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Inner Forth Futurescape

Feasibility Study

Final Report

January 2012

Helping to deliver the CSGN Central Scotland Green Network

SEPA Scottish Environment Protection Agency

Scottish Natural Heritage
All of nature for all of Scotland

Contents

1. Introduction

The Inner Forth's intertidal habitats, including mudflat and saltmarsh, are protected under national and European law through designation as a Site of Special Scientific Interest (SSSI) and a Special Protection Area (SPA) because of their outstanding value for wildlife.

However, the Inner Forth is also a waterway with a long history of industrial, agricultural, transport and recreational use that has heavily influenced the morphology and condition of the area. In total, it is thought that approximately 50% of intertidal habitat has been lost in the Inner Forth over the past 400 years.

Pressure on the area's natural habitats is likely to continue in the future with further development proposed, including National Developments identified in the National Planning Framework 2. Climate change will result in new pressures from sea level rise, storm surges and erosion. Some of the Inner Forth area is already at significant risk of flooding and this risk is likely to increase.

In recognition of these pressures, the potential to mitigate the effects through large-scale habitat creation and management and the current policy drivers supporting such an approach, RSPB Scotland proposed the Inner Forth Futurescape. This established the principle that wetland and intertidal habitat creation has the potential to deliver multiple benefits for biodiversity, water quality, flood risk management, climate change mitigation, public access and recreation and that a partnership approach would be required to deliver a project on this scale across Local Authority boundaries.

While a broad area of search had been identified for habitat creation opportunities, a need existed to investigate the practicality and desirability of delivering habitat creation projects within this area. Working in partnership with SEPA, SNH, Local Authorities, CSGN and FCS, this project has explored the potential for habitat management and creation on the Inner Forth to deliver a wide range of benefits. This has been delivered through a review of existing knowledge and habitat creation experience in the Inner Forth and a detailed evaluation of individual sites.

This report presents the results of the review and site assessments, recommendations on projects to take forward and an action plan setting out the steps that would be required to deliver the Futurescape aims.

2.Project Evolution and Methods

There has been recognition for some time that the Inner Forth area has suffered from significant habitat loss and that the area is under considerable development pressure, which is likely to be compounded in the future by the effects of climate change and increasing disturbance. Numbers of birds recorded within the Firth of Forth SPA have declined and although establishing the cause of this decline is not straightforward, there is concern that habitat and disturbance pressures are a contributing factor and that to date no strategic approach to mitigating or compensating for pressures has been taken. This type of strategic approach is required to ensure that the SPA interest is maintained and that development considered to be of national need can take place in the area. During preparation of the NPF2, RSPB Scotland therefore advocated the inclusion of a Central Scotland Green Network as a National Development and proposed that creation of new wetland habitat on a landscape scale within the Inner Forth area would be a valuable component of such a network.

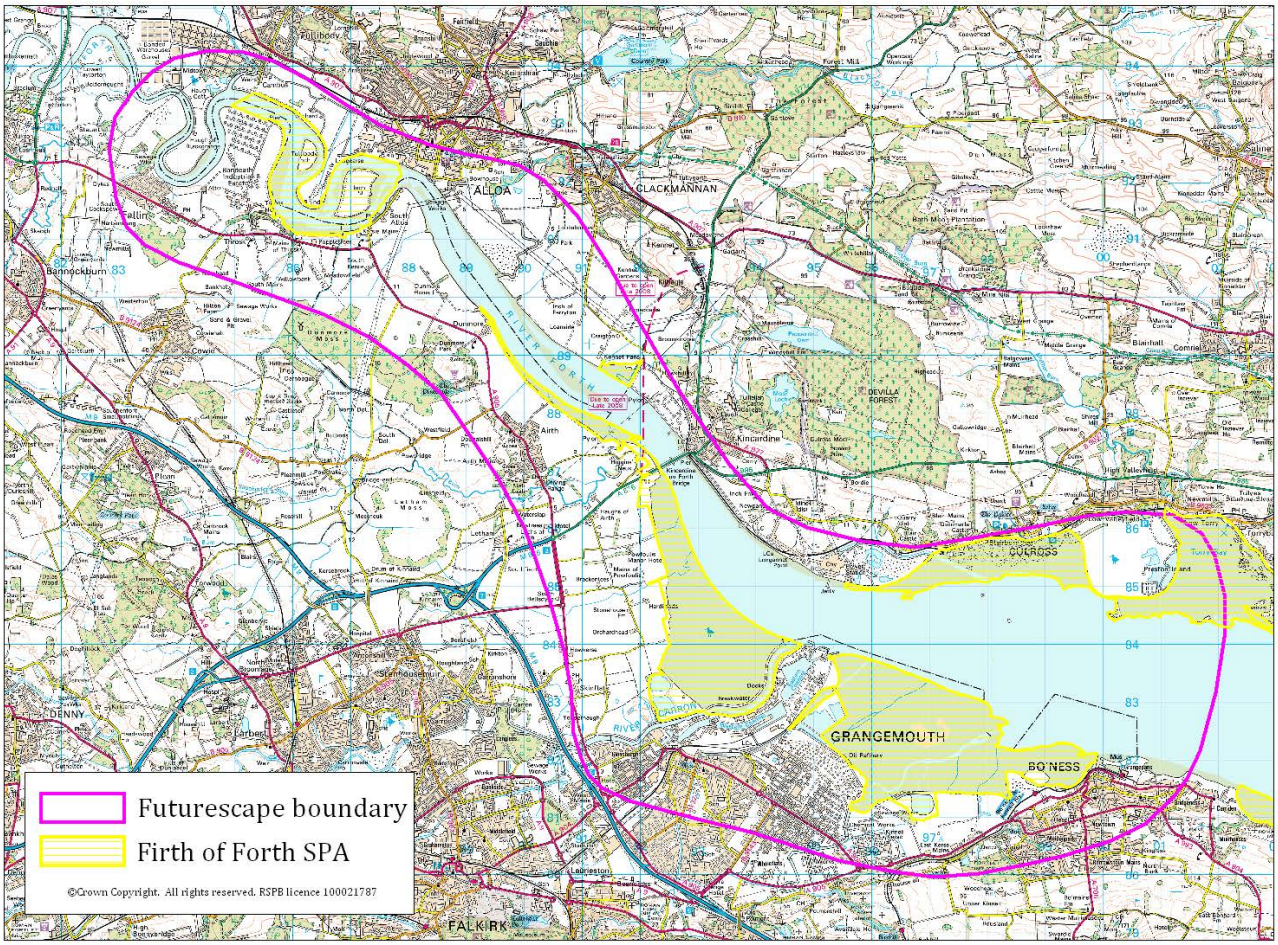

Figure 1: Futurescape boundary identified in the Firth of Forth Vision Paper

A draft vision paper for the Inner Forth area was produced by RSPB in 2009 and finalised in 2010. This set out the opportunities for delivering multiple benefits through such a landscape-scale approach. The vision document received widespread support from agencies and local and national government. It was therefore proposed to develop the idea further through a one year feasibility study, investigating in further detail whether practical habitat creation opportunities exist in the area (Figure 1) and what the benefits and disadvantages of each might be.

Funding was secured from CSGN, SEPA and SNH to employ a project officer for a year to carry out this assessment and produce a report. An action plan was seen as a crucial component to ensure that the feasibility study leads to practical delivery. Use of a project officer to carry out this work was proposed to enable maximum time to be spent on the assessment, good local knowledge to be built up and a relationship with key partners and stakeholders to be established. These benefits were felt less likely to result from a short-term consultancy contract.

Throughout the project, regular meetings of a steering group including representatives of SEPA, SNH, Falkirk Council, Stirling Council, Clackmannanshire Council, CSGN/CSFT and FCS have ensured that partners have been able to check progress and oversee the approach taken. In addition, the project officer has worked closely with these organisations to ensure the knowledge, expertise and data held by them has informed the study.

In agreement with the Steering Group, the project has included a summary of habitat creation experience in the Inner Forth to date and a review of techniques which potentially may be utilised in creating and restoring intertidal habitat. Key sites on the Inner Forth have then been evaluated with individual site assessments. The site assessments are based on a combination of site visits and desk top study. They consider current site conditions, options for future management, potential conservation value of habitat creation and likely benefits to wildlife and people. The costs and benefits of several options are considered for each site, including a 'do nothing' scenario. Maps detailing the areas in question and potential future management options form an integral aspect of the site assessment. Together with the feasibility and practicality of individual projects and the potential of these sites to contribute to the Futurescape programme, this information has been used to present a recommendation for each site.

The detailed site assessments are contained within appendices to this report and a summary of findings is included in section 7. The recommendations and conclusions are presented for the project area as a whole, with a summary of net costs and benefits. The actions needed to progress these projects, both individually and as a coordinated programme, are presented in a partnership delivery plan.

3. Inner Forth Futurescape Vision, Aims and Project Objectives

Vision

Our vision for 2030 is for large-scale habitat creation across a 2000 ha area of the Inner Forth floodplain between Stirling and Bo'ness. By creating a network of new wetland habitats including saltmarsh, mudflat and reedbed we will provide a healthy environment for wildlife and help to achieve a wide range of other benefits for people living around the Forth.

The surrounding farmland will become richer in wildlife, with woodlands, riverbanks and field margins all supporting more abundant and richer biodiversity. Newly created wetlands will help us to manage floods and adapt to the changes that climate change will bring.

Conservation organisations, government agencies, Local Authorities and land managers will work in partnership to deliver this new approach and make the most of the opportunities for sustainable flood management, recreation and education. The Inner Forth's location in Central Scotland will make it a showcase of good practice within easy reach of the majority of Scotland's population and local communities will enjoy new opportunities to access and enjoy the area.

Aims

The Inner Forth Futurescape has the following aims:

- **Recreate, restore and enhance BAP priority habitats**
  There has been significant habitat loss on the Forth because of historic development and land use change. The Futurescape aims to identify the best opportunities for habitat creation and management so that they can be safeguarded and to deliver these habitat changes.

- **Improve conditions for SPA and BAP species**
  Through delivery of habitat creation and management, the Futurescape will directly benefit a range of species for which the Firth of Forth is designated and a wider range of priority BAP species on farmland. The Futurescape will provide a strategic direction and priority for biodiversity projects in the area.

- **Help deliver the Central Scotland Green Network**
  A high quality environment and Green 'infrastructure' are an essential, integral, part of delivering sustainable economic growth and creating high quality places. Networks of linked sites often have greater value than isolated ones, for example by providing greater accessibility. The Futurescape shares many aims of the Central Scotland Green Network and will form an exemplar project, demonstrating the multiple benefits of habitat networks.

- **Contribute to Water Framework Directive delivery**
  Large-scale habitat creation projects will help deliver the Forth Area Management Plan and achieve Water Framework Directive (WFD) targets for all water bodies to reach Good

Ecological Status by 2015, for example, by using managed realignment to recreate intertidal habitat and deliver more natural waterbody morphology.

- **Contribute to delivery of sustainable flood management**
  The Flood Risk Management (Scotland) Act 2009 introduces a new sustainable approach to flood management. This includes a requirement to assess and consider whether restoring and enhancing natural features and landscapes could contribute to food risk management. The Futurescape will deliver large-scale habitat creation projects that could help implement the Act.

- **Create new opportunities for access to, enjoyment of and understanding of wildlife**
  Habitat creation sites are powerful tools for engaging people with nature, encouraging access to the environment, supporting sustainable tourism and delivering environmental education. The Inner Forth Futurescape aims to deliver this in an area that is accessible to a large proportion of the Scottish population.

Objectives

This project is the first stage of delivery of the Inner Forth Futurescape and the above vision and aims. The Steering Group agreed the following objectives for the project's one year duration:

1. Produce a strategy and delivery plan for landscape scale habitat restoration and management along the Inner Forth that will enable RSPB and partners to implement the Inner Forth Futurescape project.
2. Collate existing information on the project area, including data on biodiversity, land use, morphological alteration, flood risk and recreational use and analyse this information to ensure the strategy is based on the best possible information.
3. Investigate the feasibility and desirability of a range of land management, advisory, access and people engagement opportunities and include those considered feasible and desirable in the strategy.
4. Raise awareness of the project among relevant organisations and people living and working in the area and use the views of these stakeholders to inform the strategy.
5. Identify requirements for further research or feasibility studies, for example hydrological modelling or technical feasibility studies, required to deliver habitat projects.
6. Deliver initial projects that form part of the strategy, where feasible in the timescale of the project.

4. Background

Inner Forth Project Area Description

The Firth of Forth is the estuary of the River Forth and is a classic trumpet-shaped estuary, draining the eastern part of the Central Belt of Scotland and flowing east for approximately 48 km from its tidal limit near Stirling. From Stirling it meanders through a flat floodplain towards Alloa, before starting to widen significantly at Kincardine from where it maintains an approximate width of 2.5 km from Bo'ness to its seaward end. The Inner Forth, which is the focus of this project, has been defined as the part of the estuary from the tidal limit at Stirling to the point where the estuary widens at Bo'ness (see Figure 1). This section retains the riverine characteristics of being heavily influenced by its floodplain setting but is also where the intertidal habitats play a particularly significant part in the estuary's ecology and function.

The Forth drains a large catchment with the majority of its tributaries entering above the tidal limit. The Forth's tributaries joining below the tidal limit are the rivers Allan, Devon and Black Devon on the north shore with the Bannock Burn, Pow Burn, rivers Carron and Avon on the south shore.

Tides in the Forth are semi-diurnal (two high and two low tides per 24 hours) and the tidal range (at Rosyth) is 5 m at spring tides and 2.6 m at neaps. Double high and low waters (leaky or 'lackie' tides) are a feature of the river between Grangemouth and Stirling and occur as a result of geomorphological conditions in the estuary.

Two river islands (Inches) are found near Alloa; Alloa Inch, the larger of the two islands and Tullibody Inch. The inner estuary is relatively shallow with depths of between 2-3 m, although it reaches depths of 9 m at Kincardine Bridge and 6.9 m at Alloa where the river flow is constrained.

There are extensive areas of mudflats, particularly at Kinneil, Skinflats and Torry and several linear mud and sandbanks in the middle of the river at Airth and downstream at Dunmore with occasional rocky outcrops and artificial structures. The remnants of the Forth's once extensive saltmarsh are to be found primarily on the south bank of the Forth between South Alloa and Grangemouth and comprise a strip between 5 and 80 m wide sandwiched between mudflats and sea embankments. There is only a very small remnant of naturally functioning inter-tidal zone (mudflats to saltmarsh to carse cliff) in the entire estuary, situated from the Kincardine Bridge to 0.5 km downstream.

The landscape of the Inner Forth has been significantly shaped by the river and by human use. The Forth has created a flat floodplain to the south of the Ochil hills and below Kincardine the Forth becomes more estuarine in nature. The river and access to the sea has contributed to the area's industrial and agricultural development through provision of resources and trading links with Europe. Today the landscape is dominated by Longannet Power Station on the north bank of the river and the industrial complex at Grangemouth on the south bank. The adjacent and

surrounding landscape is a low lying mix of agricultural land (mainly cereal production and improved grass) and urban, with the towns of Alloa and Grangemouth and Bo'ness the immediate centres of population. There is little woodland though there are shelter belts and scattered hedgerows.

Ecological Significance of the Inner Forth

Designations

The Firth of Forth is of international and national importance to bird populations and other biodiversity, which is reflected through its designation as a Site of Special Scientific Interest (SSSI), Special Protection Area (SPA) and RAMSAR site. The Firth of Forth SSSI, covering a total of 7420 ha was designated in 2000 for its coastal habitats, vascular plants, invertebrates and a large number of breeding and non breeding birds. The Firth of Forth SPA (Figure 1) is designated for its wintering waterfowl, waders and passage birds. The Convention on Wetlands of International Importance**,** the Ramsar Convention, is an intergovernmental treaty that provides the framework for national action and international cooperation for the conservation and wise use of wetlands and their resources. The Firth of Forth was listed as a 'RAMSAR' site in 2001. In addition, several islands in the outer Forth have important populations of breeding seabirds and are designated as the Forth Islands SPA.

Birds

The Firth of Forth estuary is extremely important for its abundant numbers of wintering waterfowl and wader and holds nationally and internationally significant numbers; the Wetland Bird Survey (WeBS) reports show that in the winters between 1988/89 and 1992/93 the estuary supported an average of 79,000 birds comprising 37,000 wildfowl and 42,000 waders. Between 2004/05 and 2008/09, the total was 76,981. For several species the Forth is of particular importance, including pink-footed goose, shelduck, bar-tailed godwit and redshank. Waders, wildfowl, gulls and terns require undisturbed feeding and roosting areas and utilise a variety of habitats in the Inner Forth area from Blackness Bay to Haugh of Blackgrange just downstream of Stirling.

The River Forth itself is used by waterbirds such as cormorants, red-breasted mergansers, common and Sandwich terns to fish and seabirds are occasionally recorded upstream of the Kincardine Bridge.

There are three key sites within the Inner Forth where the majority of feeding birds are concentrated; the intertidal mudflats at Kinneil, Skinflats on the south shore and Torry Bay on the north shore. A number of smaller scattered sites and intertidal areas in the area for feeding and roosting. Adjacent farmland is important to wildfowl such as pink-footed and greylag geese and waders such as curlew, lapwing and golden plover. Undisturbed roost sites are particularly important to birds and a number of sites are used in the Inner Forth; the ash lagoons at Valleyfield, Kinneil Lagoons, Bothkennar Pools and Alloa Inch with higher saltmarsh areas also used along the south shore.

Numbers of certain species have fluctuated and declined, with notable declines recorded for shelduck, scaup, goldeneye, grey plover, lapwing and turnstone (WeBS alerts). The condition of the features of the Firth of Forth SSSI are mixed, with some assessed as being in 'unfavourable declining' condition and others as 'favourable maintained'. Recent WeBS counts show declines in golden plover, lapwing and curlew. Factors not related to the immediate environment of the Forth will have undoubtedly played a role in these declines and declines in some species will mirror national and international trends. However, local factors such as disturbance and changes in agricultural practices (M Bell, pers comm.) may be impacting on numbers and distribution of birds in the Inner Forth.

Saltmarsh and surrounding farmland holds regionally significant populations of breeding and wintering passerines such as tree sparrow and twite.

Mammals

Terrestrial mammals are not a notable feature of the Inner Forth area but several species of interest are present although there is a lack of information on most species.

Brown hares are widespread in areas around the Forth and are frequently seen in saltmarsh. Foxes are relatively common but the status of badger is unknown. Otters are present on the Inner Forth and are known at Black Devon, Bothkennar, Haugh of Blackgrange, Kennet Pans and Skinflats and are probably fairly widespread along the Forth. The status of water vole in tributaries and drainage ditches in not known although thought to be present in and around the Grangemouth area. Shrews and voles will be present in saltmarsh and adjacent habitats. Stoats and weasels are present and frequent the embankments along the river. The Forth Catchment Biosecurity Management Plan notes that American mink are "likely to be present on coastal rivers" and are being trapped by several local angling clubs on tributaries. Roe deer are common along the Inner Forth and frequent the embankments and have been seen out on mudflats at Skinflats at low tides.

Marine mammals are a notable feature of the outer Forth with the fourth largest breeding colony of grey seals in the UK present on the Isle of May. Common seals are less frequent but both species are seen occasionally upstream as far as Cambus.

Harbour porpoises are the most common cetaceans present in the Forth and have been recorded as far upstream as Alloa with stranded animals found at the River Allan. Bottlenose dolphins have been recorded at Kincardine. Over twenty species of cetaceans have been recorded in the Forth and there are historical records and evidence of cetaceans as far upstream as Airth and Alloa.

Sea level rise and increasing salinities along with changes in distribution and increasing fish populations in the Forth mean that there is a likelihood that marine mammals and cetaceans will become more common in the Inner Forth.

Fish

The Forth is an important area for fish populations, both for resident estuarine and migratory species. The population and distribution of fish species within the Inner Forth fluctuates annually

depending on time of year and differing life cycles of fish species. Intertidal and saltmarsh areas are of significant importance to fish populations as nursery and feeding areas. Thirty-eight species of fish have been recorded by SEPA trawl surveys and the estuary is used by a wide range of freshwater and marine species with a wide range of ecological and biological requirements.

Historically, the Forth supported significant commercial fisheries ranging from Atlantic salmon to sparling but in both cases, catches have declined and ceased in recent decades. Key fish species still occurring in the Forth include Atlantic salmon (*Salmo salar*), sparling (*Osmerus eperlanus*), river lamprey (*Lampetra fluviatlis*), sea lamprey (*Petromyzon marinus*), Sea trout (*Salmo trutta*), European eel (*Anguilla anguilla*) and thick-lipped grey mullet (*Chelon labrosus*).

Invertebrates

The Inner Forth, like most estuaries in the UK, supports a range of invertebrates from aquatic to terrestrial and non-marine invertebrates in various habitats from intertidal mud to high saltmarsh. Some species are restricted to a particular habitat, while others depend on different habitats throughout different stages of their life cycle. Several thousand species of invertebrates are associated with estuarine habitats, although the Inner Forth will lack the diversity and species richness of estuaries further south.

The Inner Forth aquatic and marine invertebrate assemblage includes crustaceans, molluscs and worms which are a vital food source for birds. The muds and sediments of the Inner Forth, while having a low diversity of species, have a high biomass which is concentrated in several key areas such as Kinneil, Skinflats and Torry Bay. The concentrations of invertebrate species are generally determined by the location of the intertidal area within the wider estuary and other factors such as sediment size and characteristics and organic matter content within the mud. Key invertebrate species present in intertidal mud in the Inner Forth include a gastropod snail, (*Hydrobia ulvae*); a clam, the Baltic tellin (*Macoma balthica*) and a ragworm (*Nereis diversicolor*) which form the main prey items of feeding waders and wildfowl in the Inner Forth.

Terrestrial and non-marine invertebrates in the Inner Forth occupy a variety of habitats ranging from saltmarsh to brackish ditches. Invertebrates occupying such habitats have to cope with the rise and fall of tides and with the ephemeral and temporary nature of habitats in or adjacent to intertidal and saltmarsh. Saltmarsh invertebrates are composed of those from territorial, freshwater and marine origins occupying niches and requiring specific vegetation type and structure. Micro-habitats within saltmarsh such as pools or ditches can be important for water beetles and bugs while the strandline is important for woodlice, specialist flies, spiders and beetles. Inappropriate grazing of livestock on saltmarsh can be detrimental to the invertebrate interest of a saltmarsh but little grazing currently takes place on Inner Forth saltmarshes.

The two saline lagoons on the Inner Forth at Kinneil Lagoons and Bothkennar Pools are home to several notable invertebrates namely two species of hoverfly, *Parhelophilus consimilis* and *Sphaerophoria loewi*; a soldier fly, *Beris clavipes* and a beetle, *Brachygluta helferi.* Cambus Pools are home to the rare sea slug *Tenellia adspersa*. One feature of the Firth of Forth SSSI is its assemblage of beetles which was classed as being in an Unfavourable Declining condition in 2000.

The interface between saline and freshwater habitats such as temporary pools, seepages, ditches landward of embankments provide important habitats for invertebrates while reedbeds in the Inner Forth at Kinneil, Bothkennar, Kennet Pans and Haugh of Blackgrange could host notable species.

There is good terrestrial invertebrate habitat in the Inner Forth area. Brownfield sites near Skinflats and in Carron, Grangemouth and Bo'ness have a number of uncommon species including the Hobo spider (*Tegenaria agrestis*) and the ground beetle *Amara praetermissa.* The low lying nature of land surrounding the Inner Forth with drainage ditches and seasonally flooded areas may be significant for invertebrates and has the potential to be improved with appropriate management. Just outwith the project area, lowland raised bogs at Wester Moss and Dunmore hold populations of large heath butterfly and the rare bog sun-jumper spider (*Heliophanus damfi*).

Habitats

The Inner Forth area currently comprises a network of intertidal habitats which despite not being contiguous, are functionally linked. The habitat types found in the area are scarce within a national context and their importance is reflected in the area's designations.

The intertidal mudflats of the Inner Forth are a defining feature and in places can reach up to 2 km in width. The three extensive areas of mudflats on the Inner Forth are over 600 ha at Kinneil on the south shore (between Grangemouth and Bo'ness), over 400 ha at Skinflats on the south shore (to the north west of Grangemouth between the River Carron mouth and Kincardine Bridge) and 300 ha at Torry Bay on the north shore (east of Valleyfield Lagoons). The mudflats are composed of fine grained muds and silts deposited by sheltered conditions within the estuary. The size of sediment particles of which the muds are composed varies within the estuary, with finer muds generally being found upstream of the Kincardine Bridge. The mudflats are relatively stable and exist in a dynamic equilibrium where deposition of sediments exceeds erosion but will be impacted by artificial constraints and influenced by factors such as sea level rise. The mudflats supports a rich invertebrate fauna which is of fundamental importance to bird and fish populations.

Saltmarsh on the Inner Forth is found in a narrow strip between 5 to 300 m wide on the south bank between South Alloa and Grangemouth and in small isolated patches on the north bank at Kennet Pans, Inch of Ferryton and more extensively at Alloa Inches. The presence of embankments on both shores of the Inner Forth restricts the development of saltmarsh and influences the vegetation structure and species composition within the saltmarsh. The transition from intertidal mud to lower, middle then upper saltmarsh is largely absent in the Inner Forth and is to be found in only one location immediately south of the Kincardine Bridge. Saltmarsh in the Inner Forth is typical of this habitat elsewhere in Scotland, being composed of and dominated by *Puccinellia maritima* and *Juncus gerardii* and with a lower species diversity than saltmarshes further south in the UK.

There are two saline lagoons in the Inner Forth area, at Kinneil Lagoons and Bothkennar Pools, Skinflats. Both have been created indirectly as a result of human activity, namely land reclamation at Kinneil and mining subsidence coupled with land drainage issues at Bothkennar. Saline

Lagoons are a scarce and vulnerable habitat and a priority habitat under the EC Habitats Directive. Saline lagoons can develop specialist invertebrate fauna and scarce invertebrates associated with saline lagoons have been recorded at Bothkennar. Both lagoons are important sites within the Inner Forth for feeding and roosting wildfowl, waders, gulls and terns.

Several brackish pools are to be found in the Inner Forth at Bothkennar, Cambus, and Black Devon Wetlands and these are important as the transitional zone between freshwater and saltwater is likely to support specialised flora and fauna, scarce in the area. Often associated with brackish water and found alongside the banks of the Forth (at Haugh of Blackgrange) and Black Devon, at Bothkennar Pools and at Kinneil Lagoons are stands of common reed *(Phragmites australis)* which is a valuable and uncommon habitat with potential to support a range of specialised flora and fauna. Reedbeds are especially valuable as both breeding and roosting sites for a variety of bird species, both in tidal and non-tidal locations. Areas of scrub composed of mainly birch, willow or hawthorn are found in scattered locations in the area at Blackness, Kinneil, Bothkennar and Black Devon.

Landward of the estuary, the predominant land use and habitat is either industrial or agricultural with hedgerows and shelter belts found throughout the area which undoubtedly play an important role in farmland bird populations. The agricultural land is predominantly in cereal, silage and hay production with grazing beef cattle scattered throughout the area.

Woodland habitat is scarce, with no extensive woodland present within the project area, with the exception of Dunmore Wood near Airth, which is a mixed broadleaved and conifer woodland. Devilla Forest (a commercial conifer forest near Kincardine) and Shore Woods near Blackness (an interesting, well-developed broadleaved woodland) lie just outside the project area.

Pressures Affecting the Environment of the Forth

Historical Habitat Loss

Land-claim for agricultural purposes from the 17th Century onwards resulted in loss of extensive areas of mudflats and saltmarsh (Figure 2). This resulted in the landscape of the Inner Forth estuary gradually changing over three centuries from that of a shallow wide river with creeks, inlets, saltmarsh and mudflats to the landscape that we are familiar with today. Land was reclaimed from South Alloa to Kinneil on the south bank and from Alloa to Longannet on the north bank.

