p><b>Mitigation:</b> None necessary.</p>	<p><b>Impact:</b> Setting back the flood embankment is likely to have a localised effect on flow. However, retaining the upstream and downstream embankment sections that are perpendicular to flow is intended to prevent the main channel from migrating. Therefore, flow characteristics and alignment of the main river are not envisaged to change significantly.</p> <p><b>Mitigation:</b> None necessary.</p>	<p><b>Impact:</b> The additional area (1ha) of floodplain formed by realigning the flood embankment will not change water levels in the channel and will provide only a very small (beneficial) increase in channel / floodplain capacity.</p> <p><b>Mitigation:</b> None necessary.</p>	<p><b>Impact:</b> Since flow in the main channel will not change (see explanation to left), any changes in sediment movement will be related only to localised patterns within the new area of subtidal and intertidal habitats, leading to increased morphological diversity (again, see at left).</p> <p><b>Mitigation:</b> None necessary.</p>

**Table 4 – HMWB Mitigation Measures Assessment for the *Arun***

Mitigation Measure	Effect of the Scheme	Explanation
Indirect / offsite mitigation (offsetting measures)	Contributes	In Reach 6 approximately 150m of the engineered flood embankment will be removed and its footprint is expected to develop as intertidal mudflat to an area of approximately 0.22ha The habitat gained here will slightly exceed the habitat lost in Reaches 1-5 (see below).
Retain marginal aquatic and riparian habitats (channel alteration)	Detracts	In Reaches 1 to 5 the new piled wall structure will be riverward of the existing wall, resulting in the loss of a narrow strip of subtidal and intertidal river bed habitat estimated at approximately 0.1ha
Preserve and where possible enhance ecological value of marginal aquatic habitat, banks and riparian zone		In Reach 6 replacement and new scour protection will largely occupy river bank that is already hard engineered but will encroach onto approximately 0.12ha of mudflat. The scour protection will be covered with sediment / soil from the riverward face of the embankment to be removed in Reach 6, to encourage colonisation.
Structures or other mechanisms in place and managed to enable fish to access waters upstream and downstream of the impounding works	No effect	There are no impounding works within the scheme area and none associated with the scheme
Bank rehabilitation / reprofiling [also RBMP Annex C SE0125 "Bank rehabilitation / reprofiling"]	No effect	This measure relates primarily to navigation-related pressures rather than flood and coastal risk management. In Reaches 1 to 5 and the southern part of Reach 6 the river bank is largely a (near) vertical engineered structure and re-profiling is not technically feasible due to space restrictions in a heavily built-up area
Removal of hard bank reinforcement / revetment, or replacement with soft engineering solution	Contributes	In Reach 6 approximately 150m of the engineered flood embankment will be removed and the landward ground levels will be modified to allow approximately 0.7ha of saltmarsh to develop, and form a natural defence in front of the new landward flood embankment. The new flood embankment will be engineered using natural materials, rather than hard engineered. In Reaches 1 to 5 this is not technically feasible due to space restrictions and the proximity of urban development New and replacement scour protection in Reach 6 will be "seeded" with locally won sediment and soil to encourage colonisation but fully "soft" engineering measures are not appropriate for the predicted flow velocities.

## 6 Conclusions

The objectives of the WFD and the South East RBPM include improvement or maintenance of the condition of water bodies' chemical, hydromorphological (physical) and biological conditions sufficient to achieve at least good ecological status or potential by 2027. The *Adur* transitional water body currently has a condition of moderate potential.

The scheme will entail placing new steel sheet pile flood defences in front of existing riverside walls and revetments (comprising steel, concrete, masonry and timber), on-land raising of flood embankments, placing of new and replacement scour protection, and managed realignment of a flood embankment to enable new areas of mudflat and saltmarsh to establish. The generic environmental objectives indicated in Article 4.1 of the WFD have been considered during this assessment of the proposed scheme, with the following conclusions:

- Objective 1 - no changes affecting high status sites. Not applicable as no water bodies potentially affected are at high status.
- Objective 2 - no changes that will cause failure to meet surface water good ecological status or potential, or result in deterioration of surface water ecological status or potential. The new sheet piled floodwall will result in the loss of a strip of subtidal and intertidal mud along the left-hand side of the channel, with consequent effects on invertebrates, periphyton and channel morphological diversity. However, the managed realignment site will result in a minor net increase (0.05ha) in mudflat habitat, as well as creating 0.7ha new saltmarsh habitat, which constitutes a significant increase of this habitat and opportunities for certain fish species in the lower *Arun*. Thus, the scheme makes an overall contribution to the morphological mitigation measures identified for the *Arun* water body by establishing areas of intertidal habitat that exceed the areas that will be lost, by setting back defences in Reach 6 to allow a more natural estuary margin to develop, and by replacing the existing hard engineered embankment with a bioengineered new set-back embankment.

No other long-term effects of the scheme are considered likely to significantly affect water body conditions. Thus the objective is met, and no further assessment under the exception tests in Article 4.7 of the WFD is required.

- Objective 3 - no changes which will permanently prevent or compromise the environmental objectives being met in other water bodies. The scheme will result in no changes in upstream river water bodies or the downstream coastal water body. Therefore the requirements of Article 4.8 of the WFD are met in respect of surface water bodies.
- Objective 4 - no changes that will cause failure to meet good groundwater status or result in deterioration in groundwater status. The scheme will result in no changes in the underlying groundwater body. Therefore the requirements of Article 4.8 of the WFD are met in respect of groundwater bodies.
- Protected Area – must receive at least the same level of protection as afforded by other existing EU Directives. The scheme can be shown to have no consequences for any water body designated under the Habitats, Birds, Nitrates or Bathing Water Directives.

**In summary: the proposed flood alleviation scheme will not result in deterioration in ecological potential in the *Adur* water body or in failure of the water body to achieve good potential in the future; it will not result in any changes which will permanently prevent or compromise the environmental objectives being met in other water bodies upstream or downstream, and will have no effect which could result in deterioration in status of any groundwater body. The quality requirements of Protected Areas will not be compromised by the scheme.**

# Appendix K – Flood Risk Statement

This appendix contains the Flood Risk Statement for the scheme. As well as informing the assessment of the scheme, it is required for planning purposes.