From the mid 19th Century the objective of land claim changed from agricultural use to industrial use. Land around Bo'ness and Grangemouth was reclaimed for industrial and harbour developments and the River Carron was straightened in the early 19th Century at Grangemouth to facilitate development of the docks. The chemical and later petro-chemical refining complex was developed on partly reclaimed land but the bulk of the refinery is located on raised carse cliff. At Kinneil, an embankment was constructed in the late 1940/50s using spoil from the nearby Kinneil

Coal Mine and with the resulting area being used as a refuse disposal site. The refuse disposal site ceased operations in the mid-1990s. The now-demolished Kincardine Power station was built on re-claimed land in the early 1960s and part of the 89 ha site on which Longannet was built is on land reclaimed from the estuary using ash from Kincardine Power Station which was demolished in 2001.

The total amount of intertidal land lost since the 17th Century has been estimated by McLusky *et al* to be as much as 50%, although the exact figure is difficult to ascertain. The Geowise report estimated that over the last 160 years, 1375 ha or 33% of the inter-tidal area has been lost. This is also reflected in the ecological status of the estuary, which is currently failing to achieve good ecological status due to morphological alterations from land claim, habitat modification and existing embankments that protect land from flooding.

The effect of land-claim on invertebrates, fish and birds in the Forth Estuary was studied by McLusky *et al,* who concluded that land-claim in the Forth Estuary had a '*very large effect on the natural inhabitants of the estuary and a simple consideration of the loss of area is inadequate to describe the effects of any land-claim scheme'*.

Development

The Inner Forth has a long and significant industrial and commercial history with industries ranging from coal mining, boat building and glass manufacture to more recent large-scale developments such as the Longannet power station and petrochemical, agro-chemical and pharmaceutical chemical plants at Grangemouth. Due to existing developments, the estuary has been designated as heavily modified under the Water Framework Directive.

The continuing value and importance of the Firth of Forth and surrounding area to the Scottish economy can be demonstrated by the presence of five National Developments within the Scottish Governments National Planning Framework 2 (NPF2), the Scottish Government's strategy for the long-term development of Scotland's towns, cities and countryside. The five developments are seen as key strategic infrastructure projects. All five developments; Longannet and Cockenzie Power Stations (new non-nuclear baseload electricity generating capacity and associated infrastructure), Grangemouth docks (improvements in port, road and rail infrastructure), Rosyth (multimodal container terminal facilities, including improvements in supporting port, road and rail infrastructure) and a replacement Forth Crossing have potential to significantly affect the natural heritage value of the area through habitat loss or disturbance, to a greater or lesser degree.

Other proposed and future developments in the area could also have further negative impacts on biodiversity and habitats. These may include windfarms and proposals for carbon capture and storage.

The investment required to deliver the developments above will be considerable and in some cases, a suitable level of protection from coastal flooding will be required as part of the development, which is recognised in the NPF2. In combination with sea level rise this could result in additional habitat loss in the future as a result of coastal squeeze.

Although new developments, either terrestrial or marine, might not always have significant impacts on the Inner Forth, there is the possibility of further habitat loss or degradation. The cumulative effect of development and other pressures have potential to lead to considerable negative impacts on an already vulnerable environment. In some circumstances, national and European law requires that replacement habitat is created before developments that would result in habitat loss can proceed.

In some cases, loss of habitat on the Inner Forth could be re-dressed by the restoration and creation of habitats on a landscape scale, which would offset potentially damaging impacts of new developments and deliver a wide range of additional environmental, social and economic benefits. Recent developments on the Inner Forth such as the Clackmannanshire Bridge, which opened in 2008, included a small amount of habitat creation, offsetting the loss of 0.5 ha of saltmarsh lost. There are other sites on the Forth where lost habitat could be recreated but they are very limited and therefore need safeguarded now if appropriate habitat compensation is to be a possibility in the future.

Climate Change

Climate change will result in new pressures on Scotland's coasts as a consequence of sea level rise, extreme high tides and erosion with potential significant effects on intertidal areas and saltmarsh. The UK Climate Change scenario of drier summers and wetter winters will also impact on estuaries with increased flows from tributaries feeding into estuaries.

Tidal records show a rising relative sea level around the coast of Great Britain, with the rate of sea level rise predicted to increase (UKCP09). Sea level is predicted to rise up to 1 m (above the 1990 Mean Sea Level) based on a High Emission Scenario by the end of this century. .

The impacts on habitats within estuaries are difficult to predict given the complex variables inherent in estuarine functions but will undoubtedly result in long-term changes to existing habitats and their distribution within the estuary. The resulting rise in sea levels will impact on and alter the physical environment and hydrological processes, leading to higher tides, tides reaching further upstream, an increase in salinities, increase in tidal volume and water velocity. This will lead to changes in biological and chemical processes with the resultant effect on water quality and ultimately the distribution of plants, invertebrates and other biodiversity.

Loss of intertidal areas as a result of sea level rise in the Inner Forth could have a highly detrimental effect on both wintering and passage birds using the area to feed and roost, with optimum feeding areas lost and distribution of prey adversely effected.

A rise in sea level amplifies the effects of high tides and storm surges, which occur as a result of a combination of meteorological factors. A predicted increase in surge height coupled with sea level rise could result in significant increases in storm surge height and potentially catastrophic flood events in areas beyond existing embankments (UKCP09). The frequency of such events is also predicted to increase.

An increase in coastal flooding could lead to greater demand for new flood defences in addition to maintenance of existing defences. In combination with sea level rise, this would lead to further loss of intertidal habitats as a result of coastal squeeze. Coastal squeeze is defined as the erosion of mudflats and saltmarsh in front of artificial sea walls or embankments as a result of rising sea levels, where natural development of new saltmarsh is restricted or prevented altogether by the inability of the mean high water mark to move landward.

It is estimated that the UK is losing up to 100 ha of saltmarsh and 450 ha of mudflat per annum through erosion (RSPB, 2004). Saltmarsh plays an important role in dissipating tidal and wave energy and loss of saltmarsh fronting the embankments on the Inner Forth would have consequences for the protection of these embankments, exposing already eroding structures to increased tidal and wave action. In RSPB's 'The Saltmarsh Creation Handbook' it is estimated that 80 m of saltmarsh reduces the cost of effective defence to less than 10% of the expense required were no saltmarsh present.

Flood Risk

The sea level rise described above resulting from climate change will be additional to the existing flooding problem in the Inner Forth area. Many areas are already recognised as at flood risk (Figure 2) and are protected with artificial flood defences.

The upper and middle Forth have been designated as an area at significant flood risk as part of the National Flood Risk Assessment, with annual damages estimated in the tens of millions of pounds. This means that there is significant flood risk affecting the developed areas within the estuary, with potentially significant economic consequences.

Many of the agricultural areas within the Inner Forth are pumped to maintain suitable conditions for agricultural production and without pumping and sea walls would flood. The responsibility and financial burden of maintaining this infrastructure lies with the landowner. The condition of many of these walls and the total costs of maintaining them in the future is unknown.

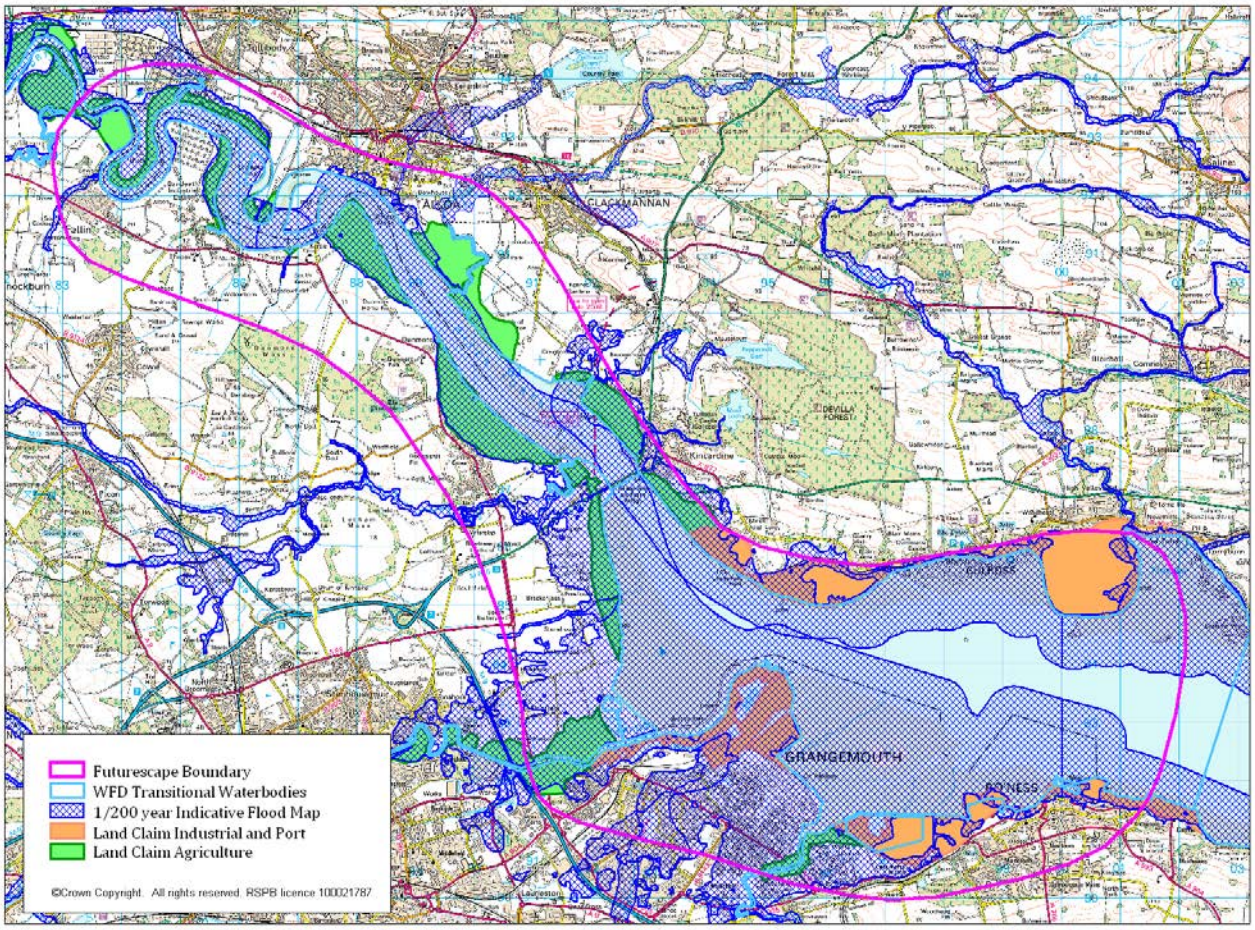

Figure 2: Land claim and flood risk in the Inner Forth area

Pollution

The Forth Integrated Management Strategy found that the public perceived the Forth as heavily polluted and this is still valid in 2011. The substantial quantities of litter on the foreshore are an obvious example of one aspect of the problem. The Forth was a heavily polluted water body until the latter part of the 20th Century, with pollution from several direct and indirect sources, including industrial and municipal discharges. Improved water treatment and regulation to improve water quality has had a significant positive impact since then.

The pressure on the environment of the Inner Forth from pollution, either from direct or diffuse sources, remains considerable, despite these marked improvements in recent years. Contamination of water and intertidal areas in the Inner Forth from direct and indirect sources of pollution affect the distribution and population of all biodiversity from macrophytes to birds. This is reflected in the classification under the Water Framework Directive which identifies the Upper and Middle Forth transitional waterbodies at risk of failing WFD objectives on the ground of point source pollution.

Several long-term studies have looked at the effects of industrial discharges and effluent on intertidal areas and attributed significant declines of shelduck, knot and dunlin to the effects of petrochemical effluent on mudflats and invertebrates (e.g Bryant, 1986) while studies of intertidal fauna by McLusky et al concluded that "*increases in diversity are shown to be a clear community response to the improvements made to the petro-chemical wastes discharged to the area*".

Conversely, numbers of wintering seaduck (scaup and goldeneye, in particular) in the Forth declined markedly following improvements to sewage treatment operations in the Forth in the 1970s.

The Forth Estuary Environmental Assessment Programme (FEAP) is an industry body comprising representatives from Syngenta, Kem-fine and BP. FEAP monitored intertidal fauna and sediment over a ten year period from 1997 to 2007. Analysis of the abundance of organisms in a certain area and the levels of materials such as metals, carbon and nitrogen led to a conclusion that the effect of industrial discharges from a range of sources had become less significant due to effective treatment.

Sources of pollution continue to originate from organic enrichment, industrial discharges, trace metals and anti-fouling paints. Pellets of pre-production plastic ("mermaids' tears"), used as raw material in plastics manufacturing and which carry concentrated chemical pollutants are found in considerable quantities along the strand line of the Forth Estuary, causing problems for seabirds when ingested. A study looking at the occurrence and abundance of plastic pellets in the Forth found that the translucent pellets were originating at Grangemouth and in some areas constituted 2% of the weight of material in the strand line.

Measures to address point source and diffuse pollution are outlined in the Forth Area Management Plan 2010-2015 produced by SEPA in partnership with the Forth Area Advisory Group. Continued long-term monitoring by SEPA will determine if measures taken to limit effects of pollution and improve water quality continue to be effective.

Disturbance

The effects of both direct and indirect disturbance could have profound negative impacts on feeding or roosting birds in the Inner Forth, especially during inclement weather. The cumulative effect of disturbance in several locations could have a detrimental effect across the area. Declines in population size, breeding success and body condition can result from disturbance and has been cited as a possible factor in declines in numbers of birds using the Inner Forth.

Disturbance can take many forms, from walkers on the shoreline adjacent to intertidal areas, wildfowling, industrial activity, artificial lighting, bait-digging on intertidal areas to boat and shipping traffic. The response of birds to disturbance varies from species to species and depends on the circumstances in which the disturbance is taking place. In certain locations and circumstances, evidence points to the conclusion that birds will become habituated to disturbance and moderate their response, while in other situations disturbance may be more problematic.

A PhD study (Ecological and anthropogenic constraints on waterbirds of the Forth Estuary: population and behavioural responses to disturbance, Dwyer, R) examined the effects of disturbance including local displacement to birds during the construction of the Clackmannanshire Bridge in 2008 and sought to understand the various factors determining the effect of human disturbance on wintering waterbird populations on the Inner Forth. The study examined factors affecting habitat use and foraging decisions in wintering birds and recommended several management measures which should be undertaken to mitigate the effects of disturbance caused as a result of human activities, such as use of set-back distances for each species and the factoring in of nocturnal distribution and behaviour of birds.

Invasive Species

The International Union for the Conservation of Nature defines alien invasive species as:

change, and threatens native biological diversity".

There are a range of invasive species both in the water environment and on the land around the Forth. These include Japanese knotweed (*Fallopia japonica*), American signal crayfish and American mink, all of which can have detrimental impacts on biodiversity. Common cord-grass (*Spartina angelica*) for example, can extend across mudflats and in doing so deprive wading birds of access to food.

Efforts to control invasive species on the Forth have been largely *ad hoc* and have had variable success. This is partly due to a lack of a coordinated approach, with sites where invasive species have been controlled often later colonised from neighbouring sites that have not been treated. The Forth Fisheries Trust recently developed a Biosecurity Plan with the aim of preventing, controlling and eradicating invasive non-native species within the Forth fisheries district.

5.Policy Context

The desirability and rationale of carrying out landscape scale conservation, specifically intertidal and saltmarsh creation, on the Inner Forth has been recognised for more than a decade since the first proposals in the mid 1990s (Bryant et al). This work has been followed by other studies and feasibility reports, which are discussed in the habitat creation review (chapter 6).

However, since the mid 1990s there have been significant changes to the policy context in which land management in Scotland takes place. This has particular bearing with relation to flood and water management. The legislation and policy drivers relevant to landscape and intertidal habitat creation on the Inner Forth are summarised below.

Town and Country Planning (Scotland) Act 1997 (as amended) and Planning etc (Scotland) Act 2006

Planning permission is almost always required for 'development' on a significant scale. This covers a wide range of building and engineering work, as well as changes in the way land and buildings are used.

The main planning law in Scotland is The Town and Country Planning Act (Scotland) 1997 as amended by The Planning etc. (Scotland) Act 2006. This legislation sets out provision for the preparation of the National Planning Framework, Strategic Development Plans and Local Development Plans, which provide a strategic steer for developments at a variety of scales. For example, the Central Scotland Green Network is identified in the National Planning Framework as a 'national development', which recognises it as being within Scotland's interests to deliver.

The area covered by the Inner Forth Futurescape sits within a number of Local Development Plans, which guide decisions on when developments, such as managed realignment, should receive planning permission.

Birds and Habitats Directives

The Directive on the Conservation of Wild Birds 2009/147/EC, also known as the Birds Directive, addresses the conservation of all wild birds throughout the European Union. The Directive is divided into two main parts: habitat conservation and species protection. Article 3 requires Member States to preserve, maintain and re-establish sufficient diversity and areas of habitats for wild birds. This should primarily (but not exclusively) involve the creation of protected areas (not just SPAs). Recognising the historic losses of wildlife, the Article also calls for the appropriate management of habitats inside and outside protected areas, the re-establishment of destroyed habitats, as well as the creation of new habitats.

Implementation of the Birds Directive in British law is primarily through the Wildlife & Countryside Act (1981) as amended by the Nature Conservation (Scotland) Act 2004.

The Directive on the conservation of natural habitats and of wild fauna and flora 92/43/EEC also known as the Habitats Directive. The Habitats Directive also has two main parts, the Natura 2000 network of protected sites and the strict system of species protection. The aim of the network is to assure the long-term survival of Europe's most valuable and threatened species and habitats. It is comprised of Special Areas of Conservation (SAC) designated by Member States under the Habitats Directive, and also incorporates Special Protection Areas (SPAs) which they designate under the 1979 Birds Directive.

This Directive is transposed into law in Great Britain by The Conservation (Natural Habitats, & c.) Regulations 1994 (as amended), commonly know as the 'Habitats Regulations'. Amendments in Scottish law were made in 2004 and 2007.

The European Commission has produced guidelines on the implementation of the birds and habitats directives in estuaries and coastal zones in January 2011 and can be viewed at: http://ec.europa.eu/environment/nature/natura2000/management/guidance_en.htm

The Water Framework Directive

The overall objective of the Water Framework Directive, which came into force in December 2000, is to bring about the effective co-ordination of water environment policy and regulation and to restore all bodies of surface water to good ecological status by 2015. The Water Environment and Water Services (Scotland) Act 2003 (WEWS) transposes the Water Framework Directive 2000/60/EC (WFD) into Scots law.

The WEWS Act established a statutory system for water management planning in Scotland based on two key features:

- River Basin Management Planning – the environmental and economic assessment and monitoring of water bodies within river basins. The purpose of RBMP is to identify pressures on the water environment and the measures needed to meet the environmental objectives set for individual water bodies.

- Regulation - controls to regulate water abstraction, impoundment, engineering works, diffuse and point source pollution. The regulations aim to achieve good `ecological status` for surface waters, and to protect groundwaters from pollution and over abstraction.

Flood Risk Management (Scotland) Act

The Flood Risk Management (Scotland) Act 2009 is a significant piece of legislation that introduces a major change to the way floods are managed. The Act establishes a framework for the sustainable management of flood risk in Scotland and, in due course, will fully replace the Flood Prevention (Scotland) Act 1961. The 2009 Act transposes the requirements of the EU Floods Directive; updates the Scottish flood risk management framework and responsibilities and deals with the issues of reservoirs safety and management now being taken forward through the Reservoirs (Scotland) Act 2011. The general duties of the Flood Risk Management Act place a requirement on Scottish Ministers, SEPA and the responsible authorities, including Scottish Water

and local authorities, to "*act in the best way calculated to manage flood risk in a sustainable way, to promote sustainable flood risk management, and to act in the way best calculated to contribute to the achievement of sustainable development*".

The legislation promotes an approach that is based on catchment management. SEPA will identify local plan districts that are based on catchments or groups of catchments. Where these districts cross local authority boundaries, all local authorities within the district are required to collaborate, and designate a lead authority responsible for the production of the local flood risk management plan. This larger scale catchment approach fits with the rationale and objectives of landscape-scale conservation.

A step towards the sustainable management of flooding in Scotland was taken in 2011 with the production of a National Flood Risk Assessment, which provides a detailed picture of flooding risk across Scotland. The new national assessment has considered all sources of flooding and identifies the areas at greatest risk from the cumulative effects, both now and in the future. The National Flood Risk Assessment has identified that in Scotland one in 20 homes and one in 14 businesses are at risk of flooding.

There is a strong ethos throughout the Act that natural flood management is an important part of the sustainable approach to flood management. This means that restoring floodplains and wetlands, re-naturalising river corridors and breaching sea walls in coastal areas can all contribute to flood management, with potential significant gains for wildlife.

The requirement to assess the potential for natural flood management (i.e. what role natural habitats, such as woodlands, wetlands and floodplains can have in reducing flood risk) is provided in Section 20 of the Act. It requires SEPA to assess whether '*alteration (including enhancement) or restoration of natural features and characteristics of any river basin or coastal area in a flood risk management district could contribute to the management of flood risk for the district'*. This information is then subsequently used by SEPA and responsible authorities in setting objectives and indentifying sustainable measures.

Climate Change (Scotland) Act

The Scottish Climate Change Adaptation Framework sets out how Scotland is going to adapt to the impacts of climate change which are now considered to be unavoidable. The Framework, published in 2009, is accompanied by 12 Sector Action Plans, one of which specifically relates to biodiversity and ecosystem resilience.

Under section 57 of the Climate Change (Scotland) Act 2009 there is a duty to produce a land use strategy. This document has now been completed and an action plan is currently being written to implement the proposals within the Strategy. The strategy identifies proposals for getting the best out of Scotland's land resources. It sets out a new vision to guide our thinking about the use of land and objectives relating to the economy, environment and communities – the three pillars of sustainability. It provides a set of Principles for Sustainable Land Use to guide policy and decision

making, builds on the Government's current activities and includes further proposals to help meet the objectives.

The Principles for Sustainable Land Use are:

A. Opportunities for land use to deliver multiple benefits should be encouraged.

B. Regulation should continue to protect essential public interests whilst placing as light a burden on businesses as is consistent with achieving its purpose. Incentives should be efficient and cost-effective.

C. Where land is highly suitable for a primary use (for example food production, flood management, water catchment management and carbon storage) this value should be recognised in decision-making.

D. Land use decisions should be informed by an understanding of the functioning of the ecosystems which they affect in order to maintain the benefits of the ecosystem services which they provide.

E. Landscape change should be managed positively and sympathetically, considering the implications of change at a scale appropriate to the landscape in question, given that all Scotland's landscapes are important to our sense of identity and to our individual and social wellbeing.

F. Land-use decisions should be informed by an understanding of the opportunities and threats brought about by the changing climate. Greenhouse gas emissions associated with land use should be reduced and land should continue to contribute to delivering climate change adaptation and mitigation objectives.

G. Where land has ceased to fulfil a useful function because it is derelict or vacant, this represents a significant loss of economic potential and amenity for the community concerned. It should be a priority to examine options for restoring all such land to economic, social or environmentally productive uses.

H. Outdoor recreation opportunities and public access to land should be encouraged, along with the provision of accessible green space close to where people live, given their importance for health and well-being.

I. People should have opportunities to contribute to debates and decisions about land use and management decisions which affect their lives and their future.

J. Opportunities to broaden our understanding of the links between land use and daily living should be encouraged.

Central Scotland Green Network

The second National Planning Framework includes the Central Scotland Green Network as a national development which aims to 'change the face of Central Scotland**,** by restoring and transforming the landscape of an area stretching from Ayrshire and Inverclyde in the west, to Fife and the Lothians in the east'. The CSGN is a 40 year initiative which will mark *"a step change in environmental quality, woodland cover and recreational opportunities...[and] make Central Scotland a more attractive place to live in, do business and visit; help to absorb CO^2; enhance biodiversity; and promote active travel and healthier life styles".*

Landscape scale conservation and land management on the Inner Forth with resulting multiple benefits would provide the CSGN with an opportunity to deliver many of its outcomes and ambitions. In particular, there is an opportunity for significant habitat creation and to provide an environment with a high-quality landscape, which contributes to climate change adaption and provides assets to local communities. The location of the Inner Firth at the core of the CSGN area and within easy reach of all of Central Scotland, ensures that the Futurescape is well placed to be a flagship project for the CSGN.

Biodiversity Action Plans

The UK Biodiversity Action Plan (UK BAP) identifies priority species and habitats that are considered as being the most threatened and requiring conservation action, when evaluated against a set of selection criteria based on international importance, rapid decline and high risk.

In May 2004 "*In Your Hands – A Strategy for the Conservation and Enhancement of Biodiversity in Scotland"* was published with the purpose of adapting the UK Biodiversity Action Plan to Scotland. It sets out a clear 25 year vision to conserve and enhance biodiversity in Scotland and is supported by detailed implementation plans which identify the priority actions to be taken forward over the coming years

For the ambitious programmes of national and Scottish action to succeed, they must be interpreted and implemented at a local level. Local Biodiversity Action Plans (LBAPs) have been established all over Scotland, and over much of the rest of the UK to do this. These plans aim to translate national and Scottish targets for the conservation of key species and habitats into focused local action, while also taking account of local values and priorities. Partnerships have been established to deliver the LBAPs consisting of various organisations drawn from local government, NGOs, the voluntary and commercial sectors, research, education and amenity groups.

LBAPs have been developed for Clackmannanshire, Falkirk, Fife and Stirling. The Inner Forth Futurescape will seek to deliver and influence actions within these plans, as well as for the UK BAP and Scottish Biodiversity Strategy.

Futurescapes and Landscape Scale Conservation

The Inner Forth Project is part of the RSPB's Futurescapes programme and is one of an initial portfolio of 34 landscapes throughout the UK where RSPB aims to deliver more space for nature

through working with a variety of partner organisations. This vital programme has been developed in response to continuing biodiversity losses in the UK. It is a direct response to the need to adapt to the impact of climate change. The landscape approach provides the scale necessary to kick-start the sustainable management of land and to ensure that protected areas, at the heart of the programme, are successful.

Landscape scale conservation is not a new concept and RSPB can draw on significant experience of working at a large scale in, for example, the Flow Country of Caithness and Sutherland and Abernethy Forest. At these nature reserves, blanket bog and Caledonian pinewoods are being restored on a truly landscape scale. Larger, connected habitats support a greater diversity of species than the equivalent area of fragmented habitats and are also more robust to change. They also offer greater potential to deliver a wide range of ecosystem benefits, for example water management delivers best when considered at a catchment scale.

RSPB is now also keen to adopt this approach where industrial and development pressures have affected the landscape. In these areas, local communities stand to benefit significantly from improvements to their local environment. In Scotland, RSPB has identified the Inner Forth as one of the highest priority sites for implementing this approach through its Futurescape programme.

6.Review of Habitat Creation in the Inner Forth

This chapter outlines the appropriate techniques that may be employed in delivering landscape scale inter-tidal and wetland creation on the Inner Forth and discusses previous studies, research and projects carried out in the area. The studies and proposals discussed are drawn from a large body of work carried out in the Inner Forth by academic institutions, consultancies and non-governmental organisations, illustrating the significance and potential of the area in land management terms. Reviewing this work and early habitat creation projects has been an important part of the process of assessing and recommending future projects.

Managed re-alignment

Delivering habitat creation of inter-tidal habitats on the Inner Forth will almost certainly involve managed realignment. Managed realignment is a process utilising soft engineering and restoration techniques to deliberately inundate land which was previously defended from a river or sea by means of artificial walls, embankments or bunds. In the Inner Forth embankments are located in areas where land has been claimed from the estuary on the southern and northern shores. Managed realignment involves breaching in one or two locations or removing an existing defence completely and using either naturally higher ground or a newly constructed defence to manage extent of flooding. Depending upon the height and shape of land behind the breached wall, there may or may not be a need to build a new line of defences behind the site. In most instances the newly flooded land is low-lying coastal flood plain and therefore a new seawall (or 'counterwall') is needed to clearly define the inundated area and protect the hinterland behind. Because the natural rise of the land is used, this new sea wall can often be much lower and potentially less costly to maintain, than the original line of defence.

The process gives a greater degree of control in water management and can be used to restore and manage land in a natural and sustainable way. Managed realignment can play a major role in alleviating uncertainty and minimising negative impacts surrounding flooding issues while maximising potential benefits such as removing the long-term cost of maintaining existing embankments. Creation of new habitat itself has benefits other than biodiversity gain, for example minimising coastal erosion and contributing to overall estuarine functionality.