# Flood Risk Statement

Version:1.2

Littlehampton Arun East Bank Tidal Walls Flood  
Defence Scheme

Environment Agency

May 2013



# Flood Risk Statement

Littlehampton Arun East Bank Tidal Walls Flood  
Defence Scheme

Environment Agency

May 2013

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## Document history

### Flood Risk Statement

Littlehampton Arun East Bank Tidal Walls Flood Defence Scheme

Environment Agency

This document has been issued and amended as follows:

Version	Date	Description	Created by	Verified by	Approved by
1.1	05/04/13	Draft	Emma Allan	Joanna Walker Jon Denner Fran Loran	
1.2	16/05/13	Final, including comments from consultation	Emma Allan	Joanna Walker	Joanna Walker

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# 1 Introduction

This statement has been prepared for the Environment Agency to describe the flood risk at Littlehampton. The statement has been prepared for the overarching project, Littlehampton Arun East Bank Tidal Walls Flood Defence Scheme. The purpose of this Flood Risk Statement (FRS) is two-fold:

1. To inform the Environmental Statement (ES) being produced for the overarching Littlehampton Arun East Bank Tidal Walls Detailed Design project.
2. To support two separate planning applications; one for the proposed works north of the A259 road bridge (Reach 6) and along Pharos Quay (Reach 4), and one for public realm enhancements along Arun Parade (Reach 1) and Pier Road (Reach 2). A map showing the reach locations is presented in Section 2, Figure 2.4.

The Littlehampton Arun East Bank Tidal Walls Detailed Design project is the latest in a series of studies/projects undertaken to inform, guide and provide solutions for the management of this coastline. They include:

- i) Littlehampton Arun East Bank Tidal Walls Project Appraisal Report (PAR) (Environment Agency, 2012);
- ii) Rivers Arun to Adur Flood and Erosion Management Strategy (Environment Agency, 2009);
- iii) Arun to Adur Flood Modelling Study (JBA, 2012); and
- ii) River Arun Training Wall Study (Halcrow, 2009).

The FRS draws from the information provided by the studies/projects; no new numerical modelling or analysis has been completed for the present FRS.

## 1.1 Contents of This Statement

This FRS presents an overview of the study area, provides details of the proposed works at Littlehampton, and describes the flood risk at Littlehampton.

The report is split into five sections, as follows:

- Section 2 – Background, including an overview of the study area and details of the proposed works at Littlehampton;
- Section 3 – Description of the flood risk at Littlehampton;
- Section 4 – Conclusions and Recommendations; and
- Section 5 – References.

## 2 Background

### 2.1 The Study Area

Littlehampton is located on the south coast of England in West Sussex (refer to Figure 2.1).

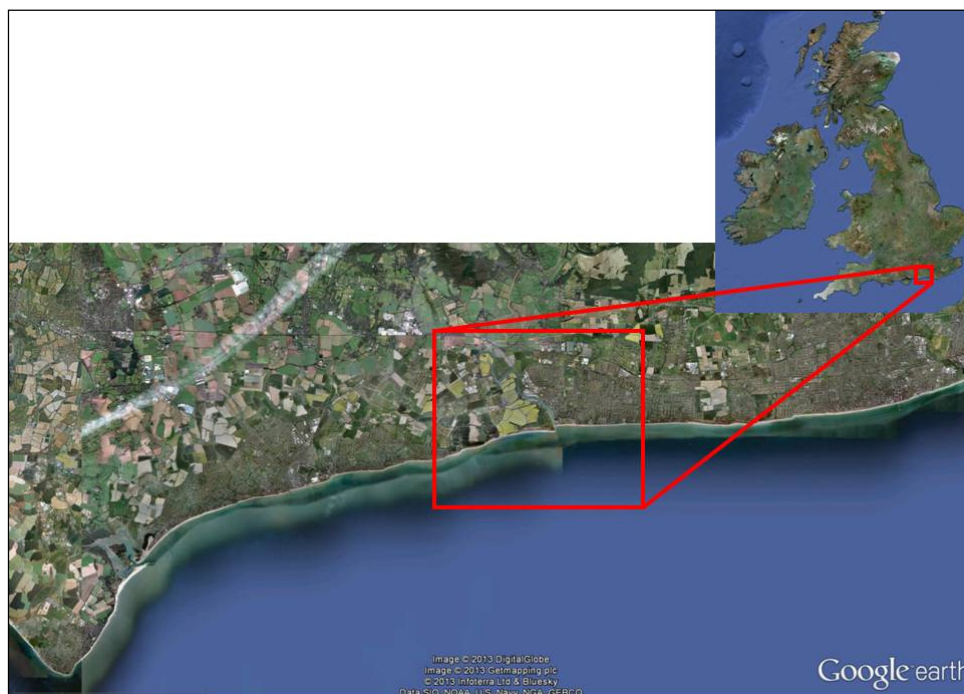


Figure 2.1 Map showing location of Littlehampton. Source of aerial photographs: Google Earth Pro.

Littlehampton is a seaside resort town located on the east bank of the River Arun. North of Littlehampton and the west bank of the River Arun is low-lying, agricultural land. The town is bounded to the north by the A259 and the Littlehampton to London railway line.

The river is tidal up to Pulborough, some 18km inland, and during dry periods the majority of the flow in the lower valley is tidal water (Halcrow, 2009). Water levels in Littlehampton are dominated by coastal conditions although fluvial flows could also be significant during a severe fluvial event (Defra, 2008). Therefore flood risk is predominantly from tides and not fluvial flows.

The low-lying agricultural land is protected from flooding by earth embankments with an average Standard of Protection (SoP) in excess of 1 in 200 (0.5%) and a residual life greater than 20 years. The town of Littlehampton is protected from flooding by a mixture of tidal defences along the east bank of the river, which have a SoP of between 1 in 1 (100%) and 1 in 300 (0.33%) and many have a short residual life (less than 10 yrs).