Coastal and estuarine managed realignment – design issues (Leggett et al, 2004) is a key document that provides detailed information and guidance on managed realignment. The Online Managed Realignment Guide (OmReg), http://www.abpmer.net features a database of managed realignment projects containing details of how, when and where they were done, the habitats created and the drivers, constraints and lessons learned. The Saltmarsh Management Manual describes techniques and provides guidance on managing and creating saltmarsh habitat (http://www.saltmarshmanagementmanual.co.uk/Index.htm).

The RSPB has significant experience of wetland creation and management involving managed realignment at sites such as Wallesea Island in Essex, Frieston Shore in Lincolnshire and Nigg Bay in Ross-shire and has produced key works in the field of coastal and estuarine habitat creation and

management, providing practical guidance on the restoration and creation of saltmarsh and associated habitats, including Nottage and Robertson, 2005 and Symes and Robertson, 2004.

In England and Wales, managed realignment has been used for many years as a natural approach to flood defence and a means of reducing the effects of storm surges and coastal erosion by creating a habitat buffer between the sea and the new defence. In Scotland a successful managed realignment project was carried out at Nigg Bay by the RSPB. This project provided valuable experience on implementing a managed realignment scheme in Scotland, where the planning and legislative processes differ from England.

The physical process of a managed realignment scheme following removal of existing defences by breaching or complete removal of defences will vary from site to site, depending on a variety of factors such as duration of tidal inundation, availability and transfer of sediment but the ultimate aim is to create a long-term self sustainable ecological system. After defence removal or breach and inundation has taken place, restored intertidal areas are colonised by algae, followed by plants then invertebrates, although this process can take many years depending on local circumstances.

Regulated Tidal Exchange

Regulated Tidal Exchange as defined in 'Environment Agency Regulated Tidal Exchange: An Inter-tidal Habitat Creation Technique' is the regulated exchange of seawater to an area behind fixed sea defences, through engineered structures such as sluices, tide-gates or pipes, to create saline or brackish habitats'. Regulated Tidal Exchange (RTE) differs from managed re-alignment in that the installation of an engineered structure, for example a sluice or culvert, is required and this results in a high level of control of water levels and times of inundation. The existing sea or river defence is retained and requires on-going maintenance. In some instances, RTE can be used as an initial phase in a managed re-alignment scheme.

A range of habitats can be created using RTE; mudflats, saltmarsh, brackish grazing marsh and saline lagoons and there are several examples of successful habitat creation in the UK and elsewhere using this technique. Areas where this technique has been employed range in size from 5 ha in the UK to 32,000 ha sites in Spain. This technique has been employed by the RSPB at the Skinflats Nature Reserve on the Inner Forth and this project is described below.

Review of habitat creation studies and proposals in the Inner Forth

There have been a number of proposed schemes and studies looking at managed realignment and habitat creation and restoration on the Inner Forth since the 1990s, originating both from a flood management and habitat creation perspective.

Four such studies are discussed below.

Bryant, D.M., McLusky, D.S., & Pethick, J. (1998) Potential for the Creation of Brackish Lagoons, Saltmarshes and Brackish Fen Habitat in the Forth Estuary. BP Oil Grangemouth Ltd

This report was written by leading academic practitioners in the field of coastal and estuarine geomorphology and management from the University of Stirling and the University of Cambridge. It was commissioned by BP Oil in collaboration with SNH to identify suitable sites for intertidal habitat restoration in the Forth Estuary. BP required a 20 ha reclaimed area of Kinneil Flats SSSI to be excluded from SSSI designation in order to develop the site and were looking for potential sites on the Forth where it would be practical to restore or recreate habitats in mitigation for the loss of part of the Kinneil Flats SSSI.

The report discussed relevant background information on the Forth estuary, tidal and wave dynamics, channel modifications, wave climate, salinity and sediments and Holocene history. Areas on the estuary where land–claim had taken place were identified and summarised from the southern and northern shores of the middle and lower estuary. Issues surrounding habitat restoration of intertidal areas are examined; geomorphological adjustments, managed retreat, ecological restoration and sea level adjustments.

An analysis and assessment of eleven potential restoration sites employing a set of criteria ranging from geomorphology to landscape value concluded that the site at Skinflats (Orchardhead to Higgin's Neuk) was the preferred option for a restoration project with further scope for habitat creation at the River Carron lagoon area (Bothkennar Pools). A proposal for the Skinflats restoration site was detailed and discussed geomorphology, ecological considerations and restoration methods. The proposal concluded that removal of flood embankments '*would allow redevelopment of saltmarsh on reclaimed land; would allow the saltmarsh/ mudflat boundary to establish a new, natural position with regard to the major hydrodynamics of the estuary; and would enhance the existing ecological importance of the Skinflats/proposed SPA/ proposed Ramsar site*'.

The preferred option at Skinflats is discussed from a bird conservation perspective within the wider aim of the proposal, which outlines three ways in which the suitability of the Forth for wildlife can be enhanced and achieved; by extending the area of existing habitats, by recreating estuarine habitats or by creating habitats which are not wholly natural but which support a significant wildlife community. The conservation management benefits of restoration are summarised and the report concludes that existing bird populations may expand, species may be newly attracted to the Forth, a problem with wintering geese impacting on crops in spring may be alleviated, casual disturbance reduced and the full spectrum of estuarine conditions restored to the Forth.

The report recognises the clear multi-functional potential of the area despite being written without reference to climate change and the effect of sea level rise. These issues have subsequently given an increased relevance to the report which has been invaluable in informing and evaluating future proposals.

GeoWise Ltd & Coastal Research Group, Glasgow University (1999) ***Use of GIS to map land claim and identify potential areas for coastal managed realignment in the Forth Estuary*** **Scottish Natural Heritage Research Report, SNH, Edinburgh**

In 1999, the Forth Estuary Forum coordinated a project with Edinburgh based consultants GeoWise Ltd, and Glasgow University to look at the potential for managed realignment on the Inner Forth. In what was the first study of its kind in Scotland, a document detailing the potential of the Inner Forth for managed realignment and which informed further studies and projects was published in 1999 by GeoWise Limited & Coastal Research Group Glasgow University. The authors are John Maslen of GeoWise Ltd and Jim Hansom of Department of Geography and Topographic Science, University of Glasgow. This comprehensive and authoritative report looked at all relevant issues and data relating to managed realignment in the Inner Forth, specifically with the objective of looking at habitat creation possibilities and flood mitigation. A Geographic Information System was used to identify and quantify sites on the Inner Forth where land-claim had taken place and where managed realignment was a possibility. The report consists of three volumes; a Management Report, a Technical report and a Mapping report.

The Management Report looked at five aspects of the Forth Estuary in relation to managed realignment, namely geomorphological factors, changes in position of the shore line through natural and human actions eg land-claim, areas where land-claim had taken place, areas where existing land use presented constraints to future managed alignment and areas where managed realignment would be a viable option.

Detailed background physical information is provided, along with the history and methods of land-claim. Managed realignment techniques and locations are discussed and sites where managed realignment would be a possibility are examined in detail with site descriptions of eighteen areas provided. Ten characteristics were identified which reflected the potential for managed realignment and within this, three key attributes were indentified which enabled scoring to be carried out.

The key attributes were:

- the contribution to and restoration of estuary functions
- the containment of adverse effects
- the site disruption and cost

All sites which scored 12/14 were considered to be good candidates for managed realignment and restoration. The number of sites scoring 12/14 or higher were eleven: the total area of these sites is 532.5 ha which would result in a 1.51% increase in the tidal prism (the volume of water that enters the estuary on each tidal cycle).

The report recommended that a strategy be put in place to take forward further work on managed realignment in the Inner Forth with a target to restore a percentage of inter-tidal areas restoration by means of managed realignment. Areas of future work recommended for further detailed investigation were site evaluation using topographic survey techniques, morphodynamic and hydrographic characteristics of each site, site engineering designs and analysis of planning

considerations and consents. A trial site where a small scale managed realignment project was recommended.

The report provided baseline information and informed further studies and work on the Inner Forth, for example the Kennet Pans managed realignment project and the Babtie Feasibility Study for Skinflats Managed Realignment Project

Babtie Group (2001) Feasibility and Implications of Managed Realignment at Skinflats; Feasibility Report . Scottish Natural Heritage

A further project instigated by the Forth Estuary Forum was commissioned in 2001 and research was carried out by Babtie Group in conjunction with Northern Ecological Services and Coastal Research Group, University of Glasgow. Funding for the research was provided by BP Amoco, Falkirk Council, RSPB, Scottish Coal and Scottish Natural Heritage. The aim of the research was to investigate the technical feasibility and economic and environmental implications of a managed realignment scheme being carried out on land between on the south bank of the Forth between Kincardine Bridge and Grangemouth and followed on from earlier studies (Bryant et al, 1996; Geowise & Coastal Research Group 1999). The study included a comprehensive literature review detailing current knowledge, reports and documents relating to a managed realignment at Skinflats and the Inner Forth.

The Feasibility Report investigated the functional and economic feasibility of carrying out a large-scale managed realignment scheme at Skinflats.

The study comprised a detailed topographic and hydrographical survey of the hinterland and foreshore at Skinflats, an ecological survey, a geomorphological survey, a numerical modelling study to assess the estuary-wide and local impacts of managed realignment at Skinflats, taking into account sea-level rise and flood scenarios.

A GIS system was developed to store and visualise all data related to the project, including outputs from the modelling studies and this system was used to predict the extent of flooding and assess the potential impacts on habitats under various options. A cost-benefit analysis (CBA) was undertaken to assess the economic feasibility of managed realignment based on results from the modelling and habitat predictions.

The feasibility report concluded that managed realignment at Skinflats was technically feasible with partial removal of the existing sea defence the preferred option. The scheme would involve removing 3.6 km of existing embankment allowing the hinterland to be inundated. A new earth embankment would be constructed along the existing extent of the carse cliff with a concrete wall being built at Powfoulis to add to the proposed defences.

The report recommended that the existing embankment at 'Carron Mouth' (Bothkennar) pools be retained as removal would lead to scouring and erosion of the mudflats due to inundation and flushing. The remaining 3.6 km embankment running toward the Kincardine Bridge could be removed and a new embankment would be tied in with the existing embankment at the western

end of Carron Shore pools and run immediately north of Hardilands Farm and onwards to the Powfoulis Hotel. Several properties would be directly affected by the proposed works namely Bothkennar Research Station, Hardilands Farm and Powfoulis Hotel.

Once in place, the managed realignment scheme would not have any detrimental effect of the natural estuarine functioning of the estuary and would have a minimal effect of the tidal prism.

Modelling showed the effect of management realignment on water levels over the wider estuary would be relatively low, although the scheme would be of some benefit in flood events and in countering the effects of sea level rise. The result of a managed realignment scheme in terms of habitat gain would be significant with a predicted gain in saltmarsh of 35 ha over a 50 year period. The cost of the scheme was estimated at over £1m which included capital works and future management but did not include land purchase. The report concluded that economically the best option would be the retention and maintenance of the existing sea wall as the benefits in economic terms of a managed realignment scheme would be small. The report recommended that for managed realignment to have a significant effect over the wider estuary, an estuary wide strategy would have to be pursued which would allow large areas of reclaimed land to revert to inter-tidal conditions. It recommended that RSPB Scotland's site at Bothkennar could be taken forward as a possible demonstration site.

Hughes GP. (April 2010) Design of a Coastal Structure
Inner Forth Estuary: Managed Realignment Scheme at Airth. University of Strathclyde

This study was produced as part of the Coastal Engineering and Modelling course at University of Strathclyde. Airth was identified as a suitable site, as it satisfied characteristics outlined in Babtie , namely site history, sediment availability and grain size, elevation and gradient of site, natural protection to hinterland. The site also satisfied criteria proposed by Pethick (2001) and French (2001) principally landward transgression of saltmarshes was possible and that the site was on historically land-claimed and sufficiently large (c 50ha) to maintain natural estuary cycles.

Ten characteristics regarding the suitability of Airth as a site where managed realignment may be carried out were evaluated using a similar methodology and criteria to the Kennet Pans scheme. All ten criteria were satisfied although the current agricultural use of the area may require further study to determine levels of soil compaction and fertiliser residue. Natural creek development could be speeded up by engineering an artificial system and additional protection may be required due to the gently sloping nature of the land between the river and Airth village.

The study looked at various options for managed realignment at Airth and concluded that defence removal, ie removing the entire northern embankment would be the most appropriate method of managed realignment. The pros and cons of complete removal as opposed to a breach are discussed. The scheme would involve a phased removal with the height of the embankment being reduced in stages. A secondary defence would be created at the south of the site to provide protection to residential areas.

Review of projects and schemes in the Inner Forth

As of November 2010, there have been three separate works carried out at sites in the Inner Forth, involving two methods of managed realignment. These projects are discussed below:

Black Devon Wetlands, Alloa, Clackmannanshire (1999)

The Black Devon Wetland project on the Black Devon in Alloa was the first known managed retreat project undertaken in Scotland.

The project originated as part of a Clackmannanshire Heritage Trust (a local environmental charity) Clackmannanshire Countryside Rivers Project with a proposal by Earl of Mar & Kellie. It was planned as a demonstration project to create a controlled network of saline lagoons, principally as a suitable habitat for wetland birds to complement the proposed SPA designation (GeoWise Ltd & Coastal Research Group, Glasgow University, 1999). SEPA notes that it aimed 'to demonstrate a way in which managed retreat can be realised, and through this, increase bio-diversity in an area of international ornithological importance.'

The initial stage of the project involved undertaking a hydrological assessment of the area. This was carried out by Dr David J Gilvear and the results published in February 1998.

The initial phase of works took place on a 7 ha site which was part of an existing 35 ha of grazed wet grassland and involved a controlled breach of the existing southern flood embankment of the River Black Devon utilising a Regulated Tidal exchange sluice system which allowed the reclaimed salt marsh adjacent to this tidal part of the river to be inundated on high tides. This has been combined with ground modelling to create permanent lagoons.

Figure 3: Regulated Tidal Exchange sluice at Black Devon Wetlands, Nov 2010

The project was funded by Scottish Natural Heritage, Clackmannanshire Council Landfill Tax, Clackmannanshire Heritage Trust and Fentons. Support from the landowner, Earl of Mar and Kellie was key to the project. RSPB staff were consulted (Dr David Beaumont) and staff from University of Stirling contributed detailed advice on the design of the wetlands and subsequent management.

The project won a SEPA Habitat Enhancement Initiative (HEI) Award in 2000. The HEI was established with *'the aim of securing measurable improvement in the management of aquatic and riparian habitats and promotion of the conservation of associated flora and fauna'* and the Black Devon Project

won praise for its *'innovative and forward looking approach taken at a local level'* and because it demonstrated *'opportunities for managed retreat and provided recreation potential for the local community'*.

The desired outcomes of the initial scheme appear not to be fully realised as ongoing maintenance appears to have been limited, perhaps as a result of limited resources being available, and consequently the scheme has not yet reached its full potential. However, the overall significance of the scheme should not be underestimated as the project demonstrated a commendable degree of innovation and successful partnership working.

The second phase of work (Black Devon Wetland and Landfill Project), took place in 2005 after the adjacent landfill site operated by Clackmannanshire Council ceased operation. The site required restoration by 2006 under terms of the SEPA licence.

The council acquired land adjacent to the landfill site in order to provide a sustainable and more economical source of soil which was required to cap the landfill site once leachate and landfill gas treatment was complete. A total of 100,000 m^3 of capping soil was required and this was stripped from the adjoining carseland. A wetland area totalling 21 ha was created with shallow pools and islands (Figure 3). The cost savings to the restoration of the landfill through local provision of soil was approximately £250,000.

Figure 4: Black Devon Wetlands following soil stripping Oct 2005 and looking north-west, Nov 2010

Following completion of the second phase works in 2005 no practical management has taken place and grazing ceased shortly afterwards. This has resulted in habitat degradation and the area becoming less attractive to wetland birds (second image, Figure 3). This clearly demonstrates the need to establish ongoing and achievable management regimes for newly created wetland sites.

Kennet Pans, Clackmannanshire

The Clackmannanshire Bridge at Kincardine is a new 1.2 km road bridge over the Firth of Forth SPA, which opened in 2008. It diverges from the existing bridge on the south side of the Forth and

crosses to the site of the demolished Kincardine Power Station on the north shore. Bridge construction resulted in loss of approximately 0.5 ha of saltmarsh and mudflat (Babtie 2002).

An opportunity to create intertidal habitat arose as part of the design and construction of the bridge and was deemed desirable set against the loss of designated habitat which would be lost as due to bridge construction. (Babtie Group 2003)

In 2003, the Babtie Group were commissioned by Scottish Executive Development Department to investigate the feasibility of carrying out a managed realignment project on the site of the former Kincardine Power Station. The study aimed to establish whether successful managed realignment was feasible at the site, to make preliminary predictions about saltmarsh and mudflat zonation within the site, to make predictions about habitat and species establishment timeframes and to make predictions of the likely bird use of the recreated ecosystem

The study investigated the suitability for managed realignment at Kennet Pans within the context of the Forth estuary as a whole and looked at the site in detail covering land use, topography, drainage and existing sea defences. Adjacent saltmarsh habitat was surveyed and mapped. The impacts of the managed realignment scheme on the wider Forth Estuary were modelled using the in-house Babtie Group river modelling package FLOODTIDE. Simulations based on three options using the options of no breach taking place as a baseline were carried out and impacts predicted. Criteria modelled were water levels, velocities through the breach, potential for ponding, risk of flooding adjacent land, wider impact on the Forth Estuary, effect of sediment accretion, effect of storm surges, climate change and sea level rise.

The results of the study identified three possible methods of managed realignment; embankment breaching, partial and entire embankment removal. Modelling showed that all of these options would result in the development of areas of mudflat and saltmarsh within the site. The preferable option chosen was removal of the west embankment as it maintained ecological connectivity with the existing saltmarsh and mudflat at Kennet Pans.

Figure 5: Kennet Pans managed realignment site looking south west, Jan 2011. (S Paterson)

A site adjacent to the route of the new bridge totalling 9 ha was identified as available and suitable for habitat creation and managed realignment. The area had previously been identified (GeoWise 1999) as suitable for a managed realignment project as '*Kennet Pans are very well sited in the middle estuary to contribute to estuarine functionality and with minimal additional engineering required*.'

The managed realignment work was carried out by the principle Clackmannanshire Bridge contractors Morgan Vicni, a joint venture between Morgan Sindall and VINCI Construction Grands Projets. A monitoring scheme was put in place to evaluate the success of the project and while results are not yet available, the area is frequented by large numbers of waders and wildfowl. The project received a Green Apple Environment Award for Environmental Best Practice, and was highly commended in the Major Project category at the 2009 British Construction Industry Awards.

Bothkennar, Skinflats, Falkirk (Skinflats Tidal Exchange Project (STEP Forth)

The RSPB acquired Skinflats reserve comprising of 415 hectares of inter-tidal mudflats and saltmarsh in 1999. A further extension of an adjacent 11 ha field at Bothkennar was added in 2001. The field was formerly used for haylage and of low conservation value. The field was bounded to the north by a seawall built as part of land-claim scheme with flood embankments to the east and west. Drainage ditches ran from west to east inside the sea wall and from south to north along the eastern boundary. These ditches drained surrounding farmland.

The wider area had previously been identified in the Geowise report as suitable for a large-scale managed realignment scheme and being identified as a key site on the Inner Forth in terms of a managed realignment. The wider Skinflats area was the subject of a feasibility report carried out in 2001 by Babtie Group. The RSPB embarked on a small scale scheme primarily to act as a demonstration site and through funding from SEPA, commissioned consultants, Ecology, Land and People (ELP) to carry out a feasibility study regarding options for managed realignment and design of a suitable managed realignment scheme. ELP investigated four options;

1. Do nothing,
2. Inter-tidal habitat creation through breaching of the sea wall only
3. Inter-tidal habitat creation through a sea wall breach and small scale excavation
4. Inter-tidal habitat creation through a sea wall breach and large scale excavation.

Option 4 was chosen as it provided the best combination of inter-tidal habitats as well as the greatest opportunity to increase wildfowl interest in the area. ELP recommended a regulated tidal exchange system, whereby a twin-walled pipe is inserted into the existing seawall which allows the Forth to flow into the field via an existing tidal creek at high tide and to exit at low tide following the pattern of flood and ebb tides and spring and neap cycles.

Planning permission was required and an Environmental Impact Assessment undertaken to inform the application for consent. An application for a FEPA licence was made for works in the marine environment and planning permission sought. Once permissions were granted and funding in place, initial engineering and earthworks work began in August 2009. The project was funded by SEPA, Forth Valley and Lomond LEADER, Falkirk Environment Trust and SNH.

Two shallow pools and a system of creeks were excavated, with the spoil used to form a secondary flood defence on the eastern boundary of the site. Following consultation with the local community, a Penstock sluice was installed plus associated earthworks. The Penstock sluice retains the water and gives a degree of control over the entry and exit of water. This is a valuable aspect of managing the RTE as the system can be closed down in times of high rainfall and localised fluvial flooding, enabling adjacent drains to take priority. This assists with sediment deposition as the tide recedes, providing conditions suitable for the establishment of saltmarsh. The resulting works created 2 ha of saline lagoons and 8 ha of developing saltmarsh. Within the first year of operation saltmarsh vegetation has started to colonise the site and it is anticipated that it will be come established from pioneer marsh at the water's edge then progress gradually in a landward direction. Stirling University have carried out botanical monitoring of the site.

Figure 6: Bothkennar field before and after installing of RTE

7. Summary of Site Assessments

The site assessments were carried out between September 2010 and August 2011 and consisted of a preliminary search for available information then up to three visits to each site. Notes and photographs were taken before carrying out an initial evaluation of suitability for habitat creation or restoration, using a variety of criteria. These included assessment of the site's potential role in meeting WFD objectives and flood alleviation in the emerging flood risk management regime.

A total of twenty one sites were visited which were all assessed in terms of habitat creation opportunities, resulting in twelve sites being identified as suitable for further consideration. The nine sites assessed but not considered further in the report were Blackness, Kinneil Kerse (Falkirk), Bolfornaught (Stirling), Cambus Pools, Tullibody and Alloa Inches, (Clackmannanshire), Newpans, Valleyfield Lagoons and Torry Bay (Fife).

All the above sites have potential or are already contributing (via sympathetic management) to the safeguarding, developing and creation of habitats within the Inner Forth or are unsuitable for habitat creation or restoration. Although not considered further in this report, ongoing positive management and interpretation of their wildlife would in many cases complement the measures proposed for the 12 habitat sites detailed in this study.

Blackness, Kinneil Kerse and Torry Bay are areas where opportunities to create or manage habitat are limited by the nature of the landscape and where, especially in the case of Torry Bay, little additional advantage could be gained. However, there is potential to develop low key visitor facilities at each site and develop and upgrade footpaths and links between sites, particularly between Blackness and Kinneil Kerse. Blackness and Torry Bay would provide excellent natural start and end points for an Inner Forth trail.

Cambus Pools are in active conservation management by Scottish Wildlife Trust and have recently received funding to carry out habitat enhancement and introduce grazing to the site which will enhance the conservation value of the site and the area. Alloa Inch (32 ha) and Tullibody Inch (13.3 ha), also in Scottish Wildlife Trust management are both functioning as naturally realigning sites due to breaches in embankments and developing saltmarsh and reedbed habitats.

Valleyfield Ash lagoons have been created by the disposal of pulverised fuel ash from Longannet Power Station covering an area of 200 ha. The lagoons are still active and are used for the disposal and storage of fuel ash but the site contains a significant area of wildlife habitat such as grassland, open water and marsh. The lagoons also provide an undisturbed roost site for the waders and wildfowl using the adjacent Torry Bay and Inner Forth areas and are included within the larger Torry Bay Local Nature Reserve area (683 ha). There is potential to develop and expand the existing work of the Fife Coast and Countryside Trust ranger and Scottish Power in creating areas suitable for breeding sand martins and shelduck utilising fuel ash, for example by creating artificial 'sand' banks & burrows.

There are existing proposals by Scottish Power and Fife Coast and Countryside Trust to install facilities such as hides and interpretation on the site and any further developments within the lagoons will be restricted by the operational requirements of Scottish Power.

The site at Newpans is unsuitable for habitat creation or restoration due to the proximity of development, housing and a railway line. Bolfornaught is a large site that is quite far upstream and the conservation benefits may be difficult to realise at this site due to physical constraints and estuarine functionality.

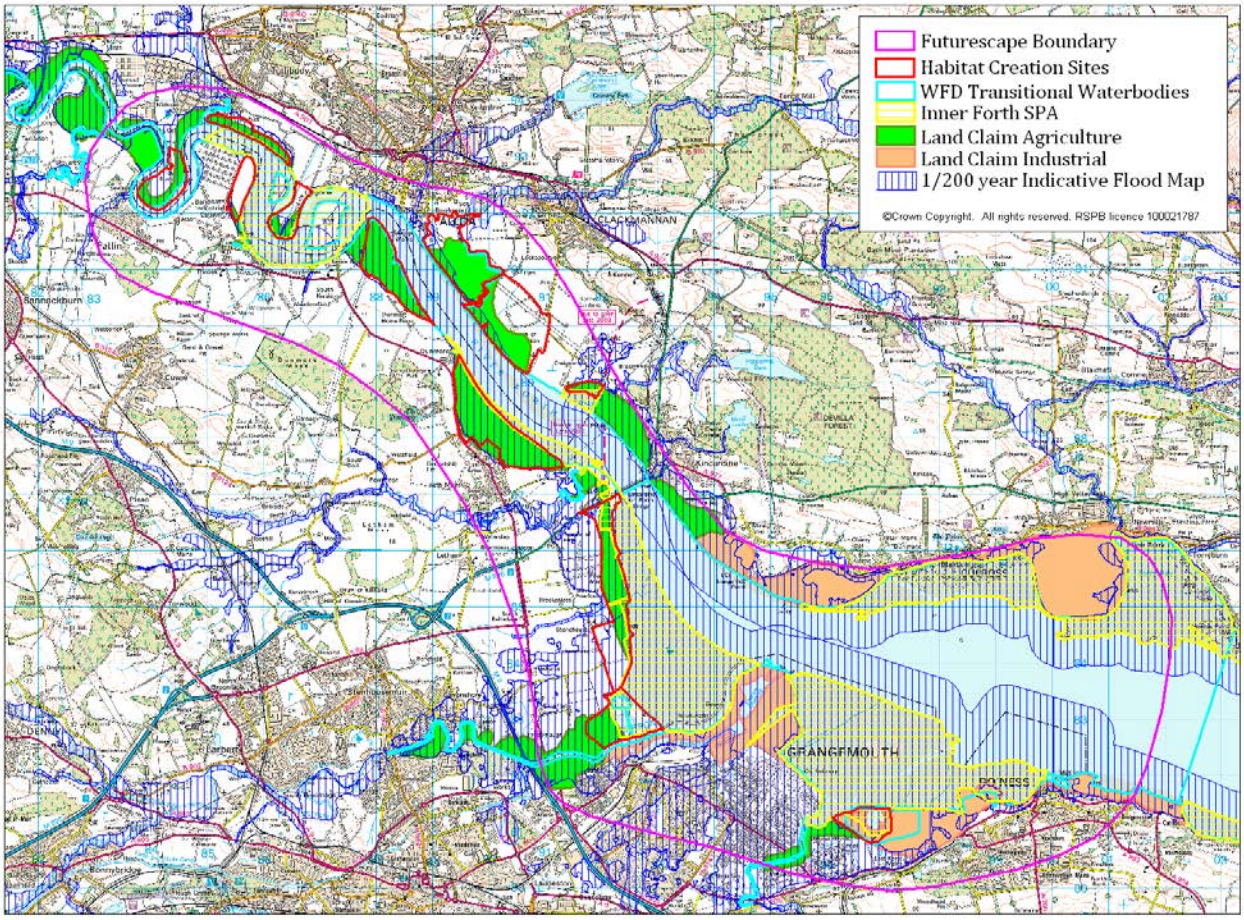

Figure 7: Potential habitat creation sites within the Inner Forth Futurescape

Detailed site assessments have been carried out for the remaining twelve sites within the study area (Figure 6) and are contained within appendices to this report. The assessments consider various management options and the benefits and disadvantages of each option before making a recommendation. While constraints to habitat creation do exist within the Inner Forth, the site assessments clearly show that there is significant potential for habitat creation and management that will deliver the aims of the Inner Forth Futurescape. The initial analysis also suggests that should all identified Futurescape sites on the inner estuary be restored to a more natural condition,

it is possible that the upper Forth estuary could be reclassified from poor ecological potential to moderate ecological potential.

Opportunities to create and restore habitat at these twelve sites can be broadly grouped into three categories. All sites are located within the original area of search and together they could form a linked network and mosaic of habitats. The total area identified as being suitable for habitat creation or management is 683 ha, of which 308 ha fulfils the criteria for carrying out managed realignment.

a) Large sites of over 100 ha where it is technically feasible and environmentally advantageous to carry out managed realignment

Landscape scale habitat creation and restoration opportunities in the Inner Forth centre around three reclaimed areas in the middle estuary at Skinflats, Airth (both Falkirk) and Inch of Ferryton (Clackmannanshire) . These sites have the potential to deliver over 300 ha of intertidal, saltmarsh and associated wetland and other habitats and together would result in significant conservation gains and contributions to flood management and meeting Water Framework Directive objectives.

A managed realignment scheme has been previously proposed at Skinflats and the technical feasibility of the scheme proposed in 2003 should be revisited alongside the appropriate landowner and community consultation as a priority. This scheme has the potential to become a showpiece managed realignment scheme in Scotland and the first on a relatively large scale. The site at Skinflats shows a demonstrable and feasible case for a managed realignment scheme and meets all the established criteria for a managed realignment scheme. The existing adjacent intertidal habitats would ensure that the conservation objectives would be fulfilled and the potential of the site realised in terms of creating habitat, restoring good ecological condition and contributing to flood management

At Inch of Ferryton, on the north shore of the Inner Forth in Clackmannanshire, the first steps to investigate the potential to deliver a managed realignment scheme are being considered. A scheme implemented at Inch of Ferryton would result in the restoration and creation of between 60 and 160 ha of habitat and would form a key strategic link in a network of sites on the north shore of the Inner Forth stretching from the Haugh of Blackgrange to Kennet Pans.

The third of the sites at Airth on the south shore would involve a managed realignment scheme to the north of the Clackmannanshire Bridge to Dunmore which would restore the area to a more natural functioning landscape and provide an enhanced level of protection to the village of Airth.

Consultation and engagement with local communities and landowners will determine interest in taking such schemes forward. The development of these three schemes would then require significant further study investigating technical issues. Detailed evaluation investigating the topography, geomorphology, hydrology of the individual sites and how they affect estuarine functions must first be undertaken, along with appropriate cost benefit analysis.

b) Areas of between 7 and 50 ha where it is technically feasible and environmentally advantageous to carry out managed realignment

A suite of five smaller sites at Haugh of Blackgrange, Cambus, Rhind, Kennet Pans, and Bandeath are all suitable for habitat restoration and creation and would provide vital links in the network of sites. Of these sites, Kennet Pans on the north shore of the river, is a key site as although relatively small (7ha), could make a significant contribution as ecological and practical factors favour development of habitat at this site

c) Sites where habitat creation and management opportunities are possible with potential for development of visitor facilities

Three sites on the Inner Forth at Kinneil Lagoons (Bo'ness), Bothkennar Pools (Skinflats) and Black Devon Wetlands (Alloa) are suitable candidates for habitat creation and management initiatives and as a means of engaging local communities. Projects at these sites are focused on enhancement of existing habitat and small scale habitat creation. They all have significant potential for interpretation, access, volunteering and education opportunities. These sites are important because they are located close to population centres, already feature considerable biodiversity interest and have opportunities to develop visitor infrastructure, linking with other visitor facilities. The development of one or more of these sites would help to build support for and raise the profile of the Inner Forth Futurescape and the potential of habitat creation projects in the area.

The twelve potential habitat creation and enhancement sites are summarised below:

Table 1: Summary of Assessed Habitat Creation Sites in Inner Forth

Site name	Total Area	Habitat Creation Opportunity	Species Benefits	Significant Flood Risk or Flood Management Potential	Key Benefits
Kinneil Lagoons	30 ha	Enhancement of saline lagoons, saltmarsh (20ha)	Wildfowl Waders Specialised invertebrates	Yes	Scarce habitats Wildlife spectacle Visitor development potential
Bothkennar Pools	60 ha	Enhancement of saline lagoons, reedbed, wet grassland, scrub (60ha)	Wildfowl Waders Specialised invertebrates Otter	Yes	Scarce habitats Wildlife spectacle Visitor development potential
Skinflats	110 ha	Managed realignment with creation of intertidal, saltmarsh, grassland (70ha)	Wildfowl Waders Fish Otter	Yes	Significant contribution to habitats and flood management
Airth	100 ha	Managed realignment with creation of	Wildfowl Waders	Yes	Significant contribution to

		intertidal, saltmarsh, grassland (70ha)	Fish Otter		habitats and flood management
Dunmore/ South Alloa	60 ha	Managed realignment with creation of intertidal, saltmarsh, grassland (25ha)	Wildfowl Waders Fish Otter	Yes	Contribution to habitats and flood management
Bandeath	30 ha	Managed realignment with creation of intertidal, saltmarsh, grassland (20ha)	Wildfowl Waders Fish Otter	Yes	Contribution to habitats and flood management
Haugh of Blackgrange	40 ha	Managed realignment with creation of intertidal, saltmarsh, grassland (25ha)	Wildfowl Waders Passerines Fish Otter	Yes	Contribution to habitats and flood management
Cambus	25 ha	Managed realignment with creation of intertidal, saltmarsh, grassland (20ha)	Wildfowl Waders Fish Otter	Yes	Contribution to habitats and flood management
Rhind	16 ha	Managed realignment with creation of intertidal, saltmarsh, grassland (16ha)	Wildfowl Waders Passerines Fish	Yes	Contribution to habitats and flood management
Black Devon Wetlands	45 ha	Habitat enhancement of brackish lagoons, wet grassland	Wildfowl Waders Passerines Specialised invertebrates	Yes	Visitor development potential Scarce habitats
Inch of Ferryton	160 ha	Managed realignment with creation of intertidal, saltmarsh, grassland	Wildfowl Waders Fish Otter	Yes	Significant contribution to habitats and flood management
Kennet Pans	7 ha	Managed realignment with creation of intertidal, saltmarsh, grassland	Wildfowl Waders Fish Otter	Yes	Contribution to habitats and flood management

Further consideration has been given to the potential of each of these sites to deliver the six aims of the Inner Forth Futurescape, as described on page 3. Table 2 provides a comparison of the fit with the Futurescapes aims against the likely scale of cost involved in delivery of the schemes and likely timescale for implementation. This has informed the recommendations section.

Table 2: Summary of Site Contributions to Futurescape Aims

	Potential Contribution to Delivery of Futurescapes Aims	

Site name	Habitats	Species	CSGN	WFD	FRM	Amenity	Cost *	Time **
Kinneil Lagoons	Enhance/ develop & safeguard >20ha priority habitat.	Benefit SPA/SSSI bird and inverts	Key site - link & extend habitat & access network	Limited	Yes	Yes Access	Low	Short
Bothkennar Pools	Enhance, develop & safeguard > 60ha of 3 BAP priority habitats	Benefit SPA SSSI features.	Key site – enhance habitats & develop access	Limited	Yes	Yes Access	Low	Short
Skinflats	Create >60ha of 2 BAP priority habitats. Links to adjacent sites	Benefit SPA & other species	Key site – contribute to 2 Vision themes	Yes, key site	Yes, key site	Limited	High	Long
Airth	Create >60ha of 2 BAP priority habitats. Links to adjacent sites	Benefit SPA & other species.	Key site - contribute to 2 Vision themes	Yes, key site	Yes, key site	Limited	High	Long
Dunmore/ South Alloa	Create >20ha of 2 BAP priority habitats. Links to adjacent sites	Benefit SPA & other species	Yes	Yes	Yes	Limited	Med	Long
Bandeath	Create >20ha of 2 BAP priority habitats. Links to adjacent sites	Benefit SPA & other species	Yes	Yes	Yes	Limited	Med	Long
Haugh of Blackgrange	Create & enhance >15ha priority BAP habitats. Links to adjacent sites	Benefit SPA & other species e.g. reedbed specialists	Yes	Yes	Yes	Limited	Med	Med
Cambus	Create 20ha of 2 BAP priority habitats	Benefit SPA species		Yes	Yes	Yes	Med	Long
Rhind	Create >10ha of 2 BAP priority habitats	Benefit SPA species		Yes	Yes	Limited	Low	Med
Black Devon Wetlands	Saline lagoons, open water, wet grassland, grassland	Benefit SPA species	Yes, contributio n to 2 Vision themes	Yes	Limited	Yes Access	Low	Short
Inch of	Create >60ha of	Benefit SPA	Yes	Yes, key	Yes, key	Yes	High	Med

Ferryton	2 BAP priority habitats. Links to adjacent sites	species		site	site			
Kennet Pans	Create 7 ha of priority BAP habitats. Links to adjacent sites	Benefit SPA/SSSI features	Yes	Yes	Yes	Limited	Low	Med

* Low = <£500K, Medium = £500k - £1m, High = >£1m

** Short = 1-3 years, Medium = 4-10 years, High = 10+ years

8.Recommendations

The suitability of the Inner Forth area for carrying out habitat restoration and creation by hydrological management and managed realignment has been recognised for over two decades. In that space of time, three small but significant projects have been carried out which have all contributed to the available body of knowledge regarding habitat creation and flood management in the Inner Forth.

However, to achieve the Inner Forth Futurescape aims, a step change in level of delivery is required. This next step will become crucial as the effects of the pressures outlined in Chapter 4 become apparent. Action will not only be desirable but increasingly become necessary to safeguard, maintain and enhance biodiversity and economic interests in the area and to maximise opportunities to deliver Water Framework Directive and Flood Risk Management Act objectives.

This will require a partnership approach by a range of organisations working in the area as well as further detailed analysis of some of the effects of habitat creation and detailed investigation of some of the proposed projects. Inevitably this will be constrained by available resources and significant investment in the project will be required if the vision is to be achieved. Actions emanating from this recommendations section have been captured in the delivery plan in chapter 9.

A Partnership Approach

The year long project culminating in this report has been overseen by a partnership steering group and the contributions of individual partners has been crucial to the development of the report. Moving forward into a delivery phase will require continuation of this approach to ensure all opportunities are taken to embed the Futurescape in other plans and programmes of work and to ensure the Futurescape continues to reflect the priorities of a wide range of stakeholders. Work with land managers and owners will become increasingly important as the project moves into a delivery phase, as implementation will be dependent on a wide range of land managers within the project area.

It is recommended that a partnership group continues to meet and input to the work of the Futurescape Officer who will be appointed to take the project forward. The enthusiasm for partnership working has been shown by members of the Inner Forth steering group and a wider grouping of partners, who have together prepared and submitted a bid for HLF Landscape Partnership funding. Although unsuccessful in 2011, there is now enthusiasm to resubmit a revised bid in 2012 and it is hoped that some aspects of the Futurescape could form part of the Landscape Partnership programme.

Delivery and funding mechanisms

To deliver the habitat creation opportunities proposed will be challenging but it is important to remember that this is a project with a long-term vision spanning several decades. Delivery will therefore be over a long timeframe and be phased.

RSPB has secured EU LIFE funding for employment of a Futurescape Officer for the project (part time for 3 years) and this will be a valuable resource for maintaining momentum and taking forward practical delivery of the projects. Resource is also available to carry out more events and activities to engage the public with wildlife in the area and this will help build awareness and interest in the project.

Given the scope and scale of the three managed realignment proposals at Skinflats, Inch of Ferryton and Airth and the costs involved, significant funding will be required. This is likely to involve a range of funding sources, including Scottish Government backed schemes, European funding sources or a major award from a grant making body. For individual projects, it is also likely that private capital, charitable trusts and specific grant applications will be required for delivery.

As one driver for the project was to identify potential mitigation and compensation opportunities for future developments, it is envisaged that some projects may be realised through the development consenting process. However, it should be remembered that this may be as a result of negative effects on the SPA features elsewhere.

In addition, the implementation of the Water Framework Directive and Flood Risk Management Act and the production of new Local Development Plans present important opportunities to embed the ethos of the Futurescape and specific projects within these plans. This should result in both support for the projects and increased likelihood of funding. Through future revisions of agri-environment funding, it is hoped that local priorities will be supported and land managers given the financial support to deliver these types of projects. An advisory role for NGO's and agencies will therefore be required to maximise opportunities to deliver through agri-environment funding.

Project Delivery

As outlined above, the habitat creation component of the Inner Forth Futurescape comprises a suite of twelve individual projects which all have potential to stand alone as separate projects which would have ecological and potential flood management benefits.

It is recommended that some of the smaller proposals be prioritised as more easily achievable and fundable. These would serve as further demonstrations of the benefits of this approach and build confidence within communities, local authorities and statutory agencies with the techniques and process. This would enable progress to be made with realising landscape scale habitat creation. A site such as Kennet Pans where a small managed realignment project could be implemented would be an opportunity to build confidence and develop the landscape scale theme.

Habitat enhancement proposals with appropriate visitor infrastructure at Bothkennar, Black Devon wetlands and Kinneil would be ideal to initiate the first steps of a wider long-term project and it will be important to incorporate these visitor aspects in project development.

Larger projects such as a managed realignment project at Skinflats would be the next logical step as this has considerable potential to contribute to biodiversity, flood management and ecological aims in an area where the technical feasibility has been proven, the outcomes quantified and where the likelihood of an unplanned event is relatively high. Given the scale of such a scheme, a long-term view must be taken and significant preparatory work carried out with landowners and communities to develop a scheme that is beneficial to all.

Similar sized proposals at Airth and Inch of Ferryton are perhaps longer-term projects but none the less important as sea level rise will undoubtedly begin to impact on estuarine habitats and embankments which currently provide protection to low lying land on both the north and south banks. Pragmatically, factors such as landowner interest and funding will play a role in dictating priorities but development of these three larger schemes will be crucial in ensuring the estuary is capable of adapting to changes. Both Inch of Ferryton and Airth have constraints but are still capable of delivering significant benefits; detailed feasibility studies would inform a decision to prioritise work.

There are potentially other areas in the Inner Forth where circumstances such as maintaining pumps and embankments may prove onerous and opportunities may arise at sites in the Upper estuary for habitat creation to be a viable alternative. Further discussion with landowners, communities, local authorities and statutory agencies at smaller sites such as Cambus and Haugh of Blackgrange could be undertaken to investigate the likelihood of this. Sites at Bandeath and Dunmore where the high cost, size and location make the case for carrying out managed realignment a marginal one should remain part of the overall long-term strategy as these factors may change in the future.

Further research

There are several areas of research that would inform and assist the development of a landscape scale habitat creation and restoration programme in the Inner Forth and provide baseline data to monitor success.

These include developing a more detailed understanding of the response of biodiversity to habitat creation and the effects of current pressures on biodiversity. Although initial assessments of contribution to flood risk management have been made, a more detailed analysis of flood risk in the Inner Forth area and the potential contribution of the proposed habitat creation sites to managing that risk is required. Detailed suggestions for research projects are provided in the delivery plan.

9.Partnership Delivery Plan

Project	Outcome	Action	Timescale*			Lead partners and delivery mechanism
			S	M	L	
Delivery: Project Management	Maintain and improve partnership approach	Establish partnership steering group with quarterly meetings	✓			RSPB to facilitate and chair
	Provide staff time to lead on delivery	Appoint Futurescape Officer	✓			RSPB to appoint in December 2011 using LIFE funding.
Delivery: Funding	Strategic approach to funding Futurescape projects	Produce funding plan for projects	✓			Futurescape Officer to lead, with input from RSPB and partners
	Secure funding for Futurescape projects	Make applications for initial projects in accordance with plan	✓			Futurescape Officer to lead, with input from RSPB and partners
		Include aspects of Futurescape in HLF Landscape Partnership if appropriate	✓			Partnership to appoint project officer to lead on LP process.
Delivery: Land and Water Planning	Incorporate Futurescape within sustainable flood management	Ensure integration into flood plan districts and that there is consistency between them	✓			SEPA to ensure inclusion and links made to Futurescape
		Include projects within Flood Risk Management Plans	✓			SEPA to ensure inclusion and links made to Futurescape
	Incorporate Futurescape within Land Use Planning	Include projects within emerging LDPs	✓			LAs to ensure inclusion and links made to Futurescape
Engagement: Communities	Ensure full engagement with local communities & organisations	Dedicate staff time and resources to liaise and work with people in area	✓	✓	✓	RSPB to ensure key part of Futurescapes and Landscape Partnership posts in the area

		Produce and implement engagement plan	✓	✓	✓	Futurescape Officer to lead with input from partners
Engagement: Business	Businesses involved and supportive of Futurescape	Meet with key businesses to discuss Futurescape	✓			SNH, Falkirk and RSPB to organise
Engagement: Agriculture	Increase joint working with land managers in area	Deliver Volunteer and Farmer Alliance surveys in area	✓			RSPB to organise surveys with existing staff resource
	Target land management to deliver Futurescapes aims	Deliver advisory visits in the area	✓			RSPB to deliver with existing staff resources
		Target RPAC resources to agreed Futurescape priorities		✓		SNH, FC, SEPA and Local Authorities to prioritise in local aspect of SRDP review
Understanding: Flooding	Understand potential contribution of Futurescape to sustainable flood management	Analysis of impact and assessment of need for Flood Risk Model	✓			SEPA to carry out analysis using in house models and data
		Commission a project specific Flood Risk/ Hydrological Model if required	✓			SEPA to commission if required
		Assess condition and maintenance costs of sea defences	✓			Lead and funding uncertain
Understanding: Biodiversity	Understand changes and drivers of change in wintering bird numbers on the Inner Forth	Analysis of WeBS count data	✓			BTO, RSPB, SNH joint project. Lead partner to be agreed. May form suitable student project.
	Understand distribution and	Targeted counts of key species outside	✓			BTO, RSPB, SNH joint project. Lead

	feeding patterns of birds using Inner Forth	standard monitoring, to include nocturnal birds distribution				partner to be agreed and funding to be sourced.
	Understand and quantify key farmland bird populations in Inner Forth area.	Assess farmland bird populations along Inner Forth to inform agricultural habitat enhancement	✓			BTO, RSPB, SNH joint project. Lead partner to be agreed and funding to be sourced.
	Understand disturbance effects in Inner Forth area	Study the effects of disturbance on wintering waders and wildfowl	✓			BTO, RSPB, SNH joint project. Lead partner to be agreed and funding to be sourced.
	Understand populations and distribution of benthic and intertidal invertebrates	Survey of populations and distribution of benthic and intertidal invertebrates	✓			Stirling University
	Understand sedimentation processes in pioneer saltmarsh	Study of sediment accumulation at habitat creation sites	✓			Stirling University
	Understand value of saltmarshes to fisheries	Assessment of use as nursery habitat	✓			To be determined
Site 1: Kinneil Lagoons	Habitat creation, management and visitor facilities	Consultation, surveys and initial designs	✓			RSPB in partnership with Falkirk Council, SNH & Friends of Kinneil Foreshore.
		Technical designs, consultation and consents		✓		RSPB in partnership with Falkirk Council, SNH & Friends of Kinneil Foreshore.
		Funding and implementation		✓		RSPB in partnership with Falkirk Council, SNH & Friends of Kinneil Foreshore.
Site 2: Bothkennar	Habitat creation, management and visitor facilities	Consultation, surveys and initial designs	✓			RSPB to lead, with agreement of approach with FC

		Technical designs, consultation and consents		✓		RSPB to lead, with agreement of approach with FC
		Funding and implementation		✓		RSPB to lead, with agreement of approach with FC
Site 3: Skinflats	Managed realignment scheme	Consultation	✓			RSPB, Falkirk Council, SNH, SEPA.
		Update Babtie report, initial designs		✓		RSPB, Falkirk Council, SNH, SEPA.
		Technical designs, consultation and consents			✓	RSPB, Falkirk Council, SNH, SEPA.
		Funding and implementation			✓	RSPB, Falkirk Council, SNH, SEPA.
Site 4: Airth	Managed realignment scheme	Consultation, surveys and initial designs	✓			Falkirk Council, SNH, SEPA, RSPB
		Technical designs, consultation and consents		✓		Falkirk Council, SNH, SEPA, RSPB.
		Funding and implementation			✓	Falkirk Council, SNH, SEPA, RSPB
Site 5: Dunmore/ South Alloa	Investigate managed realignment scheme	Consultation, consideration of costs, benefits and technical feasibility			✓	Falkirk Council, SNH, SEPA, RSPB
		Review project and proceed with technical designs if viable			✓	Falkirk Council, SNH, SEPA, RSPB
Site 6: Bandeath	Investigate managed realignment scheme	Consultation, consideration of costs, benefits and technical feasibility		✓		RSPB, Stirling, SEPA, SNH.
		Review project and proceed with technical designs if viable		✓		RSPB, Stirling, SEPA, SNH.
Site 7: Haugh of	Managed realignment	Consultation, surveys and initial	✓			RSPB, SNH, SEPA, Clackmannanshire

Blackgrange	scheme	designs				Council**
		Technical designs, consultation and consents		✓		RSPB, SNH, SEPA, Clackmannanshire Council**.
		Funding and implementation		✓		RSPB, SNH, SEPA, Clackmannanshire Council**.
Site 8: Cambus	Managed realignment scheme	Consultation, surveys and initial designs		✓		RSPB, SNH, SEPA, Clackmannanshire Council**.
		Technical designs, consultation and consents		✓		RSPB, SNH, SEPA, Clackmannanshire Council**.
		Funding and implementation			✓	RSPB, SNH, SEPA, Clackmannanshire Council**.
Site 9: Rhind	Managed realignment scheme	Consultation, surveys and initial designs		✓		RSPB, SNH, SEPA, Clackmannanshire Council**.
		Technical designs, consultation and consents		✓		RSPB, SNH, SEPA, Clackmannanshire Council**.
		Funding and implementation			✓	RSPB, SNH, SEPA, Clackmannanshire Council**.
Site 10: Black Devon	Habitat creation, management and visitor facilities	Consultation, surveys and initial designs	✓			RSPB, Clackmannanshire Council**.
		Technical designs, consultation and consents	✓			RSPB, Clackmannanshire Council**.
		Funding and implementation	✓			RSPB, Clackmannanshire Council**.
Site 11: Inch of Ferryton	Managed realignment scheme	Consultation, surveys and initial designs	✓			RSPB, landowner, SEPA
		Technical designs, consultation and consents		✓		RSPB, landowner, SEPA
		Funding and implementation		✓		RSPB, landowner, SEPA

Site 12: Kennet Pans	Managed realignment scheme	Consultation, surveys and initial designs	✓			RSPB, Clackmannanshire Council**, SNH, SEPA
		Technical designs, consultation and consents		✓		RSPB, Clackmannanshire Council**, SNH, SEPA
		Funding and implementation		✓		RSPB, Clackmannanshire Council**, SNH, SEPA

*Timescale defined as short = year 1to 3, medium = year 4 to 10, long = year 10 +

** Clacks Council is supportive of the Futurescape and will endeavour to provide support and assistance to the RSPB and other partners. This will primarily be an advisory role e.g. providing an input on draft briefs and documents

10.Conclusions

The potential for large scale wetland creation in the Inner Forth has been recognised for some time and in recent years has received renewed interest for a variety of reasons, leading to the proposal for the Inner Forth Futurescape. These include the recognised multiple benefits of landscape scale habitat creation and the increased pressure on the Inner Forth area from climate change and development. The Central Scotland Green Network has provided a focus for such an approach and many of the aims of the Futurescape align closely with those of the CSGN.

Following a general recognition that this approach merited serious consideration by all parties, this partnership project has investigated the desirability and practicality of various habitat management options at sites in the Inner Forth. The study has shown that while constraints and limitations exist, there is an exciting opportunity to create a network of wetland and associated habitats across the area, totalling over 613 ha and representing a significant change to habitat value of the area. Indications are that this could make a significant contribution to delivery of Water Framework Directive targets. Although further modelling is required, it appears that habitat management and creation of this scale could make a positive contribution to sustainable flood management in the area. In many places, there are also exciting opportunities to create new outdoor access and wildlife watching facilities associated with new habitat and thereby benefit local residents and visitors to the area.

Taking this opportunity to implement a programme of habitat restoration and creation on a significant scale in a heavily industrialised and modified landscape would have multiple benefits. This approach provides an innovative and sustainable solution to many challenges faced by government and communities in the Inner Forth area and should be a priority for land and water management plans and funding. It could form a core project within the CSGN and demonstrate how habitat creation can lie at the heart of delivering a more sustainable land use approach.

Successful implementation of the delivery plan and realisation of this ambitious vision will require a strong partnership approach and significant resource but will have long term benefits that merit this investment. The first stages of this partnership approach have been successfully demonstrated by this project and together the partners have identified opportunities for delivery and recognised the need to embed the Futurescape projects in other land and water management plans.

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Appendices

February 2012

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Contents

Appendix 1: Kinneil Lagoons Site Assessment

Introduction

This site assessment has been produced following a desktop review of available information, site visits and initial discussions with stakeholders and land managers. The recommendations made are based on current knowledge. Further consultation with communities and landowners and detailed technical assessments will be required to develop and confirm proposals.

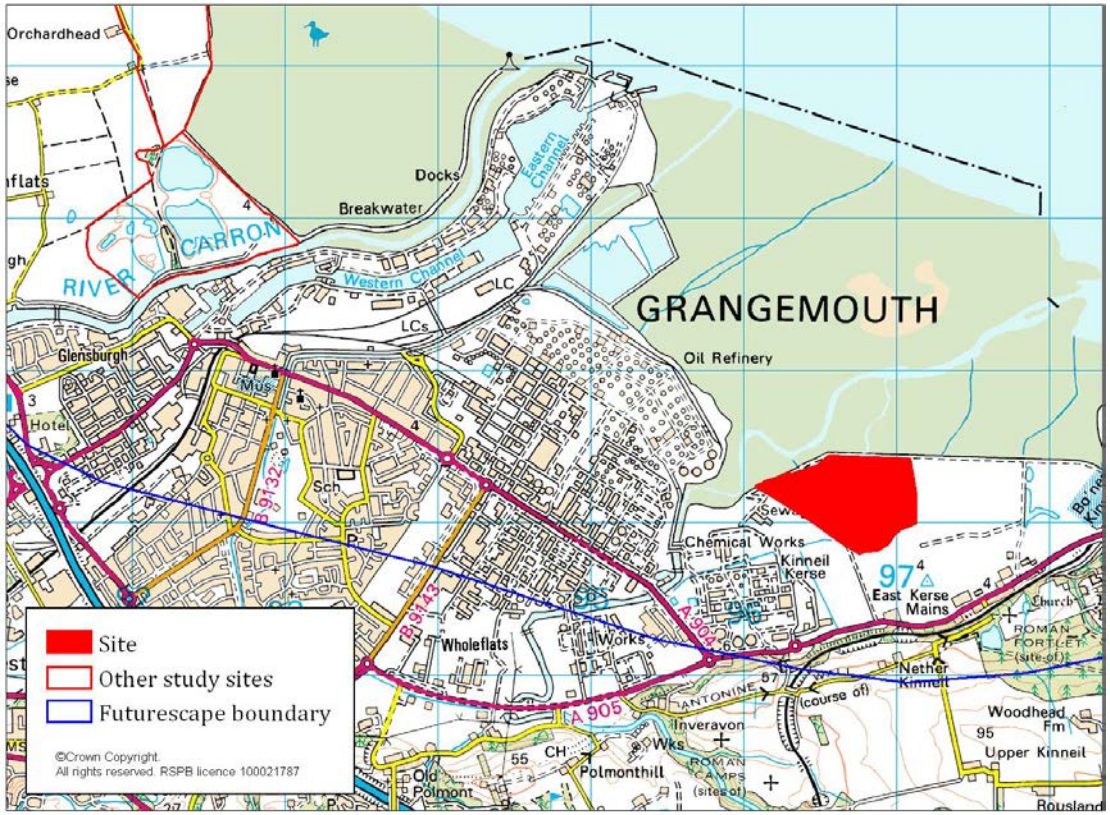


Figure 1: Location of Kinneil Lagoons

Site Description

Kinneil Lagoons are located on the southern shore of the Forth between Bo'ness and Grangemouth and are one of only two saline lagoons in the area, the other being Bothkennar Pools located 5 km to the north east. The site is approximately 32 ha in extent and is located on a large land reclamation site of over 100 ha dating from the mid 20th century when spoil from the Kinneil Kerse mine was used to construct a 3 km embankment running from east to west separating the site from the Forth. This site was then used as a refuse disposal site and infilled from the eastern end.