Within the vicinity of Littlehampton, there is the environmentally designated historic River Road Conservation Area on the east bank of the river. On the west bank of the river, there is the Climping Site of Special Scientific Interest (SSSI), for which the environmental feature is littoral sediments.

Littlehampton has two of the most deprived wards in West Sussex with pockets of high unemployment. Tourism is vital for employment and economic activity in the town. The promenades adjoining the harbour defences form a critical part of the town's tourist attractions.

## 2.2 Shoreline Management

The Littlehampton Arun East Bank Tidal Walls Flood Defence Scheme is the latest in a series of studies/projects undertaken to inform the management of the coastline at Littlehampton and the surrounding area. The following section provides a brief overview of the outcomes of those studies to put the proposed scheme / detailed design and FRS into context.

### 2.2.1 Policy Framework

There are three higher level plans that act as a policy framework in identifying the management approaches for the Strategy period. These are listed below, but not described in any further detail.

- a) The Beachy Head to Selsey Bill Shoreline Management Plan (2006);
- b) The River Arun and Western Streams Catchment Flood Management Plan (2008);
- c) The River Adur Catchment Flood Management Plan (2008).

### 2.2.2 Rivers Arun to Adur Flood and Erosion Management Strategy (2009)

A 100 year strategy for the coastline between the River Arun, Littlehampton and the River Adur, Shoreham-by-Sea, was first devised in 2000 for the Rivers Arun to Adur Coastal Defence Strategy (Scott Wilson, 2000). A review of the 2000 strategy was completed in 2009, as part of the Rivers Arun to Adur Flood and Erosion Management Strategy (Environment Agency, 2009).

In this latest strategy, the coastline being considered as part of the overarching project, Littlehampton Arun East Bank Tidal Walls Detailed Design is covered by one Operational Management Unit (OMUs), OMU1 – River Arun East Bank. The open coastline, east of the River Arun, is covered by OMU2 – Littlehampton to Rustington. The location of the OMU1 and OMU2 is shown in Figure 2.2.

The strategy identified that *'a proportion of the defences in OMU1 currently provide a standard of protection that is significantly below the lower end of the indicative standard and will fall rapidly with sea level rise. Many of the defences have a short residual life (less than 10 yrs) and/or a low crest height. As a result the defences will need significant works or replacement to prevent failure or breach, and hence significant flooding and damage to the settlements they are protecting'*. Following a series of studies, the strategy recommended the following options for Littlehampton (as priority works alongside works at Shoreham in OMU9):

- The preferred policy for OMU1 is 'Improve'. The strategy recommended to improve the SoP by raising the defences using a combination of earth works, sheet piling and concrete capping where appropriate. It was recommended that the works be undertaken in two phases; (i) Phase 1 – raise the defences to 1 in 300 (0.33%) SoP; and (ii) Phase 2 – Replace steel sheet piling at end of residual life.

- The preferred policy for OMU2 is 'Improve/Sustain'. The strategy recommended to improve the SoP through beach management, construction of a sea wall and replacement of timber groynes with either timber groynes or rock groynes at the end of their residual life.



Figure 2.2 Map showing locations of OMU1 and OMU2 (source: Environment Agency, 2012).

### 2.2.3 Littlehampton Arun East Bank Tidal Walls PAR (2012)

Following completion and approval of the Rivers Arun to Adur Flood and Erosion Management Strategy, separate approval was/will be sought for each of the proposed schemes. This included the proposed scheme for OMU1, Littlehampton Arun East Bank Tidal Walls. A Project Appraisal Report (PAR) (Environment Agency, 2012) outlining the preferred option for OMU1 was produced and finally approved by the Environment Agency in 2013. Although, the Rivers Arun to Adur Flood and Erosion Management Strategy considered OMU1 and OMU2 together as they protect one



flood cell, the PAR did not include the proposed scheme for OMU2 (Part 1) as intervention is not proposed until at least Year 35.

The PAR identified that *'the current standard of protection on the River Arun East Bank is an assortment of defence levels. Within Reach 1, 75% has a residual life less than 10 years and provides a standard of protection of 1 in 50 (2%). In Reach 4, 10% has already failed and a further 33% has a residual life less than 5 years and is deteriorating rapidly. The standard of protection here is 1 in 1 (100%). In Reach 6, 5% has a residual life less than 5 years and is also deteriorating rapidly. The remainder of the defences within all Reaches have a residual life between 5 and 35 years. The crest level of the defences provides a standard of protection to infrastructure and property of between 5% and 0.33%'*. To address this, a preferred option was devised through the PAR process.

The Littlehampton Arun East Bank Tidal Walls scheme covers the 2.5 km stretch of the river between the mouth and 0.5 km upstream of the A259 road bridge (Environment Agency, 2012). The frontage has been divided in to six reaches, as listed below and shown on the map in Figure 2.3.

- Reach 1 – mainly concrete pile and plank walls;
- Reach 2 – concrete revetment;
- Reaches 3, 4 and 5 – mainly steel sheet piled walls (harbour defences); and
- Reach 6 – earth embankments.

The preferred option for this frontage, as outlined in the Littlehampton Arun East Bank Tidal Walls PAR for OMU1, consists of approximately 2.1km of new and raised tidal defences. The works comprise a combination of steel sheet piled walls, raised walls (concrete) and raised/new earth embankments. Full details of the works for each reach are provided in Table 2.1.





Table 2.1 Summary of proposed new defences (source: Environment Agency, 2012).