Lagoons developed at the west end of the site, proving attractive to large numbers of wildfowl and waders. The refuse disposal site ceased operating in the mid 1990s.

The lagoon, which lies within a steeply embanked 'bowl', consists of a roughly circular pool, approximately 12 ha in size with two thin promontories at the north and south western edges jutting in to the body of the lagoon and a channel running parallel for 1km to the embankment at the eastern end of the site. Water enters the lagoon via two or possibly three sources; one of which is a series of 8 large pipes that allow water to enter the lagoons at high tide and drain out at low tide. There is also considerable seepage through the embankment, which is also occasionally overtopped by hide tides.

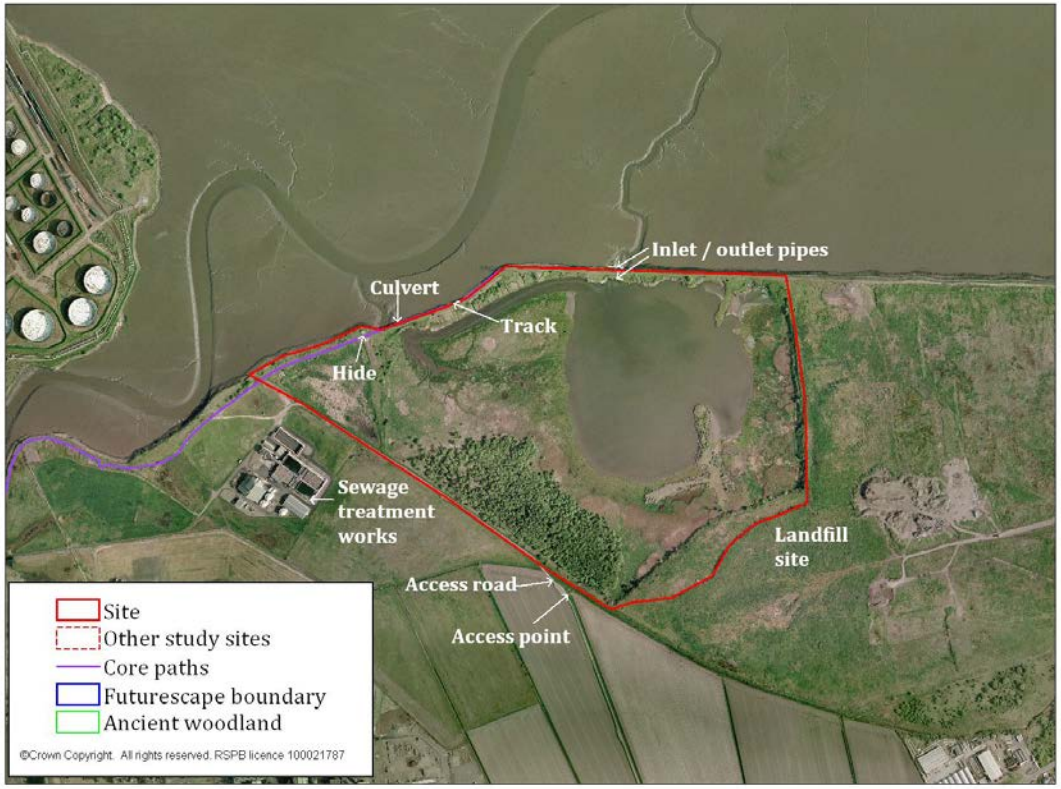


Figure 2: Overview of Kinneil Lagoons

Figure 3: Kinneil Lagoons looking south west

A culvert under the embankment at the western end of the lagoon feeds into the lagoon via a channel, which runs parallel to the embankment. The lagoon area holds water permanently although the extent of freshwater influence from upwellings or springs is unknown.

This area is surrounded by approximately 11 ha of rank vegetation and 4 ha of dense birch and willow scrub in the south west corner of the site. There is an area of common reed at the western edge of the lagoon growing beyond the shoreline. The landward edge of the embankments has had considerable quantities of building waste and rubble dumped along its northern and western edge,

presumably in an attempt to reinforce the existing embankment which shows considerable evidence of erosion along part of its length.

The site is bounded to the north by extensive intertidal mudflats, to the west by the River Avon which exits into the Forth, a sewage treatment plant, chemical works and Grangemouth oil refinery; to the east by an extensive elevated area of rank vegetation and scrub with a soil treatment and recycling centre nearby and to the south by agricultural fields, the A905 Grangemouth Road and the Bo'ness and Kinneil Steam Railway line. An area of developing scrub and woodland lies to the south east adjacent to the A905. Kinneil Local Nature Reserve which has been developed on the site of the former Kinneil Kerse coal mine lies immediately to the east.

The embankment is actively maintained by Falkirk Council and reinstatement and remedial works at the western end were carried out in winter 2010/11. The 45 ha elevated area to the west of the site comprises rank vegetation, scrub and small, shallow freshwater pools, some fringed with bulrush and common reed.

Figure 4: Pipes through embankment from lagoon to Forth

Figure 5: South east shore of lagoon

Figure 6: Kinneil lagoons embankment looking east

The site is adjacent to the area designated as the Middle Forth Estuary as part of the SEPA River Basin Management Plan process which covers 38.24 km^2 from Carriden to the Kincardine Bridge on the south shore and from Kincardine to Torry Bay on the north shore. The Middle Forth Estuary has been classified as a Heavily Modified Water Body and as having Moderate Ecological Potential with a current ecological status of Moderate and an overall chemical status as Pass.

SEPA have established an ongoing programme of monitoring to identify pressures and measures which will protect or improve the status of water bodies over successive RBMP cycles. Targets and environmental objectives have been set for the Middle Forth Estuary which aim to achieve Moderate Ecological Potential for the RBMP cycles in 2015 and 2021 with Good Ecological Potential achieved by 2027.

Pressures identified in the Middle Forth Estuary include morphological alterations in the form of current and historical activity, for example, dredging and historical land reclamation, point source pollution in the form of inputs and sewage treatment plus issues surrounding abstraction.

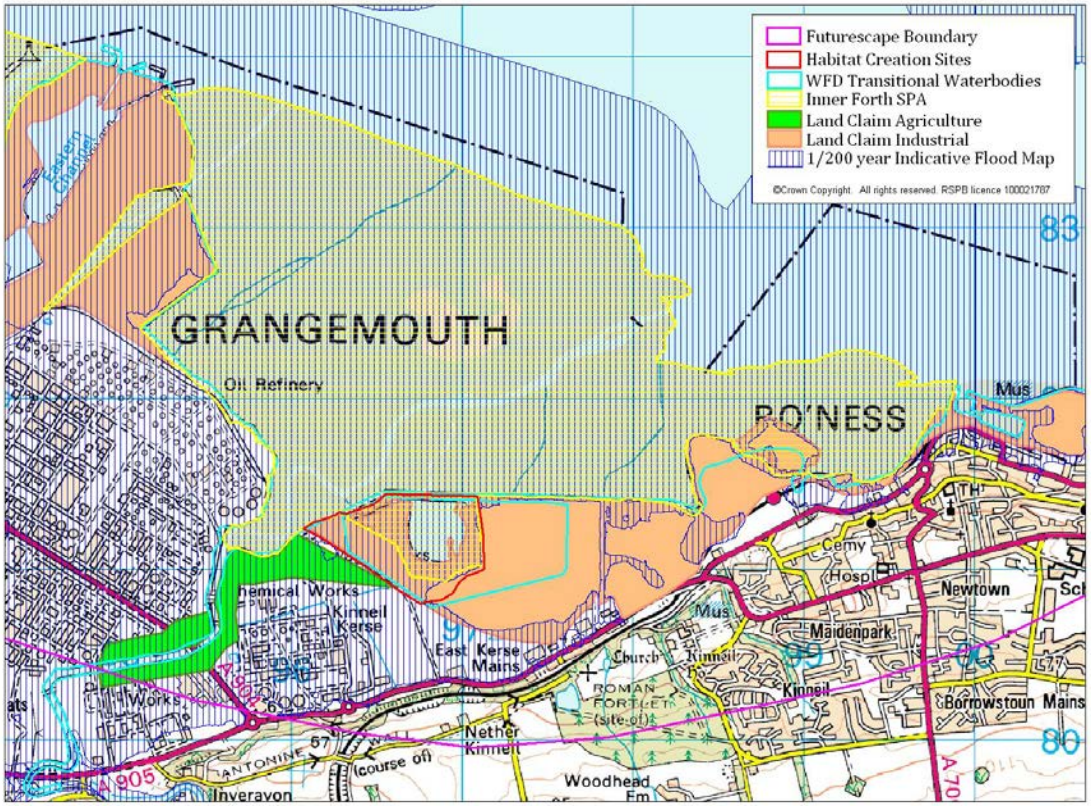


Figure 7: Land claim and flood risk at Kinneil Lagoons

The site is within a Potentially Vulnerable Area as identified within the National Flood Risk Assessment with potential impacts to a large number of residential and commercial properties, community facilities, transport links and agricultural land. The area has a Very High rating in the flood risk category as assessed by infrastructure, historic flooding, groundwater, climate change and flood defences.

The Weighted Annual Average Damages to the area are estimated at over £3 million (this figure gives an indicative estimate of direct costs to residential properties, non-residential properties and agriculture). The known source of flooding in the area is predominantly coastal at 57% with 34% from surface water and 9% from rivers. Kinneil Lagoons has limited potential in flood management in the area, other than storage of water entering the lagoon at high tide.

Table 1: Site summary

Site name	Kinneil Lagoons
Location and Local Authority Area	Bo'ness, Grangemouth Falkirk
Grid Reference	NS9681
Area	Approx 35 ha including surrounding elevated area.
Ownership	Falkirk Council
Access	Informal access is available from both the west and east via a track from the Kinneil Kerse area and via an unsurfaced track along the embankment near the Scottish Water treatment works. Access to the lagoons is also possible via a set of wooden steps leading from the access road to the Scottish Water treatment plant. It is not certain who maintains the steps or associated footpaths. None of the footpaths are Core Paths. The nearest Core Paths are at Kinneil Kerse and Kinneil.
Buildings and services	There is a concrete birdwatching hide located at the west end of the lagoons overlooking the River Avon mouth which is owned by Scottish Wildlife Trust. The hide is kept locked with keys available from the SWT's Jupiter Centre in Grangemouth. The hide isn't promoted by SWT and does not feature in any publicity. There are no known services on the site.
Designations	SSSI, SPA
Liabilities and health and safely issues	Given the history of land-use in the adjacent area there may be significant issues regarding contamination, diffuse pollution from the adjacent refuse tip and hazardous waste. The area is in a 'Hazard Consultation Zone' referring to the adjacent petro-chemical complex.

Future Vision

Kinneil Lagoons is well-managed for biodiversity and public access, safeguarding and expanding a nationally scarce habitat, providing a valuable resource ideally located within easy travelling distance of Central Scotland. The site is popular with local residents and bird watchers from further afield.

The site has been transformed from one of an apparently neglected industrial wasteland to a high quality, inspirational site where visitors can enjoy watching a wildlife spectacle on their doorstep with novel yet robust interpretation, clearly defined access routes and unobtrusive viewing points.

The site is linked via footpaths with the nearby Kinneil Kerse Local Nature Reserve and woodland area at Bo'ness to provide a substantial area where people can visit and enjoy a wide variety of wildlife. Local community groups and volunteers play an integral role in the management of the Lagoons from bird monitoring to leading guided walks and local industry plays a role in managing the site through voluntary staff work days.

Conservation Interest and Potential

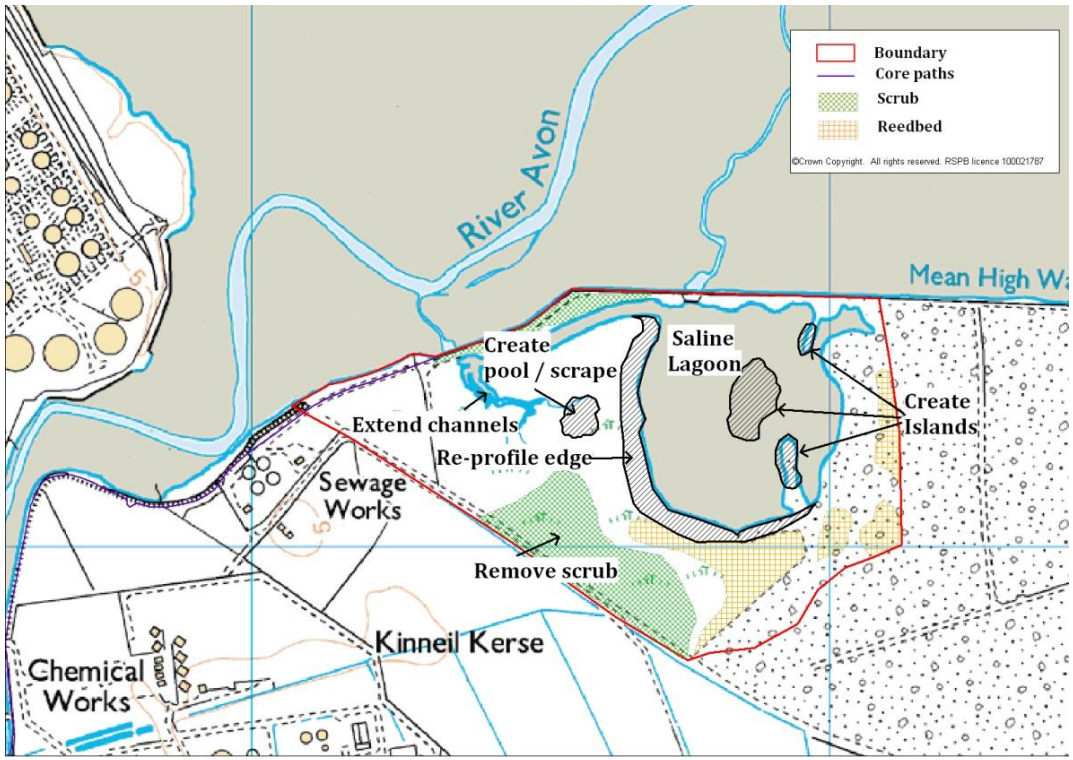


Figure 8: Current Habitats and proposed management.

Kinneil Lagoons lie within the Firth of Forth SSSI and SPA, which was designated in 1989 on account of the wildfowl and wader interest on the site. The lagoons are a key roost site on the Forth along with mudflats and pools at Skinflats (Bothkennar Pools) and Torry Bay in Fife.

Kinneil Lagoons are only one of two saline lagoons in the Falkirk area, the other being at Bothkennar Pools, Skinflats. An aspirational project in the draft Falkirk BAP (2011-2016) is to 'investigate the current ecological status of Kinneil Lagoons and undertake positive management and enhancement works'.

Unfortunately, the lagoons were not surveyed as part of the Marine Nature Conservation review of lagoons in mainland Scotland in 1994. The site is counted monthly as part of the coordinated Wetland Bird Survey and was surveyed for the British Trust for Ornithology Atlas 2011.

A NVC survey of the site was carried out in 2003 (SNH, 2003) and summarised the results of the survey at Kinneil as 'exhibiting an incredible range of habitats within a discrete unit.' The report also mentions that the saltmarsh and swamp areas at Kinneil have changed significantly since previous surveys and a local ornithologist commented that the succession of the saltmarsh and swamp communities within the area was leaving few shallow areas for bird interests.

The lagoons showed 'successional change from lower marsh saltmarsh communities dominated by *Salicornia* species through *Festuca rubra/Puccinellia maritima* saltmarsh communities, to upper marsh swamps with *Scirpus maritimus, Phragmites australis* and *Festuca arundinacea'*.

The conservation interest of the site appears to be declining and without active intervention will continue to do so. A coordinated programme of investigation which will inform future management should be the starting point for any future work and identify measures to realise the potential of the lagoons.

Table 2: Habitats (Lagoon area only)

Habitat	Current	Potential
Saline lagoons	12 ha	20 ha
Scrub	2.4 ha	1 ha
Saltmarsh	6 ha	9 ha

Table 3: Current and potential bird numbers

Species	Current	Potential
Breeding (prs)		
Shelduck	2	4
Redshank	Present	4
Wintering		
Black-tailed godwit	Present	Increase
Bar-tailed godwit	Present	Increase
Knot	Present	Increase
Potential colonists		
Snipe	With provision of suitable habitat	
Ringed plover	With provision of suitable nesting opportunities	
Oystercatcher	With provision of suitable nesting opportunities	
Avocet	Scarce but regular visitors but habitat would be suitable for nesting	
Lapwing	With provision of suitable habitat	
Common tern	With provision of suitable habitat	

Other biodiversity

A NVC survey was carried out in 2003 and an SNH condition monitoring survey was carried out in 2011 but results are not currently available. Little information is available on other biodiversity recorded at Kinneil Lagoons.

Management Activities and Options

There is currently no management carried out at Kinneil Lagoons although the embankment is actively maintained by Falkirk Council with extensive remedial work taking place in winter 2010/11. Opportunities in this area will be restricted by the nature of land-use history but there are opportunities to maximise the potential of the site through targeted and appropriate management of the lagoons.

Development and expansion of saline lagoons is limited by topography but it would be advantageous to expand the saline lagoon and develop the transitional zone between the stages of saltmarsh and brackish areas in the lagoons. An understanding of the hydrology of the lagoons is essential to informing any possible management regime and any design would have to be carefully planned in order to maintain a self-sustaining system and take into account rising sea levels which will impact on this site.

Appropriate measures as determined by ecological and hydrological investigation may be undertaken and could involve extending the lagoon by removing encroaching vegetation , improving water flow around the lagoon by clearing silted-up channels and lowering of a section of the lagoon to provide a refuge in times of low water for fish and invertebrates . The possibility of creating one or two compartments with a range of salinities by means of low earth bunds should be explored.

Creation of islands, either constructed permanent features or temporary floating islands would provide suitable nesting and roosting sites for waders. It may be possible to create an island within the lagoon by removing a section or extending the channel to isolate the area at the east of the lagoon of or removing a section of either one of the promontories leaving an island. The islands could be constructed from locally won material if appropriate and suitable. Design of the islands would need to be carefully considered to take into account wave action and erosion and appropriate measures, such as plastic shuttering, may be necessary to counter erosion.

In order to minimise the threat from ground predators and limit possible disturbance, a ditch could be excavated around the base of the enclosing embankment to prevent access by foxes.

By instigating habitat creation and enhancements to the existing habitats at Kinneil Lagoons plus potentially alleviating sources of diffuse pollution through safeguarding the site, there is potential to make a contribution to achieving Good Ecological Potential in the Middle Forth Estuary by 2027.

Table 4: Options Available for Future Management

	Option A - Maintain Embankment	Option B - Habitat Enhancement and Creation	Option C - Managed Realignment
Description	Maintain current situation.	Saline lagoon habitat enhancement. Improvements to access through the development of footpaths and other visitor facilities. Opportunities for people engagement, community and volunteer involvement.	Managed realignment.
Works needed	Works to repair the sea defences along the site boundary were undertaken in winter 2010/2011, so it is unlikely that further works will be required in the near future.	Scrub clearance, earthworks, island creation, re-profile/remove encroaching vegetation, water control structures. Footpath and track upgrading. Limited infrastructure (install steps/ wheelchair friendly access points), viewing platforms	Scrub clearance, island creation, earthworks, re-profile the banks of the lagoons, construction of reinforced banks.
Constraints	n/a	Existing armoured embankments, proximity of industrial works, HGV traffic on access road.	Existing sea defences, contaminated land.
Site assessment needed	A detailed ecological survey would inform and guide any future management	Detailed ecological, hydrological, topographical, geological, land-use and historical surveys would be required. An assessment of diffuse pollution/ contamination/hazardous waste would also be necessary.	Detailed ecological, hydrological, topographical, geological, land-use and historical surveys would be required. Relevant engineering studies such as a geotechnical investigation would be required. An assessment of diffuse pollution/ contamination would also be necessary.

Timescale	n/a	1-3 years	10 + years
Demonstration site potential	As one of only two saline lagoons in the area there is potential to use the site as a demonstration/ education resource.	Potential to demonstrate management of saline lagoon creation and management and coastal management issues.	Potential to demonstrate a managed realignment scheme
Threats to conservation interest/potential	Natural succession, ie lagoons drying out, scrub developing or sediment accreting. Rising sea levels causing increased water levels. Diffuse pollution. Habitats at the site are already degraded and continued non-intervention may lead to a build up of sediment, high levels of salinity, vegetation encroachment and invasive species which could compromise the conservation interest.	Natural succession, ie lagoons drying out, scrub developing or sediment accreting. Rising sea levels causing increased water levels. Diffuse pollution. Habitats at the site are already degraded and continued non-intervention may lead to a build up of sediment, high levels of salinity, vegetation encroachment and invasive species which could compromise the conservation interest.	Natural succession, ie lagoons drying out, scrub developing or sediment accreting. Rising sea levels causing increased water levels. Pollution.
Consents required	n/a	As the site is designated, consent would be required from SNH and an Environmental Impact Assessment required. Planning permission is likely to be required for any major	As the site is designated, consent would be required from SNH and an Environmental Impact Assessment required. As the scheme involves Planning permission is likely to be

		habitat creation works eg island/ pool creation and any associated visitor infrastructure. A Controlled Activities Regulations licence would be required and consultations with Marine Scotland and other relevant agencies would be necessary. Public consultation would be carried out and may be a requirement.	required for any major habitat creation works eg island/ pool creation and any associated visitor infrastructure. A Controlled Activities Regulations licence may be required and consultations with Marine Scotland and other relevant agencies would be necessary. Public consultation would be necessary.
Capital costs	n/a	Proposed works would require a significant level of funding >£50k.	Likely capital costs will be significant >£1m
Establishment costs	n/a	Design, survey and permissions would be required. Estimated >£50k.	Set-up costs likely to be significant <£1m
Management costs	n/a	Ongoing management costs would be <£10k p/a with majority of tasks undertaken by voluntary groups overseen by local RSPB staff as per a Kinneil Lagoons Management plan.	On-going management costs are likely to be considerable with maintenance and regular inspection of hard engineering.
Immediate actions required	n/a	Pollution and contaminated land. Removal of any potential hazardous materials. Traffic access entering and exiting the adjacent works.	Contaminated land and the removal of any potential hazardous materials.
Funding opportunities	n/a	The scope and potential benefits of the project would make the proposals an attractive proposition. Funding streams from local and national	Funding streams from statutory agencies, Scottish Government and European sources.

		industrial concerns, trusts, statutory agencies and European sources.	

Table 5: Current and potential access and interpretation

Facility	Current	Potential
Footpaths	A 2.5 km track runs along the length of the sea defences accessed from either Kinneil Kerse or via west end of lagoons at the sewage works	There is considerable potential to upgrade footpaths in the area and develop a new route (2.5 km) around the lagoons. There is also an opportunity to develop disabled access due to the relatively shallow gradients at the site.
Car Park	Informal car park near the Sewage Works	There would appear to be available space to develop formal car parking facilities. This would be necessary to enable visitors to be separated from HGV's accessing the Water Treatment works
Interpretation	None	Interpretation of the area and its wildlife, including identification panels
Birdwatching hide	One concrete hide owned by SWT	One or two viewing platforms on the north and south facing aspects of the lagoons would provide informal facilities for visitors.

Recommendations

Option B is the preferred option due to a combination of the likelihood of potential being realised and attractiveness to funders. Option A (Maintain Embankment) will result in the existing habitat becoming degraded and subsequent changes will result in the area becoming less attractive to wildlife. Option C would be a prohibitively expensive option, with costs outweighing any potential benefit regarding estuarine functionality.

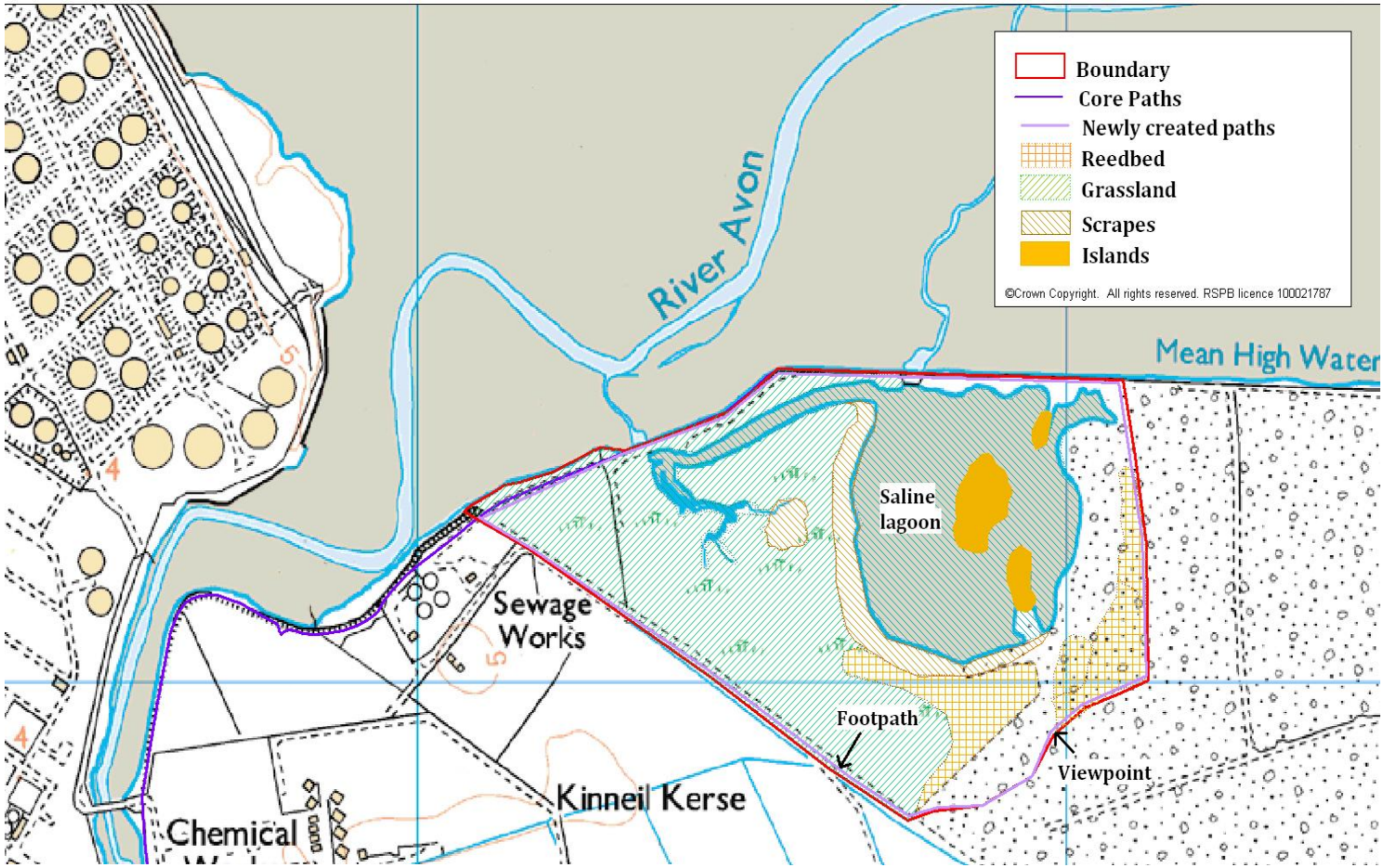


Figure 9: Outcome map for Kinneil Lagoons

Table 6: Options Appraisal

Strengths			Weaknesses		
Option A	**Option B**	**Option C**	**Option A**	**Option B**	**Option C**
No cost	Moderate cost. Will enhance nationally scarce habitats Increase local awareness and participation. Good views of lagoons and wildlife	Will contribute to a small increase in estuarine functionality.	Area will become less attractive and vulnerable to development/ encroachment.	Adjacent to industrial complex with associated noise etc. Attract anti-social behaviour Safety issues (steep banks & unconsolidated ground) Work required to bring paths up to standard	Loss of lagoon will be detrimental to SPA features. Loss of access along sea defence. Would restrict future habitat creation and management opportunities.
Opportunities			**Threats**		
Option A	**Option B**	**Option C**	**Option A**	**Option B**	**Option C**
None	Increase visitors to area Increases opportunity for conservation messages & interpretation Increases opportunities for guided walks/ events Develop links to Kinneil Kerse, Kinneil House and Boness Railway Museum.	Create new habitat	Habitat will gradually deteriorate and degrade.	Loss of an undisturbed area not currently frequented by visitors	High cost High on-going maintenance costs Issues re adjacent refuse tip

Appendix 2: Bothkennar Pools Site Assessment

Introduction

This site assessment has been produced following a desktop review of available information, site visits and initial discussions with stakeholders and land managers. The recommendations made are based on current knowledge. Further consultation with communities and landowners and detailed technical assessments will be required to develop and confirm proposals.