Reach	Type defences	Delivered	SoP	Design Life
1 - Arun Parade	New steel sheet piled wall (308m) to be constructed directly in front of the existing defence. Reinstatement of the promenade, steps and ramps. Arun DC public realm improvement works.	2014	1 in 300 to year 75	100yrs
2 - Pier Road	New steel combi wall (128m) to be constructed directly in front of the existing defence. Reinstatement of the promenade, steps, ramps and new pontoon access. Arun DC public realm improvement works.	2014	1 in 300 to year 75	100yrs
3 A- County Wharf South	Raise existing concrete cap and promenade (535m) when needed (approx. 2030). [This solution would be replaced in approx. 2050 with new steel sheet piled wall which would be constructed directly in front of the existing defence].	2030 & 2050	1 in 300 to year 100	16 yrs & 100 yrs
3B - County Wharf North	New steel sheet piled wall (81m) constructed directly in front of the existing defence. Reinstatement of pontoons and access.	2014	1 in 300 to year 75	100yrs
4A - River Road South	New steel sheet piled wall (74m) to be constructed directly in front of the existing defence.	2014	1 in 300 to year 75	100yrs
4B - River Road North	New steel sheet piled wall (99m) to be constructed directly in front of the existing defence, plus reinstatement of public footpath next to River Road.	2014	1 in 300 to year 75	100yrs
5A - Arun View public house	Raised existing defences (26m) and new steel sheet piled wall (20m) to be constructed directly in front of the existing defence.	2014	1 in 300 to year 75	100yrs
5B - Railway Wharf	The existing defences will be raised by increasing the height of the existing concrete cap (357m). This solution would be replaced in approx. 2030 with new steel sheet piled wall which would be constructed directly in front of the existing defence].	2014 & 2030	1 in 300 to year 100	16 yrs and 100 yrs
6A - South of A259 road bridge	Raise the height of the existing embankment (429m) with a cantilevered plastic pile wall and repair of scour protection	2014	1 in 300 to year 75	100yrs
6B - North of A259 road bridge	Raised earth embankment and new realigned earth embankment (639m) and replace scour protection.	2014	1 in 300 to year 100	100 yrs

## 2.2.4 Detailed Design Stage (Present)

Following approval of the Littlehampton Arun East Bank Tidal Walls PAR, detailed design of the proposed works, for which this FRS forms part, is now underway. Some changes to the proposed works set-out in the PAR (and described in Section 2.2.3) have changed during the detailed design phase. Refer to Table 2.2 and Figure 2.4, which provides details of the current scheme proposals.

The scheme is delivered in partnership with Arun District Council (Arun DC), Littlehampton Harbour Board (LBH) and West Sussex County Council (WSCC). The Environment Agency is the Lead Organisation (Environment Agency, 2012).

*Table 2.2 Summary of Littlehampton Arun East Bank Tidal Walls Flood Defence Scheme current proposals.*

Reach	Type defences	Delivered	SoP	Design Life
1 (Arun Parade)	A new sheet piled vertical flood defence wall installed directly riverward of the existing sheet piled wall and capped with concrete. The wall will be approximately 300m long and 1.3m higher than the existing defence. Tidal flaps will be replaced/ refurbished as necessary. Extensive public realm works landward side will comprise high quality landscape materials, planting, seating areas and accessibility features. Replacement access to the river will be provided. Replacement lighting will be provided.	2014	1 in 300 to year 75	100yrs
2 ( Pier Road)	A new sheet piled vertical flood defence wall installed directly riverward of the existing sloping concrete revetment and capped with concrete. The wall will be approximately 150m long and 1.0m higher than the existing defence and landside works will comprise extensive public realm works. Tidal flaps will be replaced/ refurbished as necessary. Replacement access to the pontoons will be provided. Replacement lighting will be provided.	2014	1 in 300 to year 75	100yrs
3 (walkway)	No works are needed for at least 20 years, when the existing flood defence will be raised using concrete.	2030 & 2050	1 in 300 to year 100	16 yrs & 100 yrs
3 (private frontage)	A raised new vertical sheet piled flood defence wall installed riverward of the existing wall and capped with concrete. The wall will be approximately 100m long and 1.0m higher than the existing wall. Tidal flaps will be replaced/ refurbished as necessary. Replacement access to the pontoons will be provided and private gardens will be reinstated.	2014	1 in 300 to year 75	100yrs

Reach	Type defences	Delivered	SoP	Design Life
4A - River Road South	Defences currently being re-built by a 3 <sup>rd</sup> party developer. Now excluded from the scheme.	N/A	N/A	N/A
4 (Pharos Quay)	In the southern end of this frontage (approximately 40m) a retaining wall will be installed to a height of approximately 1.0m above footpath level. This retaining wall will take a landward alignment and will be installed alongside the footpath. Vehicular and pedestrian access to the private quay (Pharos Quay) will be provided. Works to the northern end of this frontage (adjoining to the footbridge) comprise a new vertical sheet piled wall with concrete cap to a level approximately 0.9m higher than the existing wall. This reach will be landscaped to reflect the Conservation Area status.	2014 & 2050	1 in 300 to year 75	100yrs
5 (Arun View Pub)	The river-facing walls of the Arun View Pub will be flood-proofed using concrete and flood glass units. A short section of vertical sheet piling may be required subject to further detailed structural investigations of the building. Tidal flaps will be replaced/ refurbished as necessary. The walls alongside the patios will be raised using flood glass units and access to the pontoons will be reinstated.	2014	1 in 300 to year 75	100yrs
5 (wharves)	A 300m length (approximately) of the existing flood defences will be raised by construction of a 0.4m high reinforced concrete wall. To the eastern end of this reach the existing concrete cap will be raised, but the majority of this reach works will comprise a retaining wall constructed in-situ on an alignment immediately landward of the existing wall.	2014 & 2030	1 in 300 to year 100	16 yrs and 100 yrs
6 (non-realigned)	The existing flood defence level will be raised by 0.8m through installation of approximately 600m length of steel sheet piled wall driven through the existing embankment, aligned along the riverward side of the existing embankment crest. In the northern 200m length of this reach, the existing embankments will be raised by 0.8m with imported fill. The scour protection at the top of the existing embankment will be repaired using open stone asphalt (which will be of a similar construction detail to the existing protection). Tidal flaps will be replaced/ refurbished as necessary.	2014	1 in 300 to year 75	100yrs