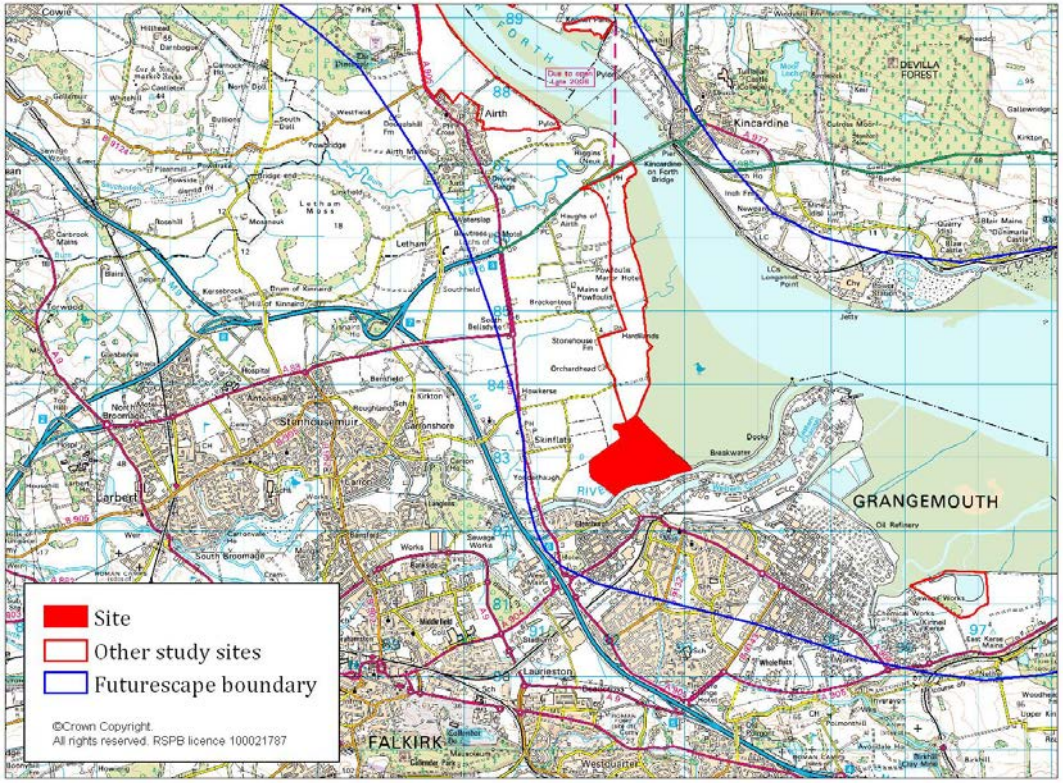


Figure 1: Location of Bothkennar Pools

Site Description

Bothkennar Pools are located immediately north of the River Carron mouth and 1.5 km east of the village of Skinflats. This area occupies the site of the former Island Farm and two meandering loops of the River Carron before canalisation in the early 19th century. The site lies at a lower elevation than the surrounding land and is made up of a complex of pools, wet grassland, reedbed, woodland, scrub and agricultural fields bounded by 5 m embankments to the south and west. Fields in agricultural production lie immediately to the north east and north west of the freshwater/brackish pool.

The pools and wetlands include an 8 ha shallow saline pool or lagoon at the south end of the site, an 8.5 ha freshwater/brackish pool immediately north of the saline lagoon and a 12 ha small freshwater/brackish reedbed, as well as areas of fen and willow scrub.

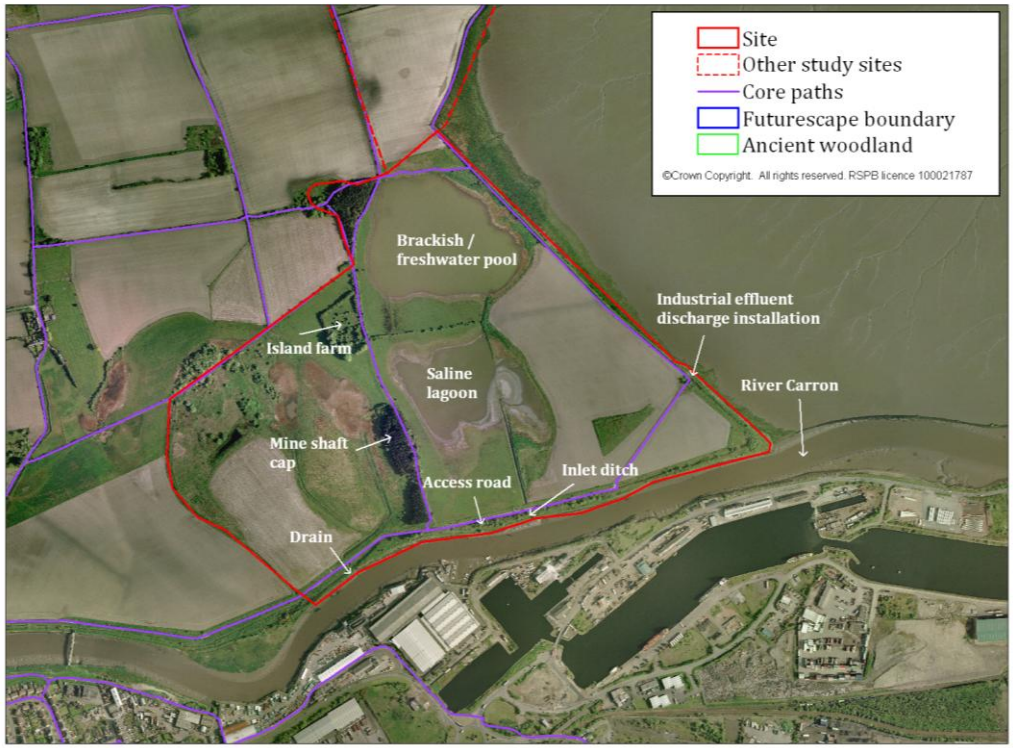


Figure 2: Overview of Bothkennar Pools

To the east of the saline lagoon lies a 14 ha irregular shaped arable field, currently in grass. This field is at a higher elevation between the pools and the embankment. A small 2 ha area of pasture with a small amount of rush occupies the south end of the pools. A surfaced road accesses an effluent discharge installation running parallel to the River Carron as far as NS927827. This discharged effluent from chemical works in adjacent Grangemouth into the Forth and it is not known if this still functions or is redundant.

To the east of the pools a 1.5 ha plantation comprising mainly Scots Pine with sycamore and an understory of elder stands on the site of the carse terrace which has been reclaimed with mining spoil to form a raised promontory extending

The saline lagoon is fed from an inlet flowing along a 145 m ditch which flows direct from the River Carron via a drain which passes under the embankment at NS925827. The saline pool shows extensive mud visible at low tides and dries out frequently during spells of low tides and rainfall. The pool is almost bisected by the inlet ditch and fringed with common reed to the west. The larger freshwater/brackish pool is separated from the saline pool by a raised bank approximately 150 m wide with remnants of a hedge and is connected to the saline pool via a narrow channel. The pool is fringed by common reed on the north west edge and redundant fence lines are visible in the pools; evidence that the area was previously drained.

The area of reedbed and fen is drained via a ditch which empties into the Carron at NS921825 via a flap-valve.

Figure 3: Inlet ditch from River Carron

toward the River Carron. The plantation is in relatively poor condition with trees at the east end of the plantation suffering extensive fire damage. Several footpaths cross the site with access from Brackenlees Road and Newton Road.

A smaller 1 ha plantation lies 300 m to the north of the southern plantation and is comprised mainly of Scots pine and sycamore with an understory comprising mainly of elder plus a small amount of hawthorn and rowan. The plantation is fringed with hawthorn scrub to the east.

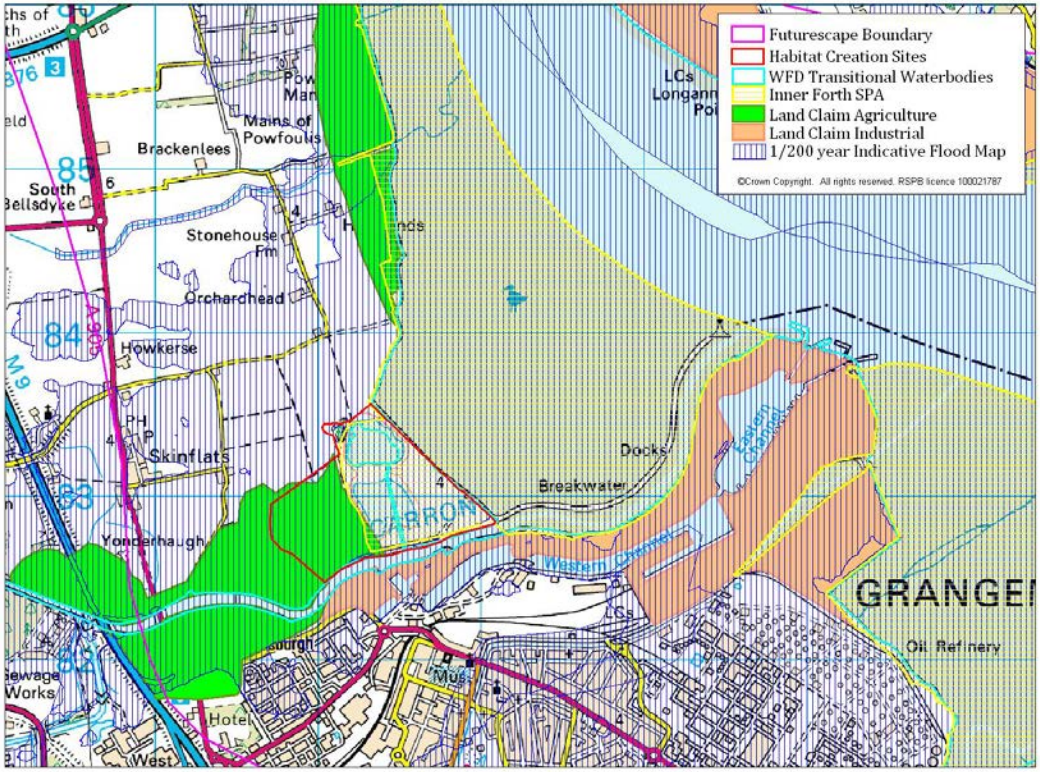


Figure 4: Land claim and flood risk at Bothkennar Pools

The site is adjacent to the area designated as the Middle Forth Estuary as part of the SEPA River Basin Management Plan process which covers 38.24 km² from Carriden to the Kincardine Bridge on the south shore and from Kincardine to Torry Bay on the north shore. The Middle Forth Estuary has been classified as a Heavily Modified Water Body and as having Moderate Ecological Potential with a current ecological status of Moderate and an overall chemical status as Pass.

The Island Farm Lagoon water body lies wholly within the site boundary and is classified as being at Good Ecological Status with no pressures. Any proposals for the site will need to ensure this status is maintained or improved.

SEPA have established an ongoing programme of monitoring to identify pressures and measures which will protect or improve the status of water bodies over successive RBMP cycles. Targets and environmental objectives have been set for the Middle Forth Estuary which aim to achieve Moderate Ecological Potential for the RBMP cycles in 2015 and 2021 with Good Ecological Potential achieved by 2027.

Pressures identified in the Middle Forth Estuary include morphological alterations in the form of current and historical activity, for example, dredging and historical land reclamation, point source pollution in the form of inputs and sewage treatment plus issues surrounding abstraction.

The site is within a Potentially Vulnerable Area as identified within the National Flood Risk Assessment with potential impacts to a large number of residential and commercial properties, community facilities, transport links, agricultural land. The area has a Very High rating in the flood risk category as assessed by infrastructure, historic flooding, groundwater, climate change and flood defences.

The Weighted Annual Average Damages (this figure gives an indicative estimate of direct costs to residential properties, non-residential properties and agriculture) to the area are estimated at over £7m. The known source of flooding in the area is predominantly coastal at 68% with 15% from surface water and 17% from rivers.

Future Vision

Bothkennar Pools is a high quality wetland nature reserve incorporating an intriguing mosaic of habitats within a relatively small area, attracting a wide range and variety of biodiversity and, in time, providing a gateway to extensive habitat creation work in the wider Inner Forth area. A network of trails linking with the nearby Helix project via the River Carron footpath enables and enhances access for both the local community and visitors to an inspirational wildlife experience.

Visitor facilities at Bothkennar Pools are developed sensitively to provide unobtrusive viewing areas, limited car parking nearby and innovative and responsive interpretation. Opportunities exist for local people to play an integral role in monitoring and managing the site through volunteering.

Table 1: Site summary

Site name	Bothkennar Pools
Location and Local Authority Area	Bothkennar Pools Falkirk
Grid Reference	NS922830
Area	70 ha
Ownership	Falkirk Council
Access	A surfaced single track access road (Ferry Road) leading to a industrial pipeline valve passes south of Bothkennar Pools and runs parallel to the River Carron via a locked gate at Newton Road (NS919824).

	The SUSTRANS National Cycle Network route 76 and 'Round the Forth' cycle route passes to the west of the area along Newton and Brackenlees Road and continues north along the unclassified road to the A876. Falkirk Council Core Paths access and cross the area utilising unclassified roads, footpaths and tracks.
Buildings and services	None, though there are remnants of several demolished buildings at the site of Island Farm and within the plantation. Details of any services present on the site and adjacent would be necessary.
Designations	SSSI, part SPA
Liabilities and health and safely issues	The embankment on the eastern boundary, separating the site from the River Carron would have to be assessed as part of a flood risk assessment. Sections of the embankment require upgrading and evidence of considerable seepage from the river through the embankment is apparent. Almost the entire site lies within the Coal Authority referral area and a coal mining report would be required as part of a detailed feasibility study. A report obtained in 2005 concluded that 'a prudent developer would seek appropriate technical advice before works are undertaken on the site'. A substantial capped mine shaft lies within the plantation at NS922828 along with debris and remains of buildings. A former ICI pipeline valve, now used/licensed by an unknown party, stands at NS92908298 which pumped industrial effluent from Grangemouth into the Forth. Further investigation as to the current use of this pipeline is necessary. The area is in a 'Hazard Consultation Zone' The two plantations to the east of Bothkennar pools would require an initial tree safety inspection and, dependant on the findings and recommendations, possibly continue on an annual basis. There is an extensive stand of Giant Hogweed at the east of the site and stands of Japanese Knotweed on the River Carron embankment.

Conservation Interest and Potential

The diversity of habitats within a relatively small area at Bothkennar Pools makes this an extremely attractive site although the habitats are generally degraded and in poor condition, requiring intervention and management to realise their ecological potential.

Bothkennar Pools is of significant importance as it is one of only two saline lagoons in the Forth Estuary and lies within the Firth of Forth SSSI and partly within the SPA. This part of the SPA has developed as a significant area for passage and wintering birds and the brackish and freshwater lagoons behind the sea wall are used as a feeding, roosting and loafing area for a range of species such as gulls, terns, waders and wildfowl. The 8 ha saline lagoon, which has developed as the result of a faulty flap-valve allowing seawater into the lagoon and preventing it from draining fully at low tide, is one of only two in the Falkirk area. This habitat is listed as a priority habitat under the European Habitats Directive.

The Skinflats lagoons were surveyed in 1994 as part of the Marine Nature Conservation review of lagoons in mainland Scotland, and by Babtie as part of the Skinflats managed realignment study. An NVC survey was carried out on behalf of SNH in 2003. Bird numbers are monitored monthly via the BTO/ RSPB/JNCC/WWT WeBS counts. Low water levels in recent years at the southern lagoon are perceived to be responsible for a decline in wildfowl using the site. (MV Bell pers comm.)

Figure 5: Bothkennar Pools looking north

Figure 6: Reedbed at Bothkennar looking north west

An aspirational project in the draft Falkirk Biodiversity Action Plan (2011-2016) states to 'secure positive, long term management of the saline lagoons at Skinflats' .There is potential for enhancement and creation of saline, brackish and freshwater lagoons at Bothkennar Pools which would provide habitat for breeding, feeding and roosting birds, and opportunities for colonisation by specialised plants and invertebrates.

The reedbed, fen and scrub to the west of the plantation is of local significance as this habitat is scare within the area and is likely to support specialised botanical and invertebrate interest. This area was surveyed in 1986 as part of a Nature Conservancy Council Phase 1 survey of the Skinflats SSSI and in 1995 for SNH. Conservation management of this area would provide a useful addition to the mosaic of habitats at the site and enhance its attractiveness to wildlife.

The area of wet grassland at Bothkennar Pools has poor species diversity but has previously held breeding waders such as snipe. The arable field and rough pasture between the lagoon and the embankment prove attractive to pink-footed geese and farmland passerines. The small area of plantation consists primarily of Scots Pine and is of limited value. Conservation management of the wet grassland and reedbed/ fen areas at Bothkennar would restore this habitat to a condition which would increase biodiversity interest.

The development and enhancement of habitats at Bothkennar could contribute to achieving Good Ecological Potential by 2027 by carrying out improvements to hydrological management and utilising reedbeds to improve local water quality.

Table 2: Habitats

Habitat	Current	Potential
Saline/ brackish lagoon	16.5 ha	20 ha
Wet grassland	4 ha	10 ha
Reedbed	4 ha	10 ha
Scrub	8 ha	8 ha

Table3: Current and potential bird numbers at Bothkennar Pools

Species	Current	Potential
Breeding (prs)		
Grey partridge	2-3 pairs	4-6 pairs
Shelduck	Present	Increase
Lapwing	6-8 pairs	10-12 pairs
Oystercatcher	1	3
Kestrel	1	1
Skylark	Present	Increase
Grasshopper warbler	2-3 reeling males	6-8 reeling males
Tree sparrow	3-6 est	6-12

Yellowhammer	Present	Increase
Passage/ Wintering		
Pink-footed goose	2000	4000
Shelduck	Present	Maintain/increase
Wigeon	Present	Maintain/increase
Teal	Present	Maintain/increase
Pintail	Present	Maintain/increase
Ringed plover	Present	Maintain/increase
Golden plover	Present	Maintain/increase
Grey plover	Present	Maintain/increase
Bar-tailed godwit	Present	Maintain/increase
Curlew	Present	Maintain/increase
Redshank	Present	Maintain/increase
Dunlin	Present	Maintain/increase
Twite	40	50-60
Reed bunting	Present	Increase
Potential colonists		
Bittern	Has wintered	
Avocet	Scarce visitor to Bothkennar Pools but provision of enhanced habitat with suitable nest sites may encourage breeding attempt.	
Spotted crake	Provision of suitable habitat may encourage breeding attempt.	
Marsh harrier	An enhanced and enlarged reedbed may encourage passage birds to linger.	
Snipe	Wet grassland.	
Corn bunting	Present until 1990s. Provision of suitable habitat may encourage recolonisation.	
Common tern	Provision of nest sites ie islands may encourage colonisation.	

Table 4: Other biodiversity

Species	Current occurrence/ abundance?	Potential
Otter	Present Along River Carron and Bothkennar Pools	Maintain/increase
Brown hare	Present	Maintain/increase
Celery-leaved buttercup	NVC	Maintain/increase
Reflexed Saltmarsh Grass	NVC	Maintain/increase

Parhelophilus consimilis – hoverfly	Falkirk BAP	Maintain/increase
Beris clavipes (a soldier-fly),	Falkirk BAP	Maintain/increase
Sphaerophoria loewi (a hoverfly)	Falkirk BAP	Maintain/increase
Brachygluta helferi(a beetle)	Falkirk BAP	Maintain/increase

Management Activities and Options

Several studies (Geowise 1999, Babtie 2003) have concluded that the area is unsuitable for a managed realignment scheme given the low lying elevation of the site. Consequently the retention and maintenance of the existing embankments is necessary. There is currently no active management at Bothkennar Pools other than agricultural operations and grazing by cattle during the summer months.

Saline Lagoon

The lagoon has developed as the result of a faulty flap-valve allowing seawater into the lagoon and preventing it from draining fully at low tide. Repair of the valve would result in the loss of the lagoon. It would be advantageous to develop a water management system that provides suitable conditions for birds throughout the year, expanding the saline lagoon and creating a transitional zone between saline and freshwater habitats. Ephemeral shallow pools could be created using the inlet ditch and appropriate water control structures. Creation of a largely self-sustaining lagoon system (saline/ brackish/ fresh) fed by the existing inputs with three hydrologically linked lagoons with simple water control structures would maximise diversity of habitats and conditions in the lagoons. Design would have to be carefully planned and variables such as local tidal conditions, evaporation and rainfall levels taken into account. The results of a benthic invertebrate survey of the lagoons will determine any course of remedial action to be taken if the biomass in the lagoons is lacking, which may involve artificially boosting the nutrients in the substrate to encourage invertebrates this could be done by 'fallowing' an area ie allowing vegetation to develop then plough in if conditions allow machinery access.

One or two islands could be created using locally won material and topped with shingle or gravel to provide loafing and nesting areas. A membrane beneath the shingle or gravel cap may be necessary. Alternatively, a floating island could be anchored in the larger brackish/ freshwater lagoon. Island design would need to take into account wave action and appropriate measures, such as plastic shuttering, may be necessary to prevent erosion. It may be appropriate to erect predator proof fencing and dig a perimeter ditch around the saline lagoon to deter ground predators and dogs.

Reedbed/Fen

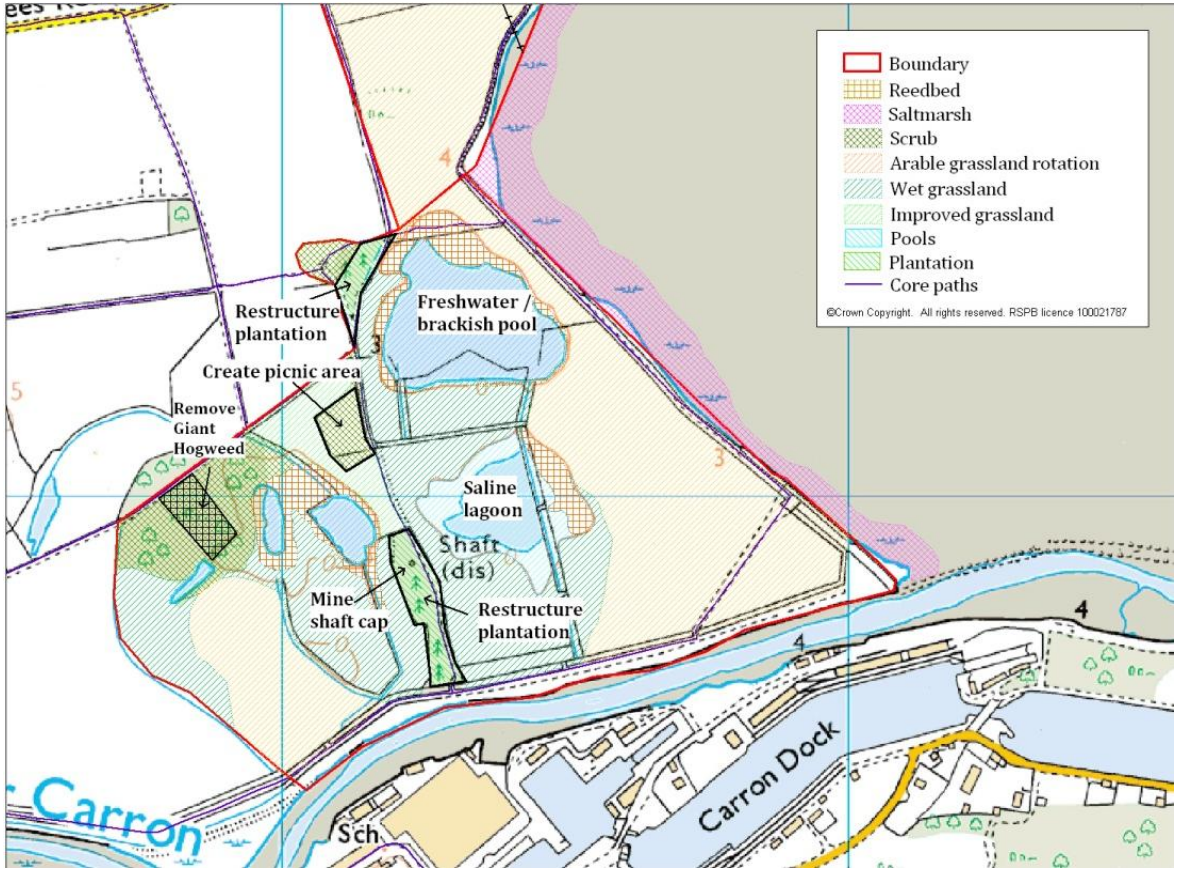


Figure 7: Current Habitats and Proposed Management

The reedbed at Bothkennar has developed in the last 15-20 years and emergent vegetation was noted as nearly closing up the ponds in 1995. Ditches in the surrounding agricultural area were cleared during winter 2010/11 by the local farmer. The reedbed is apparently fed by freshwater according to initial investigations and although small, the Bothkennar reedbed has potential for expansion and would benefit from specific reedbed management subject to detailed hydrological and ecological surveys.

A detailed ecological assessment would determine the value of developing the existing reedbed habitat or whether restoring the former habitats, including open water, brackish swamp/ fen, would be more ecologically advantageous. A mosaic of habitats could be considered although the small area favours a single habitat from a sustainable management perspective. Ditch clearance and re-profiling, creating open water, trial reed cutting in a small area and scrub clearance would increase the conservation value of this area.

Wet grassland

The condition of wet grassland at Bothkennar Pools would have to be assessed but initial work could involve vegetation management, primarily soft-rush control by topping, targeted grazing and creation of shallow drains.

Dry grassland/arable

An assessment of the current conservation value of the area should determine the management of this area but continued cropping with an adjacent area of wild bird cover for winter passerines may be a beneficial option.

Table 5: Options available for future management

	Option A - Maintain Status Quo	Option B - Habitat Enhancement and Creation
Description	The site would continue to be managed as an agricultural unit, with both grazing and arable production.	Enhancement of the saline lagoon and other wetland habitats. Improvements to access develop footpaths and other visitor facilities. Opportunities for people engagement, community and volunteer involvement.
Works needed	In the next few years it may be necessary to undertake repairs to the embankment on eastern boundary, separating the site from the River Carron.	Hydrological management works as determined by results of ecological, hydrological and geomorphological surveys – limited amount of earthworks, ditch clearance, installation of water control structures. Vegetation control – mechanical or by grazing – install necessary infrastructure eg fencing, crossing points, watering facilities for livestock. Reedbed management – hydrological management and restoration works as determined by results of ecological, hydrological and geomorphological surveys – ditch clearing & reprofiling/ restoring open water, limited cutting of reed. Grassland creation/ management. Visitor management – creation of car parking facilities, installation of interpretation, viewing facilities, upgrading of footpaths.

Constraints	n/a	See Liabilities
Site assessment needed	An assessment of the stability of the embankment along the River Carron may be needed in the near future.	Detailed ecological, topographic, hydrological and geomorphological assessments will be needed to inform future habitat creation and management including assessment of water control structures, invertebrate populations, botanical interest and changes, level of predation on ground nesting birds, level of disturbance. Condition assessment of wet grassland and reedbed including investigation of fish species present. Flood risk assessment, focusing on the embankments along the River Carron.
Timescale	n/a	Within 5 years
Demonstration site potential	n/a	Bothkennar would be an ideal location on the Inner Forth to develop understanding and build awareness of landscape scale conservation to local communities, statutory agencies, MSP's.
Threats to conservation interest/ potential	The site would be put on open market which could potentially result in operations being carried out, which would compromise the existing conservation interest, for example increased drainage. A change in ownership may result in a negative change to the current access which although unregulated and results in an unquantifiable amount of disturbance, there is potential for vehicular access to be expanded and a subsequent increase in anti-social	If the site were to be put on the open market this could eventually result in operations being carried out, which would compromise the existing conservation interest, for example increased drainage. A change in ownership may result in a negative change to the current access which although unregulated and results in an unquantifiable amount of disturbance, there is potential for vehicular access to be expanded and a subsequent increase in anti-social activities such as fly-tipping, illegal wildfowling etc. The site's hydrology, history of earthworks and uncertainty of the state of repair of its adjacent embankments mean that it could be susceptible to a sudden change and loss of its conservation interest.

	activities such as fly-tipping, illegal wildfowling etc. Habitats at the site are already degraded and continued non-intervention may lead to a build up of sediment, high levels of salinity, vegetation encroachment, invasive species which could compromise the conservation interest. The site's hydrology, history of earthworks and uncertainty of the state of repair of its adjacent embankments mean that it could be susceptible to a sudden change and loss of its conservation interest.	
Consents required	n/a	CARS license Depending on scale of proposed works would require Environmental Impact Assessment, Appropriate Assessment and planning consent. As the site is covered by SSSI and SPA, consent would be required from SNH for any works. Consultation with local Community Council, relevant community groups such as Communities Along the Carron would be required. A full public consultation would be required and communications plan produced.
Capital costs	>£200,000 should works to the	Land purchase and associated legal costs, stabilisation works to the

	embankment along the River Carron be necessary.	embankment between the River Carron and Bothkennar Pools, provision and installation of new drainage structures, earthworks, water management and island creation, fencing, scrub removal, tree safety work. >£500,000
Set up costs	n/a	Design of scheme, manufacture of water control structures, specialised machinery and employment of staff/ staff time. >£50k
Management costs	Standard costs for routine management of the site as an agricultural unit. This may include an increase in the drainage system due to leakage through the embankment along the River Carron.	Ideally the project would be designed to minimise future management requirements other than grazing, routine maintenance of drainage control structures, secondary defences and any other earthworks. A monitoring programme to evaluate the outcome of the project would be necessary over at least 5 years and at appropriate intervals beyond.
Immediate actions required	n/a	Assessment of embankment, tree safety issues.
Funding opportunities	n/a	The scope and range of potential benefits of the project would make this proposal an attractive proposition for funders. Funding streams from Scottish Government flood & coastal defence, local and national industrial concerns, trusts, statutory agencies and European sources Private capital / NGO funding.

Access and Interpretation Opportunities

Table 6: Current and potential access and interpretation

Facility	Current	Potential
Vehicular	A surfaced road accesses the site	No change
Footpath	Core Paths	Upgrade
Cycle path	Route 76 passes close by	No change
Footpath direction fingerposts	Several	Upgrade to high quality 'branded' signage
Interpretation	None	Upgrade to provide information on area and wildlife

Recommendations

Option B is the only realistic and preferable option for this site. Despite the site being on reclaimed land the immediate area is not suitable for a managed realignment project because of technical and practical difficulties. Option B would bring significant benefits to the local area.

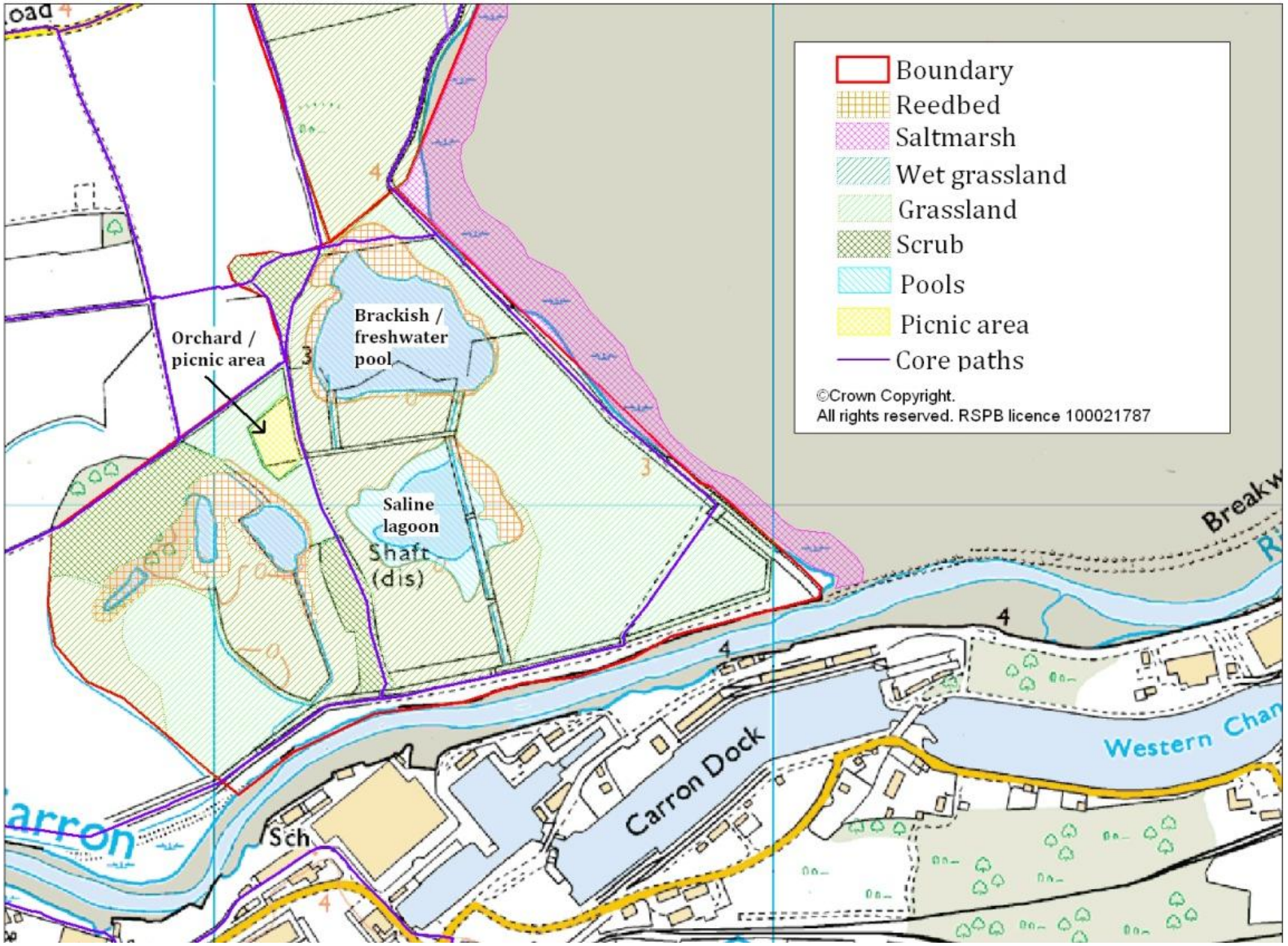


Figure 8: Outcome map for Bothkennar Pools

Table 7: Options Appraisal

Strengths		Weaknesses	
Option A	**Option B**	**Option A**	**Option B**
None	Will safeguard and enhance nationally scarce habitat Increase local participation and awareness Good views of lagoons and wildlife Good variety of biodiversity already present Network of paths present	Area will become less attractive and vulnerable to development/ encroachment Increased disturbance	Long-term viability of site re sea level rise and maintenance of embankment Increase in disturbance Mosaic of habits may require intensive management Invasive species present
Opportunities		**Threats**	
Option A	**Option B**	**Option A**	**Option B**
N/a	Community involvement Increased and improved public access Development of visitor infrastructure	Habitat will gradually deteriorate and degrade.	Issues regarding embankment and liabilities

Appendix 3: Skinflats Site Assessment

Introduction

This site assessment has been produced following a desktop review of available information, site visits and initial discussions with stakeholders and land managers. The recommendations made are based on current knowledge. Further consultation with communities and landowners and detailed technical assessments will be required to develop and confirm proposals.

Site Description

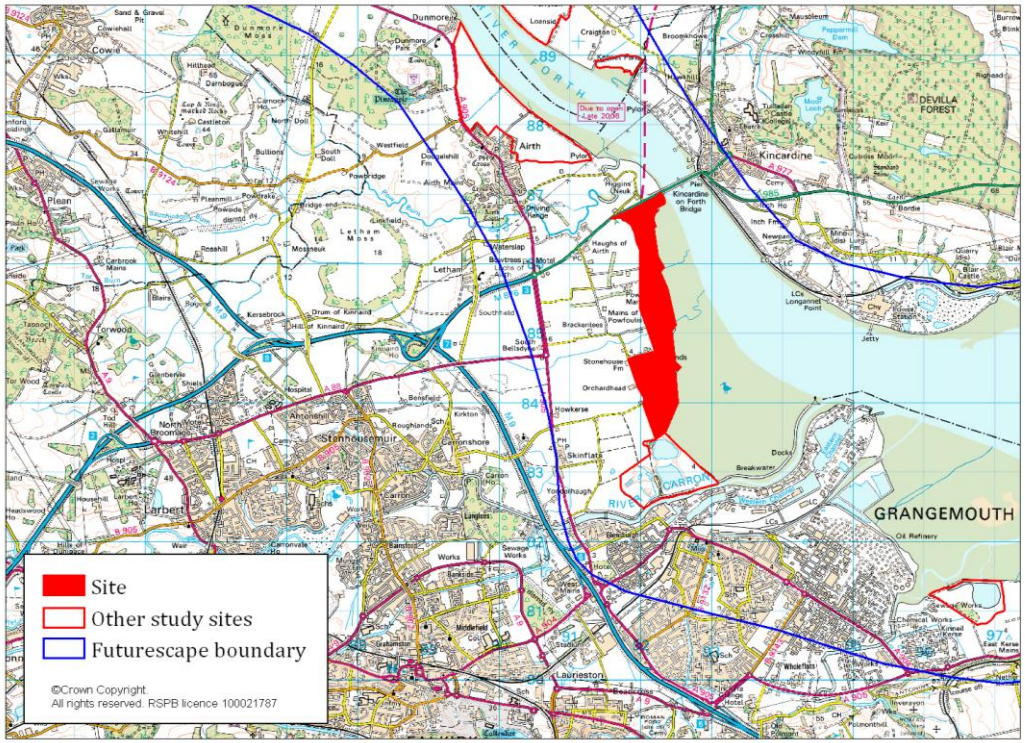


Figure 1: Location of Skinflats

This site covers over 100 ha of reclaimed land on the south shore of the Forth between the mouth of the River Carron at Grangemouth, north to the Kincardine Bridge. The area is bounded to the east by an embankment running almost the length of the site, to the north by the saltmarsh immediately south of the Kincardine Bridge, the south by the River Carron and Bothkennar Pools and to the west by the 4 m contour, covering an area of approximately 100 ha. To the west of the site between the village of Skinflats and the A905 and immediately south of the A876 is low lying land covering approximately 280ha.

Three watercourses drain the area; the Powfoulis drain which empties into the Forth south east of the RSPB office (formerly the Bothkennar Research station) and Powfoulis Manor Hotel (NS922859), the Muirdyke Burn which empties south east of Powfoulis Manor Hotel at NS924851 and the Pocknave drain which empties south east of Hardilands Farm at NS924844.

A 4 km earth embankment runs north to south from 0.5 km south of the Kincardine Bridge to the Carron Mouth, ranging in height from 5m high at the River Carron mouth to 4m at the east end resulting in a poorly integrated and artificial shoreline. A linear area of saltmarsh is present from the Carron Mouth to Kincardine Bridge with the area of saltmarsh immediately south of the Kincardine Bridge the only example of saltmarsh showing all stages of development between intertidal mud to carse cliff.

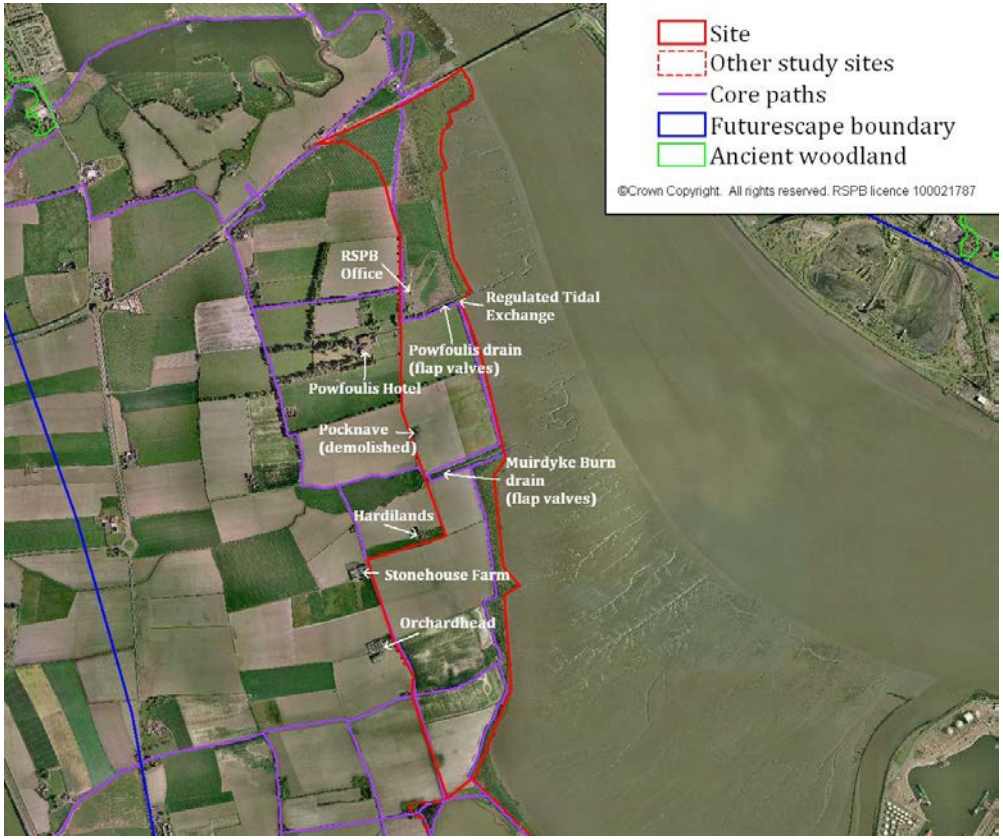


Figure 2: Overview of Skinflats

The embankment is faced with stone at several locations and is well vegetated along its entire length with extensive tree planting carried out on the landward side of the embankment at Powfoulis. There is extensive erosion in several places. The embankment is non-continuous and diverts to the south west for 380 m to allow the Muirdyke burn to drain; at Powfoulis where the embankment diverts 320 m south west on its northern side to allow the Powfoulis drain to empty, and at the southern end of the embankment, 560 m north west of Orchardhead Farm, where the Pocknave drain empties. Both drains and the Muirdyke burn are embanked and drain via flap drains. The embankment to the north of Bothkennar Pools (NS925841) has been widened and reinforced by rubble and other waste which has formed a 150 x 50 m wide area covering 0.34 ha.

North of Bothkennar Pools is low lying reclaimed land below the 5 m contour, predominantly in agricultural use with large rectilinear fields mainly in arable production and some improved grassland fields grazed by cattle at the north of the site.

There is a small amount of woodland and hedges, mainly comprising mature roadside avenues and shelter belts around Powfoulis plus isolated areas of sycamore and hawthorn scrub associated with the demolished farm at Pocknave.

The intertidal area between the Carron mouth and Kincardine Bridge is designated SSSI and SPA and totals 536 ha of which 365 ha is intertidal mudflats. RSPB lease 413 ha of intertidal mudflats plus saltmarsh between the River Carron mouth and Kincardine Bridge.

A regulated tidal exchange project has been developed on the RSPB reserve at Haughs of Airth, Bothkennar with the objective of restoring 11ha of reclaimed land to saltmarsh. The regulated tidal exchange infrastructure comprises a penstock sluice through which a pipe has been has been installed linking it to the Powfoulis drain in the south east corner of a 14 ha field allowing the river to flood the site where creeks and pools have been excavated.

One property lies within the area; the RSPB office at Bothkennar (formerly Bothkennar Research Station). There are several properties adjacent or in close proximity of the site; Hardilands Farm (private residence),Powfoulis Manor Hotel, Saltgreens (private residence), Mains of Powfoulis (private residence), Stonehouse Farm, Orchardhead and Springfield Cottages.

The site is adjacent to the area designated as the Middle Forth Estuary as part of the SEPA River Basin Management Plan process which covers 38.24 km^2 from Carriden to the Kincardine Bridge on the south shore and from Kincardine to Torry Bay on the north shore. The Middle Forth Estuary has been classified as a Heavily Modified Water Body and as having Moderate Ecological Potential with a current ecological status of Moderate and an overall chemical status as Pass.

SEPA have established an ongoing programme of monitoring to identify pressures and measures which will protect or improve the status of water bodies over successive RBMP cycles. Targets and environmental objectives have been set for the Middle Forth Estuary which aim to achieve Moderate Ecological Potential for the RBMP cycles in 2015 and 2021 with Good Ecological Potential achieved by 2027.

Figure 3: Arable farmland at Skinflats

Figure 4: Saltmarsh south of Kincardine Bridge

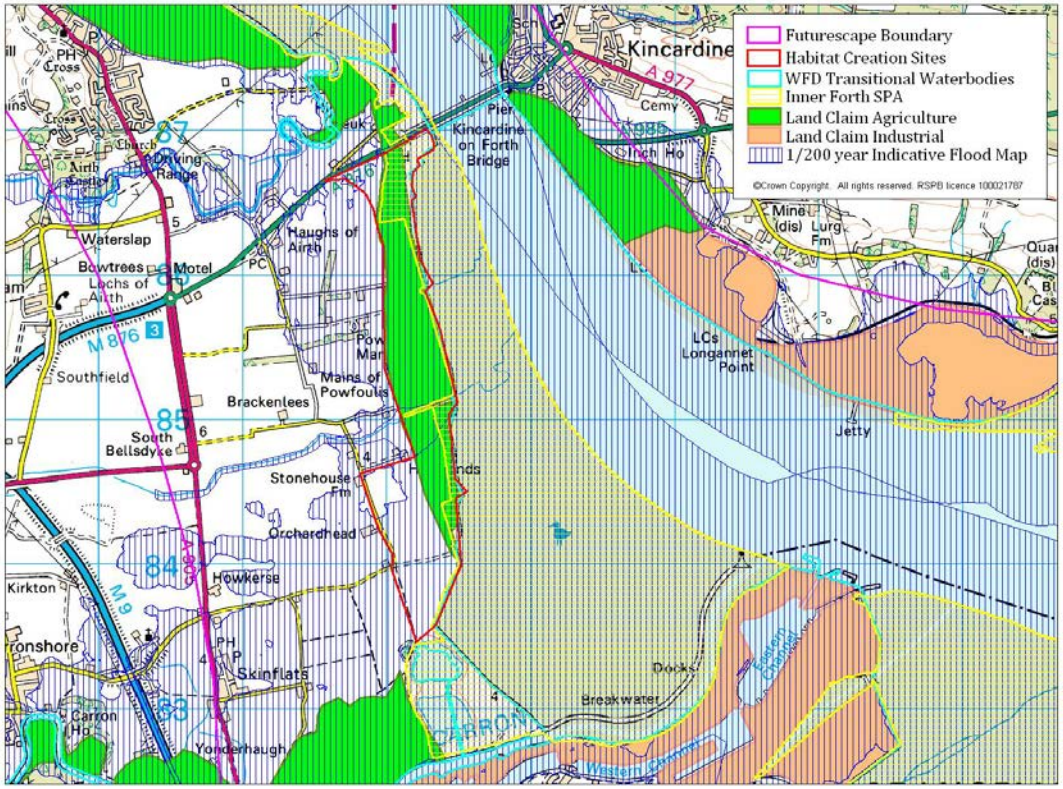


Figure 5: Land claim and flood risk at Skinflats

Pressures identified in the Middle Forth Estuary include morphological alterations in the form of current and historical activity, for example, dredging and historical land reclamation, point source pollution in the form of inputs and sewage treatment plus issues surrounding abstraction.

The site is within a Potentially Vulnerable Area as identified within the National Flood Risk Assessment with potential impacts to a large number of residential and commercial properties, community facilities, transport links, agricultural land. The area has a Very High rating in the flood risk category as assessed by infrastructure, historic flooding, groundwater, climate change and flood defences. The Weighted Annual Average Damages to the area are estimated at over £7m (this figure gives an indicative estimate of direct costs to residential properties, non-residential properties and agriculture). The known source of flooding in the area is predominantly coastal at 68% with 15% from surface water and 17% from rivers.

Future Vision

The Skinflats area is be one of the largest habitat creation and managed realignment project on the Inner Forth and one of the largest and most ambitious of its kind in Scotland, providing an inspiration for similar projects on the Inner Forth and elsewhere in Scotland. The landscape has been transformed from one of artificial embankments and rectilinear fields to one of a more natural appearance with a developing saltmarsh, a network of creeks, fulfilling a wide variety of functions from ecological to recreational.

Creation of 100 ha of intertidal habitats has helped redress the loss of these valuable habitats and made a contribution to an enhanced and sustainable level of flood protection for the area. The site links to the adjacent Bothkennar Pools where a high quality wetland nature reserve incorporating a freshwater, brackish and saline lagoons, freshwater reedbed and wet grassland has been developed.

A network of trails linking with the nearby Helix project via the River Carron footpath enables access to an inspirational wildlife experience. The site would be a resource for local education groups from primary to tertiary and the role of volunteers would be integral to the on-going monitoring and management of the area.

Table 1: Site summary

Site name	Skinflats
Location and Local Authority Area	Skinflats Falkirk
Grid Reference	NS922852
Area	110ha
Ownership	Several private landowners, including RSPB Scotland
Access	Minor roads (Brackenlees Road) pass to the north of the site. The SUSTRANS National Cycle Network route 76 and 'Round the Forth' cycle route passes to the west of the area along Newton and Brackenlees Road and continues north along the unclassified road to the A876. Falkirk Council Core Paths access and cross the area utilising unclassified roads, footpaths and tracks. Private roads leading to Hardilands Farm, Powfoulis Hotel & RSPB office. Access tracks lead to foreshore at Springfield Cottage (NS920839), Brackenlees Road (NS916849) and at the RSPB office (NS920859).
Buildings and services	Several residential properties are located within or adjacent to the area; RSPB offices at the site of the former SERC research station, Powfoulis Manor Hotel, and Hardilands Farm. The Powfoulis Hotel, Stables and Dovecot are Grade B listed buildings. Site of demolished Pocknave Farm (NS920852)
Designations	None
Liabilities and health and safely issues	Almost the entire site lies within the Coal Authority referral area and a coal mining report would be required as part of a detailed feasibility study. A report obtained in 2005 concluded that 'a prudent developer would seek appropriate technical advice before works are undertaken on the site'. The area is in a HSE 'Hazard Consultation Zone' relating to the petro-chemical complex at Grangemouth.

Conservation Interest and Potential

The intertidal mudflats and saltmarsh adjacent to the Skinflats site are designated as SSSI, SPA and Ramsar and are a key feeding area for passage and wintering waders and wildfowl on the Inner Forth. They are the second largest expanse of intertidal area in the Forth estuary. The area is currently of moderate conservation interest with farmland bird species, including breeding lapwing and wintering pink-footed geese present. The saltmarsh at Skinflats between the Carron Mouth and Kincardine Bridge is typical of the relatively species poor saltmarsh habitat of the Inner Forth with pioneer, low, mid and high marsh saltmarsh present.

The potential for the creation of intertidal areas is dependant on a managed realignment project being undertaken. The exact area of intertidal habitat created by the implementation of such a scheme is difficult to ascertain but was estimated by Babtie Group at 35 ha over 50 years. The proximity of intertidal area seaward of the embankment will ensure colonisation and development by saltmarsh vegetation and invertebrates and given the area involved, key bird species using the area such as shelduck, dunlin, redshank, knot, curlew, black-tailed godwit and bar-tailed godwit could be predicated to respond positively within a relatively short time scale. The area with its network of creeks and shallow pools would become a nursery and refuge area for fish species.

The development and enhancement of habitats at Skinflats would make a significant contribution to achieving Good Ecological Potential by 2027 by removing morphological alterations and improving estuarine functionality.

Table 2: Habitats

Habitat	Current	Potential
Intertidal	390.7ha	Exact area of habitats would be determined by results of hydrological and geomorphological surveys.
Saltmarsh	32.9ha	Exact ratio of habitats would be determined by results of hydrological, geomorphological surveys.
Saline/ brackish lagoon	0	c.2-3 ha

Table 3: Current and potential bird numbers

Species	Current	Potential
Breeding (prs)		
Grey partridge	2-3 pairs	4-6 pairs
Shelduck	Not known	Maintain/ increase
Lapwing	6-8 pairs	10-12pairs

Oystercatcher	1	3
Kestrel	1	2
Skylark	Present	Maintain/ increase
Grasshopper	2-3 reeling	6-8 reeling males
Tree sparrow	3-6 est	6-12
Yellowhammer	Present	Increase
Passage/ Wintering		
Pink-footed	2000	4000
Shelduck	Present	Maintain/ increase
Wigeon	0	Increase
Teal	0	Increase
Pintail	0	Increase
Ringed plover	0	Increase
Golden plover	Present	Increase
Grey plover	0	Increase
Bar-tailed godwit		Increase
Curlew	Present	Increase
Redshank	Present	Increase
Dunlin	0	Increase
Twite	40	80-100
Reed bunting		Increase
Potential colonists		
Avocet	Scarce visitor to Bothkennar Pools but provision of enhanced habitat with suitable nest sites may encourage more regular visits and possible breeding attempt	
Snipe	Wet grassland	
Corn bunting	Present until mid 1990's. Provision of suitable habitat to west of managed realignment site may encourage recolonisation.	

Table 4: Other biodiversity

Species	Current occurrence	Potential
Otter	Present Along River Carron and Bothkennar Pools	Increase
Brown hare	Present	Increase

Management Activities and Options

The site is largely in agricultural production, mainly cereals (winter wheat/ spring barley) and grass (beef cattle). The site has previously been identified (Bryant, GeoWise, Babtie Group) as a suitable location for a managed realignment scheme due to its middle estuary location, shape, salinity and natural drainage. The site fulfils the criteria for a suitable managed realignment scheme outlined in Babtie Group 2001a.

The managed realigned scheme at Skinflats could be approached in several ways as per standard techniques; breaching the embankment in one or two locations, a sequential programme of embankment removal or complete embankment removal. A programme of sequential managed realignment from the southern end of the site working north would most likely be the acceptable practical working scenario and would enable any potential technical problems to be identified and solutions found prior to work commencing on a later phase of work. This phased approach would enable public confidence to develop as the scheme progresses although would add considerably to the overall cost of the project.

Complete embankment removal would involve removing 3.6 km of embankment from north of Bothkennar Pools to limit of embankment at the northern boundary of the RSPB reserve; approximate 35,000 m^3 of earth. This material could be used to backfill existing ditches to avoid ponding of inundation and the surplus regraded into the existing agricultural fields. A number of trees planted on the embankment at Powfoulis would have to be removed. Existing avenues and relict fence lines could remain.

Figure 5: Current habitats and proposed management

The dumped waste material comprising concrete, rubble and bricks on the embankment would have to be removed and disposed of off-site. Measures to limit the possible effects of erosion and scour post embankment removal would have to be undertaken with ploughing of fields halted in the period before managed realignment commences.

Drainage of the site would be via the Muirdyke Burn or Powfoulis Burn as the land falls naturally towards these creeks – the outlets from both would be relocated to the tidal limit.

A relict creek system exists between the Muirdyke and Powfoulis burns and it would be advantage to re-instate these creeks which would not only aid drainage but speed up habitat restoration process. An option within this option would be to remove the embankment up to the Powfoulis drain and leave the regulated tidal exchange (RTE) structure in situ. The practicalities of removing or leaving the RTE system in situ would require careful consideration from both a practical and cost perspective. Development and establishment of an area of dry grassland on higher ground would be necessary to ensure provision of future grazing on saltmarsh.