Reach	Type defences	Delivered	SoP	Design Life
6 Realignment	<p>The objective in this area is to promote a salt marsh and mudflat with scour protection at the toe of the A259 highway embankment. The salt marsh and mudflat will be created by removing part of the existing flood embankment and re-using approximately 50% of the material to raise existing ground levels behind. The scour protection will be provided by grassing the highway embankment slopes to the 120 yr design life elevation of 5.45m Above Ordnance Datum.</p> <p>A working platform will be created along the toe of the highway embankment to allow future maintenance of the scour protection and highway embankment. The elevation of this working platform will be approximately 3.85m Above Ordnance Datum (which will be above current ground levels) so that it is accessible during the design life of the scheme (100 years). The platform will be constructed from the remaining 50% of the flood bund material (approximately 2,500m<sup>3</sup>). A 50m section of new earth flood embankment will be constructed using 3,000m<sup>3</sup> of imported fill to join the realigned flood defence with the existing defence.</p> <p>The A259 highways embankment will be protected by the addition of earthworks to form the working platform and the scour protection. Native trees and shrubs will be planted on the road embankment to replace the planting lost. A coastal grass seed mix would be planted on the riverward side of the embankment and a species rich mix on the landward side.</p>	2014	1 in 300 to year 100	100 yrs

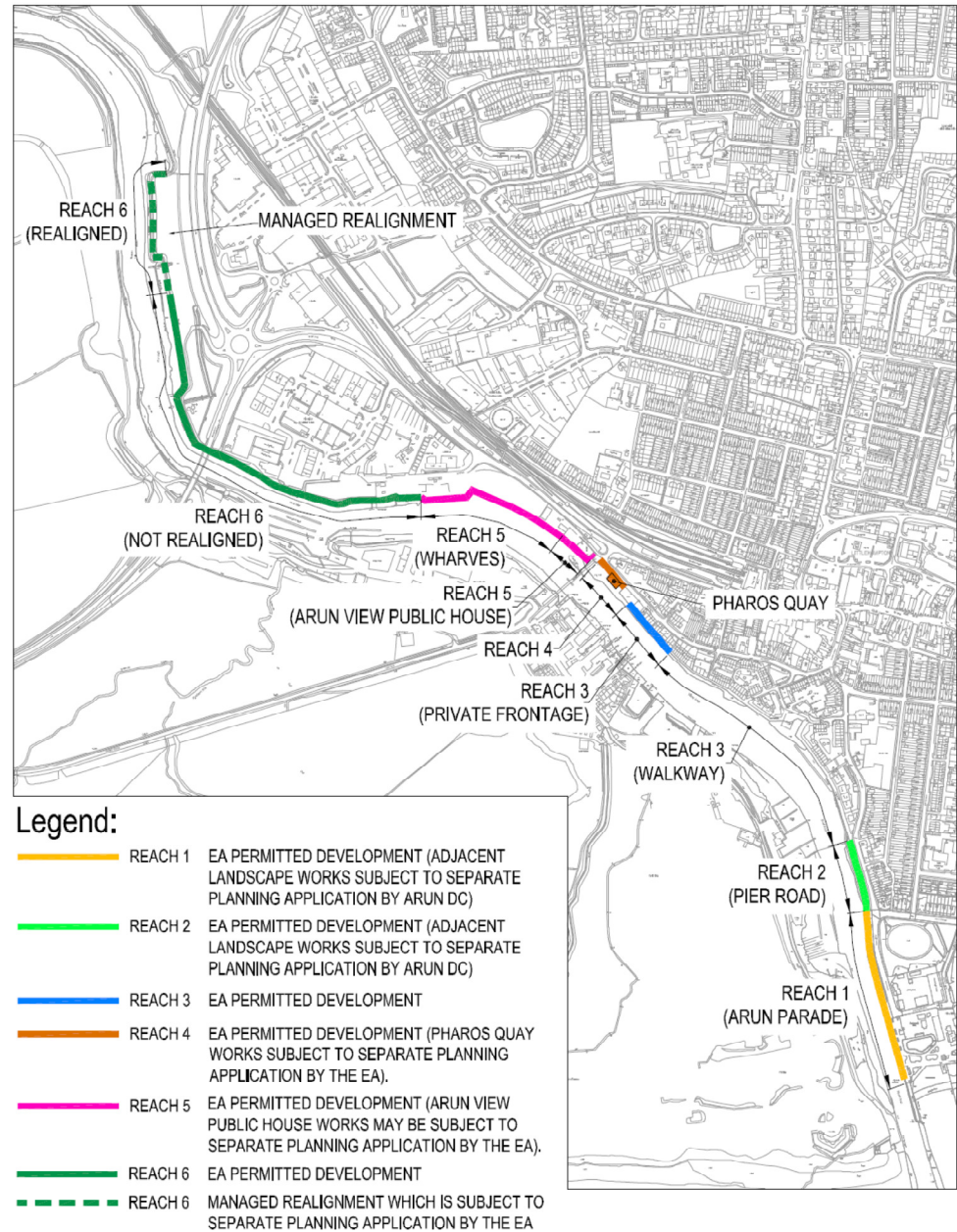


Figure 2.4 Plan of scheme reaches and planning requirements.

### 3 Flood Risk Statement

The FRS covers the same area as covered by the Littlehampton Arun East Bank Tidal Walls scheme, which is the 2.5 km stretch of the river between the mouth and 0.5 km upstream of the A259 road bridge.

The FRS has been prepared in accordance with the National Planning Policy Framework (March 2012), specifically, component 10: Meeting the challenge of climate change, flooding and coastal change, and the accompanying Technical Guidance. Although former Planning Policy Statements (PPS) no longer apply following publication in 2012 of the new National Planning Policy Framework (Department of Communities and Local Government, March 2012), their relevance to the proposed Flood Alleviation Scheme has been considered because:

- The scheme was originally developed and designed when these PPSs were part of national planning policy.
- The new national framework has, at its heart, a presumption in favour of sustainable development and therefore guidance within documents such as former PPS1 Sustainable Development and Climate Change, PPS9 Planning for Biodiversity and Geological Conservation and PPS25 Development and Flood Risk is useful when designing a sustainable Flood Alleviation Scheme.

The FRS will be used to inform the Environmental Statement (ES) and to support two separate planning applications; one for the proposed works north of the A259 road bridge (Reach 6) and along Pharos Quay (Reach 4), and one for public realm enhancements along Arun Parade (Reach 1) and Pier Road (Reach 2).

No new analysis of flood risk has been completed for this FRS, rather the statement draws from existing information, including:

1. Arun to Adur Flood Modelling Study (JBA, 2012) – as part of an ongoing modelling project, which is independent of the Littlehampton Arun East Bank Tidal Walls PAR and detailed design work, the Environment Agency and JBA Consulting are working together to assess the future penetration of sea level rise tides/ waves into the mouth of the River Arun. It should be noted that the modelling does not allow for the inclusion of the increased defence heights resulting from the Littlehampton Arun East Bank Tidal Walls detailed design work.
2. Littlehampton Arun East Bank Tidal Walls Project Appraisal Report (PAR) (Environment Agency, 2012); and
3. Rivers Arun to Adur Flood and Erosion Management Strategy (Environment Agency, 2009).

#### 3.1 History of Flooding

Significant tidal flooding of Littlehampton occurred in 1983 when over 100 houses and 20 businesses were seriously affected by flood damage following overtopping of the east bank defences in Reaches 1, 2, 3 and 4 (Environment Agency, 2012). The depth of flooding was in excess of 1m in places. Some of the existing defences through Littlehampton were raised following this flood event, however, large areas



have also been developed creating additional residential property within the flood cell.

The defences in Reaches 1, 4A (now excluded from scheme) and 6A (now referred to as non-realigned) have been overtopped, although no residential/commercial properties have been affected by flooding. The exception is one commercial property in Reach 4A which is regularly affected.

Wave overtopping of the promenade at Reach 1 occurs regularly in stormy conditions (seaweed is washed onto the promenade), but a small secondary defence built following the floods of 1983 prevents damage to low lying property.

A section of the defences at Reach 4A has failed, and local tidal flooding of the road and a private car park typically occurs annually at this location during the peak of spring tides, but recedes quickly.

The poor defences in Reach 6 (non-realigned) are regularly overtopped, with flooding extending into the industrial wharf area. Due to the nature of the use of this wharf (aggregates handling), this short-duration tidal overtopping during the peak of the tide does not currently impact on operations and raised ground at the back prevents propagation of floodwater inland.

### 3.2 Existing Flood Risk

Along the east bank of the River Arun, the flood risk is relatively high, namely because of the variable and low SoP provided by the existing defences, but also because of the town centre is below current flood defence heights.

- The SoP afforded by the existing defences gives rise to flood risk from overtopping, ranging from 1 in 1 (100%) to 1 in 300 (0.33%) (refer to Table 3.1) and it is anticipated that this SoP will reduce further with sea level rise (Environment Agency, 2012). The onset of widespread flooding to property is estimated to be at a 1 in 20 (5%) event. The main mechanism of flooding along this frontage is likely to be through overtopping and/or breach defences. Overwash and overtopping will cause initial flooding, but a sudden failure of the defences could follow, causing a dramatic rise in the flood levels (Environment Agency, 2012).
- The area around Reach 6 (the area north and south of the A259 road bridge) is significantly below surge water levels and Littlehampton town centre is sited in a topographic bowl. In total, a 500,000m<sup>2</sup> area is in excess of 1m below the 1 in 200 (0.5%) AEP flood level. Parts of the town centre are in excess of 2m below the 1 in 200 water level. The map in Figure 2.2 (the area shaded in blue) shows the extent of land that would be flooded in a 1 in 200 year event with the existing defences in their existing condition.

Table 3.1 Existing SoP of defences along the east bank of the River Arun (source: Environment Agency, 2012). \* Please note that the 'reach' refers to the revised names given during the detailed design phase.

Reach*	Existing defences	Current SoP	Residual Life
1 (Arun Parade)	Concrete post and plank wall, part of section with secondary wall	1 in 50	1 – 10yrs
2 (Pier Road)	Concrete revetment with toe piles and upstand flood wall	1 in 50	5 – 15yrs
3 (walkway)	Steel sheet piles/tubular combi wall	>1 in 300	20 – 35yrs
3 (private frontage)	Concrete and steel sheet piled walls.	1 in 20	20yrs
4 (Pharos Quay)	Masonry and concrete walls	1 in 5 (a 17m section of defences has failed, with local SoP 1 in 1)	0 – 20yrs (Reach 4A) 10 – 20yrs (Reach 4B)
5 (Arun View Pub)	Concrete and steel sheet piled walls	1 in 20	5 – 20yrs
5 (wharves)	Steel sheet piled walls	1 in 20	20 – 30yrs
6 (non realigned)	Embankment and various concrete walls	1 in 10 (46m has no formal defences; localised flooding in a 1 in 1)	1 – 15yrs
6 Realignment	Earth embankment	1 in 10	10 – 20yrs

### 3.3 Implications of Flooding

#### 3.3.1 Do-Nothing Scenario

The PAR (Environment Agency, 2012) reports that if no works are undertaken to the defences along the east bank of the River Arun, then rapid deterioration and further failures are expected in the short term (within the next 10 years). This could result in a breach causing wide-spread flooding, flood damages, health and safety implications and an increasingly unsustainable town, both as a local community and as a regional tourist centre. These findings draw from the flood inundation and erosion modelling completed for the Rivers Arun to Adur Flood and Erosion Management Strategy (Environment Agency, 2009). The results of the flood modelling for the River Arun under a No Active Intervention (i.e. Do Nothing) scenario are presented in Figure 3.1.

The residential and commercial properties that could be lost under this scenario are identified in Table 3.2. Other assets at risk of tidal flooding include Littlehampton



harbour, RNLI station, harbour board office, civic centre, infrastructure (such as roads, services, e.g. electricity sub-station), industrial areas south of the A259 road-bridge, and recreational/tourist assets, including rights of way and public open space/green areas.

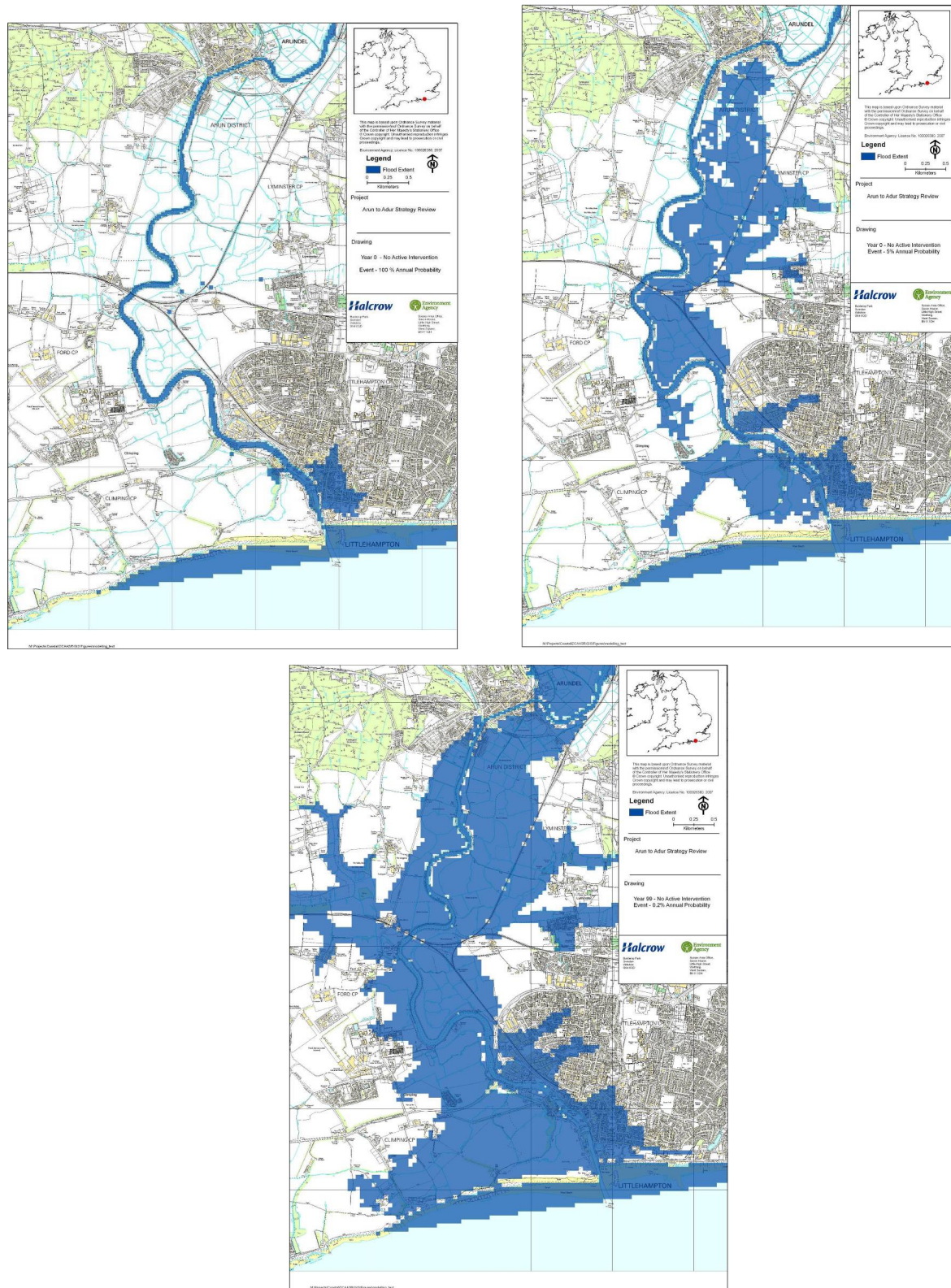


Figure 3.1 Modelled flood extent for No Active Intervention scenario for 1 in 1 year water level (100% annual probability) (top-left); 1 in 20 year water level (5% annual probability) (top-right); and 1 in 500 year water level (0.2% annual probability) (bottom).

Table 3.2 Properties at risk from flooding under a Do-Nothing scenario (Environment Agency, 2012).

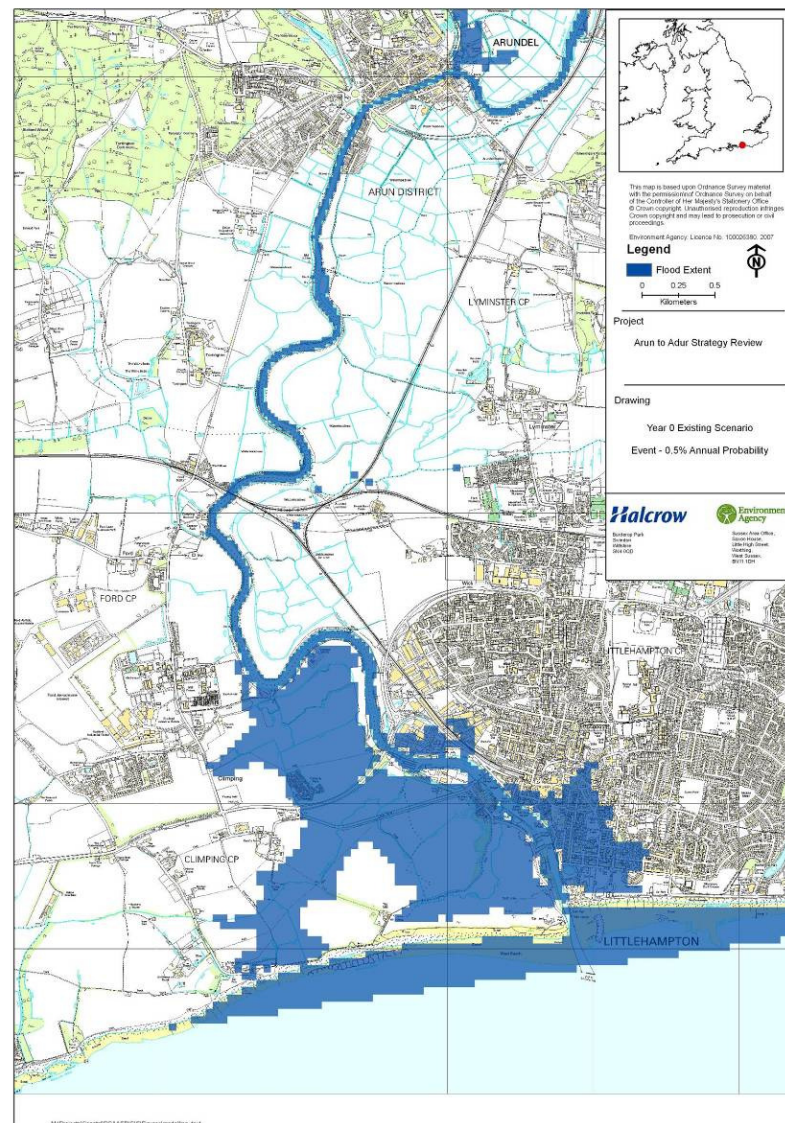
Event	2010			2110 (Do Nothing)		
	Residential	Commercial	Total	Residential	Commercial	Total
1 in 20 (5%)	684	309	993	1597	488	2085
1 in 75 (1.33%)	734	325	1059	1726	507	2233
1 in 100 (1%)	749	335	1084	1765	514	2279
1 in 200 (0.5%)	781	336	1117	1837	521	2358
1 in 300 (0.33%)	790	340	1130	1915	526	2440

### 3.3.2 With Existing Defences

With the existing defences in place, and assuming no change to the SoP, there is a risk of flooding along the east bank of the River Arun at Littlehampton, as well as the west bank of the River Arun.

As described in Section 3.3.1 above, flood inundation and erosion modelling was completed for the Rivers Arun to Adur Flood and Erosion Management Strategy (Environment Agency, 2009). A series of flood inundation maps were produced for the 'Existing Scenario' (i.e. With Existing Defences) and for different water levels. The Existing Scenarios assumes that defences are maintained proactively in their present form to provide protection from breaching, but are not subject to any improvement. Therefore, flooding under the 'Existing Scenario' is occurs due to wave and tidal overtopping of the defences. The results of the flood modelling for the River Arun under the 'Existing Scenario' are presented in Figure 3.2.





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### 3.3.3 During Construction of the New Scheme

During construction, materials and equipment will be stored behind existing defences and temporary defences provided by the Contractor during the works to limit the potential for damage and water pollution.

Whilst working on the project, the Contractor will register with the local Environment Agency Flood Incident Management team for automatic notification of flood warnings to ensure that equipment, materials and personnel can be removed from the area if the risk is severe enough.

For many reaches the existing defences will remain in place, but where existing defences are compromised during the construction work, temporary works will ensure risk to property is managed. Any temporary works will also require Environment Agency flood defence consent, which will be used to control the risk.

Along the River Arun, there are a number of tidal flaps at the end of some outfalls which help to manage flood risk for lower magnitude events. As described in Table 2.2, any tidal flaps affected by the works will be replaced / refurbished as necessary.

Any drainage system disturbed during construction along Reaches 1-6 will be re-instated or replaced to the same standard as before the works. In addition, provision has been made in the Contractor's contract for them to provide temporary defences to a high standard of protection.

### 3.3.4 With New Scheme in Place

With the new scheme on the east bank of the River Arun, the town of Littlehampton will be protected from a 1 in 300 tidal flood event. The scheme is not anticipated to have an effect on water levels outside of those that would occur naturally under sea level rise. The rationale behind this is described below.

#### 3.3.4.1 East Bank River Arun

With the 2.1km of new and raised tidal defences in place, the 790 residential and 340 commercial properties in Littlehampton currently at risk from flooding would be protected into the future from a 1 in 300 year tidal flood event. As sea levels rise the number of properties that the improved defence will protect will increase (subject to future works phases being implemented).

Further up river, the scheme includes for the riverwall on the east bank to be reconstructed; this is to be achieved by driving a new steel piled wall slightly into the river. The effect of this will be to slightly narrow the river and thus marginally throttle the flows able to come in from the sea, however, any affect on the west bank will be negligible.

The scheme does not provide any increased protection to surface water/groundwater flooding behind the defences.

#### 3.3.4.2 West Bank River Arun

The scheme and SSSI are located within the River Arun estuary, very close to the mouth of the river. Within this system, water levels are always dominated by sea levels, therefore, by changing the level of defences or width of channel there would not be any direct impact on the habitats covered by the Climping Beach SSSI (flora

and fauna) and West Beach Local Nature Reserve (LNR) which is part located within Climping Beach SSSI.

## **4 Conclusions and Recommendations**

### **4.1 Conclusions**

The development is deemed appropriate under the National Planning Policy Framework.

The scheme will reduce current flood risk from a 1 in 300 year flood to 790 residential, 340 commercial properties, as well as other assets including Littlehampton harbour, RNLI station, harbour board office, civic centre, infrastructure (such as roads, services, e.g. electricity sub-station), industrial areas south of the A259 road-bridge, and recreational/tourist assets, including rights of way and public open space/green areas. As sea levels rise, the scheme will protect further properties and infrastructure (subject to future works phases being implemented).

The risk of flooding in the lower reaches of the River Arun is dominated by tidal effects, i.e. the sea flowing into the river on a high spring tide and/or surge and inundating land rather than fluvial flow coming down from upstream. The SOP on the west bank is currently lower than those of the east bank; as such the west bank will start and continue to flood before the current or proposed flood defence levels are reached on the east bank. The raising of the defence levels on the east bank will therefore have a negligible effect on the west bank.

### **4.2 Recommendations**

Due to the overall reduction in flood risk achieved by this scheme it is recommended that planning consent should not be refused on flood risk grounds.

## 5 References

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