Further habitat creation and land management opportunities lie in the low lying area between Skinflats village and the A876. This land is in agricultural use with several low lying wet areas which could be developed into wetland areas designed with a capacity to store water in times of flooding. There are opportunities to plant hedgerows along existing field boundaries and plant

suitable tree species along the route of ditches and burns that cross the area, which fits with the existing form of the landscape. The opportunity to develop wet woodland in this area could be explored.

Table 5: Options available for future management

	Option A – Do Nothing	**Option B – Maintain Embankment**	**Option C – Phased Managed Realignment**	**Option D - Managed Realignment**
Description	Maintain current situation	Maintain embankment	Managed realignment	Managed realignment
Works needed	n/a	Raise and widen existing 3.6m earth/ armoured embankment to provide protection to 1:250 year flood event standard. Maintenance of embankment and drainage system.	Embankment removal, earth moving, rubble and waste removal, tree removal, re-grading of material into field, construction of secondary defence, re-instatement of creek system, removal and relocation of control structures at Pocknave, Muirdyke & possibly at Powfoulis.	Embankment removal, waste removal, earth moving, re-grading of material, construction of secondary defence, re-instatement of creek system, relocation of control structures at Pocknave, Muirdyke & possibly at Powfoulis
Constraints	n/a	Embankment is adjacent to SPA/SSSI.	Public right of way runs along embankment from Bothkennar Pools to Kincardine Bridge. Core Paths 006/1433 (River Carron to Bothkennar), 006/1417 (Brackenlees to Bothkennar) and 006/1440 Brackenlees Road run along the eastern boundary of the site. The area is in a HSE 'Hazard Consultation Zone' relating to	Public right of way runs along embankment from Bothkennar Pools to Kincardine Bridge. Core Paths 006/1433 (River Carron to Bothkennar), 006/1417 (Brackenlees to Bothkennar) and 006/1440 Brackenlees Road run along the eastern boundary of the site. The area is in a HSE 'Hazard Consultation Zone' relating to

			the petro-chemical complex at Grangemouth. Almost the entire site lies within the Coal Authority referral area and a coal mining report would be required as part of a detailed feasibility study. Embankment is adjacent to SPA/SSSI.	the petro-chemical complex at Grangemouth. Almost the entire site lies within the Coal Authority referral area and a coal mining report would be required as part of a detailed feasibility study. Embankment is adjacent to SPA/SSSI.
Site assessment needed	n/a	Assessment of condition of embankment. Assessment of drainage infrastructure.	The feasibility of managed realignment at Skinflats has been explored since the mid 1990s and these reports and studies are discussed in detail in the feasibility report. A detailed feasibility study commissioned by SNH and carried out in 2001 (Babtie Group) developed a technically feasible and environmentally acceptable project. Work to confirm, refine and possibly adapt the conclusions of the Babtie study would be required. A geotechnical investigation regarding material for	The feasibility of managed realignment at Skinflats has been explored since the mid 1990s and these reports and studies are discussed in detail in the feasibility report. A detailed feasibility study carried out in 2001 (Babtie Group) developed a technically feasible and environmentally acceptable project. Work to confirm and refine the conclusions of the Babtie study would be required. A geotechnical investigation regarding material for secondary defence/ embankment fill and a local

			secondary defence/ embankment fill and a local drainage study would be necessary. A flood risk assessment from Carron Pools would be necessary.	drainage study would be necessary. A flood risk assessment from Carron Pools would be necessary.
Timescale	n/a	Immediate	10-20 years	10-20 years
Demonstration site potential	n/a	n/a	Skinflats and the adjacent site at Bothkennar would be an ideal location on the Inner Forth to develop understanding and build awareness of landscape scale conservation to local communities and decision makers.	Skinflats and the adjacent site at Bothkennar would be an ideal location on the Inner Forth to develop understanding and build awareness of landscape scale conservation to local communities and decision makers.
Threats to conservation interest/potential	n/a	n/a	New developments leading to the loss of habitat creation opportunities. Change in land use which may compromise future opportunities. Community engagement regarding a managed realignment scheme at	Community engagement regarding a managed realignment scheme at Skinflats would require sensitive and considered handling with a suitable investment of time and expertise – similar to The Coastal Futures Project - a partnership of the RSPB, Environment Agency, Natural England and Defra to support

			Skinflats would require sensitive and considered handling with a suitable investment of time and expertise – similar to the Coastal Futures Project - a partnership of the RSPB, Environment Agency, Natural England and Defra to support communities dealing with coastal change and sea level rise on the Humber. Public perception of managed realignment is the major issue and potential stumbling block to any such project.	communities dealing with coastal change and sea level rise on the Humber. Public perception of managed realignment is the major issue and potential stumbling block to any such project.
Consents required	n/a	Initial consultation with local planners would determine planning consent requirements. As the area is adjacent to the SPA any works would require consent from SNH. A Marine Licence is likely to be required for works.	Works would require Environmental Impact Assessment, Appropriate Assessment and full planning consents. A Marine Licence would be required. As the site is covered by SSSI and part is SPA, consent would be required from SNH for any works and would be involved in the planning, development and management of the project	Works would require Environmental Impact Assessment, Appropriate Assessment and full planning consents. A Marine Licence would be required As the site is adjacent to a SSSI and SPA, consent would be required from SNH for any works and would be involved in the planning, development and management of the scheme

			A full public consultation would be required and communications plan produced.	A full public consultation would be required and communications plan produced.
Capital costs	n/a	The costs of upgrading and repairing the embankment would be considerable and would be borne by the landowner unless carried out as a grant-aided flood defence scheme. >£1m	Capital costs will involve removal of existing embankment and regrading of material, construction of secondary defence, provision of new drainage structures, land purchase and associated legal costs. >£1m	Capital costs will involve removal of existing embankment and regarding of material, construction of secondary defence, provision of new drainage structures, land purchase and associated legal costs. >£1m
Set up costs	n/a	n/a	Design of scheme, manufacture of water control structures, specialised machinery and staff.	Design of scheme, manufacture of water control structures, specialised machinery and staff.
Management costs	n/a	Inspection, maintenance and repair costs.	Ideally, the project would be designed to minimise future management requirements other than routine maintenance of drainage control structures, secondary defences and any other earthworks. A monitoring programme to evaluate the outcome of the	Ideally, the project would be designed to minimise future management requirements other than routine maintenance of drainage control structures, secondary defences and any other earthworks. A monitoring programme to evaluate the outcome of the

			project would be necessary over at least 5 years and at appropriate intervals beyond.	project would be necessary over at least 5 years and at appropriate intervals beyond.
Immediate actions required	n/a	Assessment of embankment.	See constraints.	See constraints.
Funding opportunities	n/a	Individual landowners. Falkirk Council. Scottish Government.	The scope and range of potential benefits of the project would make this proposal an attractive proposition. Given the scope and scale of the project funding would have to come from Scottish Government, local and national industrial concerns, trusts, statutory agencies and European sources with contributions from private capital and NGOs.	The scope and range of potential benefits of the project would make this proposal an attractive proposition. Given the scope and scale of the project funding would have to come from Scottish Government, local and national industrial concerns, trusts, statutory agencies and European sources with contributions from private capital and NGOs.

Access and Interpretation Opportunities

Access in the area is limited to Public Rights of Way and minor public roads.

Table 6: Current and potential access and interpretation

Facility	Current	Potential
Vehicular	Vehicular access via Bothkennar Road.	No change anticipated
Footpath	Public right-of-way along embankment between River Carron and Kincardine – no formal maintained footpath. Route of core path follows minor road	Rights of way along foreshore would require relocating and could incorporate viewpoints
Cycle path	Round the Forth cycle route utilises minor roads to the north of the site.	No change
Footpath direction	Several fingerposts	High quality functional themed signage
Interpretation	None	Interpretation of the area and its wildlife

Recommendations

With predicted sea level rise and increased rainfall leading to increased chance of flood events, Option A is unsustainable in the long-term with any flood events having potentially serious consequences for land, property and infrastructure in the area should the existing embankment fail: Option B requires a potential significant investment on behalf of the landowners if alternative funding is not available and is entirely dependant on goodwill and financial ability. Flood management in the Inner Forth requires a strategic and equitable approach which this option does not provide.

Given the complexities and ambition of Options C and D, coupled with potential public concerns over significant changes, a phased scheme would be the most acceptable and pragmatic route to pursue. Option C would enable relationships to be built with the local community and land managers and confidence in this approach to grow as the scheme progressed and the positive results could be demonstrated.

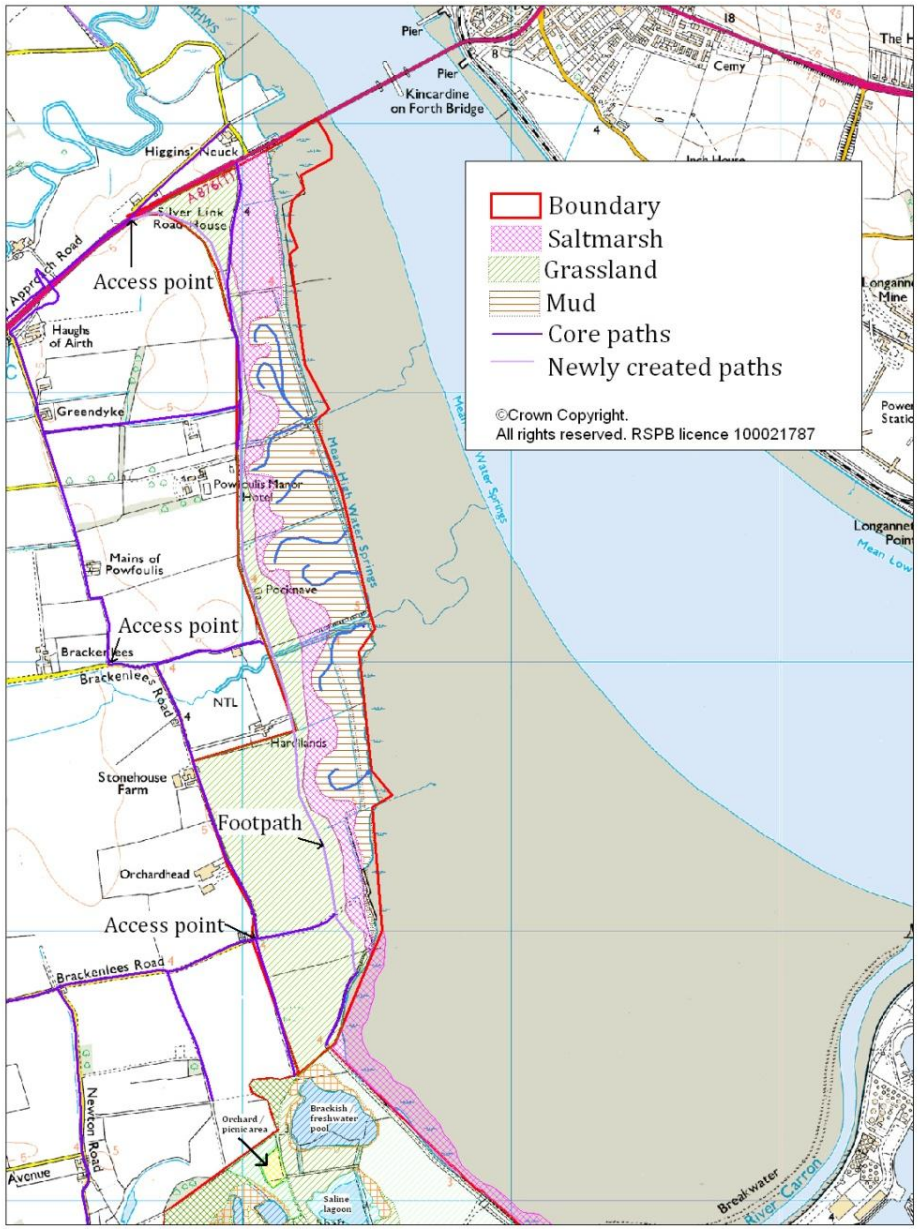


Figure 7: Outcome map for Skinflats

Table 7: Options Appraisal

Strengths				Weaknesses			
Option A	**Option B**	**Option C**	**Option D**	**Option A**	**Option B**	**Option C**	**Option D**
No cost	Increased short-term flood protection in local area. Maintenance of agricultural production.	Reduced long-term maintenance & repair costs Flexibility in design of scheme Positive public/ community perception more likely Contribute to WFD	Cost effective Maximum contribution to estuarine functionality Reduced long-term maintenance costs Flood risk management Contribute to WFD	Increased chance of coastal flood event due to embankment failure	High cost to landowner Maintenance/ repair costs Maintain conditions leading to coastal squeeze Inefficiencies in local drainage system will be accentuated with sea level rise.	Extra cost in mobilisation of equipment Perceived loss of public access Increased opportunity for disturbance through wildfowling Loss of agricultural production	High initial cost Perceived loss of public access Increased opportunity for disturbance through wildfowling
Opportunities				**Threats**			
Option A	**Option B**	**Option C**	**Option D**	**Option A**	**Option B**	**Option C**	**Option D**
n/a	n/a	Community involvement. Trial habitat	Community involvement Increased	n/a	n/a	Landowner and community concerns	Landowner and community concerns

		creation techniques Develop saltmarsh grazing Development of visitor infrastructure Development of demonstration & study site	public access Development of visitor infrastructure Development of demonstration & study site			Consents re Habitats Regulations, planning Access issues	Lack of funding Consents re Habitats Regulations, planning Access issues

Appendix 4: Airth to Dunmore Site Assessment

Introduction

This site assessment has been produced following a desktop review of available information, site visits and initial discussions with stakeholders and land managers. The recommendations made are based on current knowledge. Further consultation with communities and landowners and detailed technical assessments will be required to develop and confirm proposals.

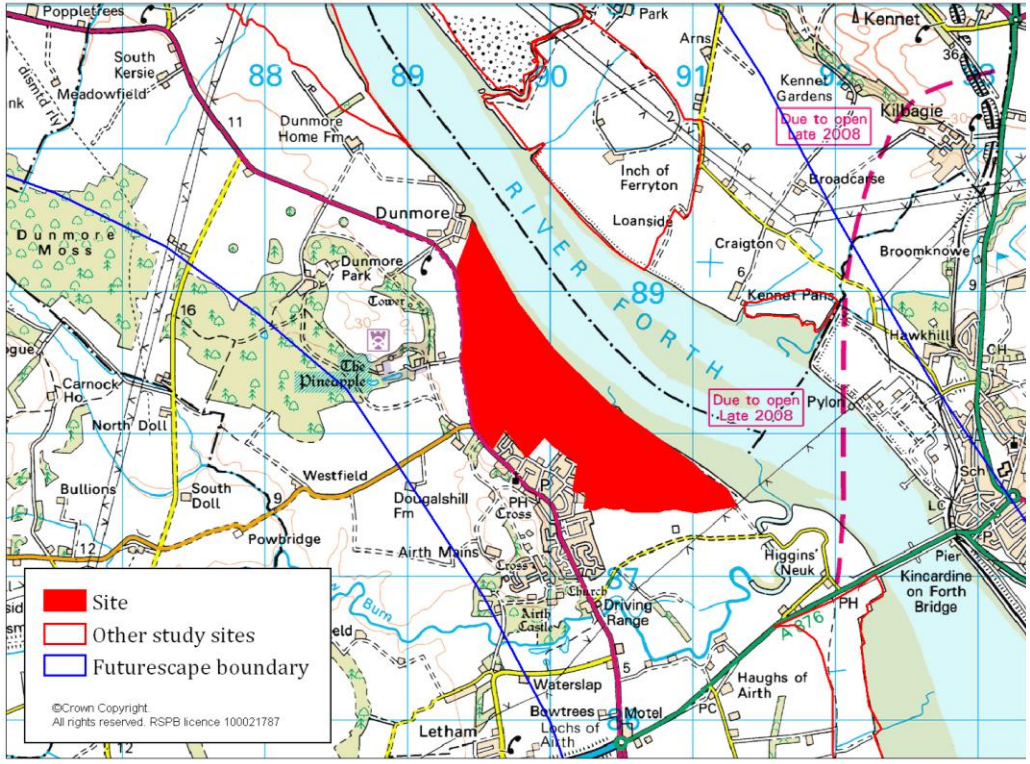


Figure 1: Location of Airth to Dunmore Site

Site Description

The site at Airth is located on the south bank of the River Forth to the east of the village of Airth and south of the village of Dunmore. It covers an area of over 90 ha.

The area is bisected by two drainage ditches and therefore can be compartmentalised into three sections (Figure 6) comprising extensive agricultural fields all currently in arable or silage or hay production. All lie below the 5m contour and comprise areas of 40ha (a), 20 ha (b) and 38 ha (c).

The area is entirely reclaimed land, on which work began in 1726 and was completed in 1814 and has significant historical and cultural aspects, integral to the heritage of the Forth, in particular the Royal Dockyard which existed at Airth in the 16th century. Before land claim changed the landscape of the area, both Airth and Dunmore (previously known as Elphinstone) were ports and played an important role in commercial activity on the Forth in the 17th century.

Figure 2: Overview of Airth to Dunmore

The seaward side of the embankment at this intersection has been reinforced by rubble and other waste material but there are considerable signs of erosion in this area (Figure 3).

A public right of way runs from Higgins' Neuk to Airth utilising the crest of the embankment. This footpath is actively maintained by Falkirk Council between the south east end of the embankment as far as the sewage treatment works at the north west. The path is signposted as continuing towards Dunmore to the North West but appears not to be maintained in this direction.

A 1 m deep drainage ditch, which flows south east to north west and which

The area is bounded and defined by the 5 m contour which runs north to south between Dunmore and Airth then veers west for approximately 1.5 km before meandering east toward the south of Airth. The route of the A905 between Bowtrees roundabout and Dunmore runs approximately parallel with the 5 m contour and defines the site to the east. A 5 m high, well-vegetated earth embankment, steeply sided on the landward side, runs 2.7 km from south west to north east enclosing the site to the east.

A second embankment runs inland in a south easterly direction at NS904881 for 0.45km presumably to provide protection to the sewage treatment works from flooding from the south west of the site.

Figure 3: Eroding embankment on seaward side of embankment near sewage treatment works

Figure 4: Embankment looking east from sewage treatment works

originates inland , runs parallel landward of the embankment and empties via a pipe running through the embankment. The wooden structures surrounding the pipe are in a state of disrepair and a large hole has been excavated in the embankment presumably to carry out remedial work. A larger ditch or borrow pit to the north of the track appears to be saline and connects to the river via pipes through the bank. The ditch is fed by a drain originating to the north west of Airth and flows in a north westerly direction before veering south east.

A second drain to the north of Airth, runs south west to north east and is embanked on both sides, empties into the Forth at NS900885

To the south, the Pow Burn forms a natural boundary and follows a meandering route to the Forth where it empties at NS916874. A minor road leaves the A905 just south of Airth and crosses the southern area of the site before joining the A876 at Higgins Neuk, crossing the Pow Burn at NS915872. The remains of the demolished Eastfield Farm are located just north of the unclassified road at NS908872. A 200 m track leads from the farm ruins to the carse cliff/ 5m contour.

Figure 5: Looking south west towards Airth along reinforced embankment and carse cliff

A 380kV pylon (South Crossing Tower), one of the largest in Scotland, and associated infrastructure is located at the east of the site (NS912874), 200 m north of the Pow Burn, carrying cables across the Forth from Longannet Power Station and is a dominant feature in the landscape. A Scottish Water sewage treatment works built in the 1990s is located below the intersections of the embankments at NS903881 and lies at 2 m below MHWS. The works are accessed via a surfaced track leading from Shore Road in Airth.

On the seaward side of the embankment between Higgins Neuk and the northernmost drain is an area of intertidal mudflats and saltmarsh covering approximately 52 ha.

The site is adjacent to the area designated as the Upper Forth Estuary as part of the River Basin Management Plan process, which covers 9.67 km^2 from Kincardine Bridge to Stirling on the south shore and from Stirling to Kincardine on the north shore. It has been classified as a Heavily Modified Water Body and as having Poor Ecological Potential with a current ecological status of Poor and an overall chemical status as Pass.

SEPA have established an ongoing programme of monitoring to identify pressures and measures which will protect or improve the status of water bodies in order that good status is achieved over successive RBMP cycles. Targets and environmental objectives have been set for the Upper Forth Estuary to maintain Poor Ecological Potential for the RBMP cycles in 2015 and 2021 with Good Ecological Status achieved by 2027.

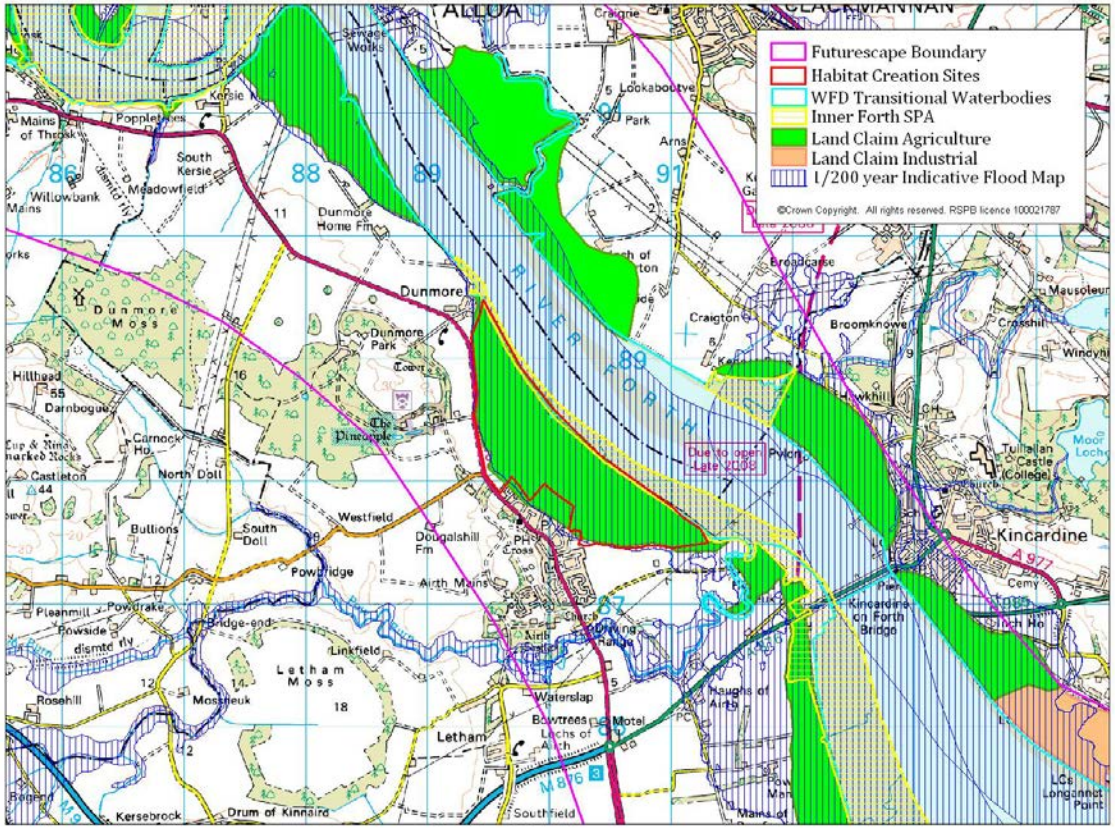


Figure 6: Land claim and flood risk at Airth to Dunmore

Pressures identified in the Upper Forth Estuary include morphological alterations in the form of historical land reclamation, point source pollution in the form of inputs and sewage treatment.

The site is within a Potentially Vulnerable Area as identified within the National Flood Risk Assessment with potential impacts to a number of residential and commercial properties, community facilities, transport links, agricultural land. The area has a medium rating in the flood risk category as assessed by infrastructure, historic flooding, groundwater, climate change and flood defences.

Future Vision

The site at Airth is a significant managed realignment site in a Scottish context and plays a major strategic role in realising a multi-functional landscape in the Inner Forth with benefits for both biodiversity and people. The landscape has been returned to a more naturally functioning system including creating over 90 ha of saltmarsh, mudflats, creeks and grassland, partly reversing the historic loss of these valuable habitats. An important contribution has been made to achieving Good Ecological Potential by removing morphological pressures along the coast.

In combination with the Skinflats site to the south this area has become a very significant area of intertidal habitats comprising over 200 ha. Landward of the intertidal habitats, on higher ground, a mosaic of grassland and woodland with hedgerows has been developed and existing habitats managed to improve the richness of the landscape for a wide variety of wildlife.

The site is accessible via a network of footpaths and tracks with viewpoints and is well used by the local community. It is also a resource for local education groups from primary to tertiary and the role of volunteers is be integral to the on-going monitoring and management of the area.

Table 1: Site summary

Site name	Airth
Location and Local Authority Area	Airth, Falkirk
Grid Reference	NS902879
Area	90 ha
Ownership	Unknown - private
Access	Unclassified road from A905 at Airth linking with A876 at Clackmannanshire Bridge Road to Scottish Water sewage/ water pumping station leading from Shore Road in Airth Public Right of Way from Higgins' Neuk to Scottish Water works leading to Airth and Dunmore.
Buildings and services	Pylon and associated infrastructure. Sewage treatment/ water pumping station (Scottish Water). BT lines to Sewage Treatment Works Electricity lines to Sewage treatment works Derelict farm buildings present at Eastfield, Airth

Designations	None
Liabilities and health and safely issues	Almost the entire site lies within the Coal Authority referral area and a coal mining report would be required as part of a detailed feasibility study. 380kV pylon and associated infrastructure Giant hogweed at sewage works

Conservation Interest and Potential

The current conservation interest of the site landward of the embankment at Airth is limited although farmland bird species such as grey partridge skylark and tree sparrow are present. The potential of the area to contribute to landscape scale habitat creation and restoration is dependant on a managed realignment scheme and subsequent creation of intertidal habitats proceeding.

The adjacent intertidal mudflats and saltmarsh between Higgins Neuk and Dunmore are designated as SSSI, SPA and Ramsar and are a key area for passage and wintering waders and wildfowl. Twite winter in the area and flocks of up to 250 have been recorded in the area in recent years (Forth Bird Report 2008). A large sand bar just off shore is an important feeding and loafing area for waders and gulls at low tide. The saltmarsh fronting the area is part of a band which varies between 50–200 m in width and which is almost continuous for 16 km between the River Carron and South Alloa. The saltmarsh is typical of saltmarsh communities in the Inner Forth from lower marsh zones dominated by *Puccinellia maritima* and *Salicornia* species, through *Juncus gerardii* saltmarsh communities, to upper marsh swamps with *Scirpus maritimus*. The saltmarsh is notably poor in the variety of species and communities. Much of the saltmarsh has been affected by past management practices with a history of turf stripping, grazing and general invasive management.

The site at Airth is ideally located within the estuary in close proximity to several other potential managed realignment sites, which in combination could make a major contribution to landscape scale conservation and flood management.

The intertidal area fronting the site at Airth was described as a low quality site in terms of prey (invertebrate) density and biomass by Dwyer (2010) and this conclusion should be borne in mind when designing a habitat creation scheme. Measures to increase available invertebrate biomass should be explored.

To the west of the A905 between Airth and the village of Dunmore lies Dunmore Wood, an extensive complex of conifer and broad-leaved woodland totalling approximately 150 ha.

Table 2: Current and potential bird numbers

Wintering (peak count winter 2010/11 – counts cover South Alloa to Kincardine Bridge area)		
Species	Current	Potential
Cormorant	13 (Oct 11)	Increase
Grey heron	33 (Oct 11)	Increase
Pink-footed goose	1400 (Mar 11)	3000
Greylag goose	400 (Sep 10)	800
Shelduck	16 (Feb 11)	300
Wigeon	367 (Jan 11)	500
Teal	527 (Jan 11)	1000
Mallard	112 (Oct 11)	300
Oystercatcher	94 (Feb 11)	150
Lapwing	95 (Oct 11)	300
Dunlin	90 (Feb 11)	150
Black-tailed	53 (Mar 11)	100
Curlew	129 (Jan 11)	200
Redshank	41 (Feb 11)	100

Note: Monthly Webs counts are carried out between South Alloa and Kincardine Bridge and low tide counts were carried out in the early 1990's by the BTO.

Other biodiversity

Little is known at present about biodiversity in the area.

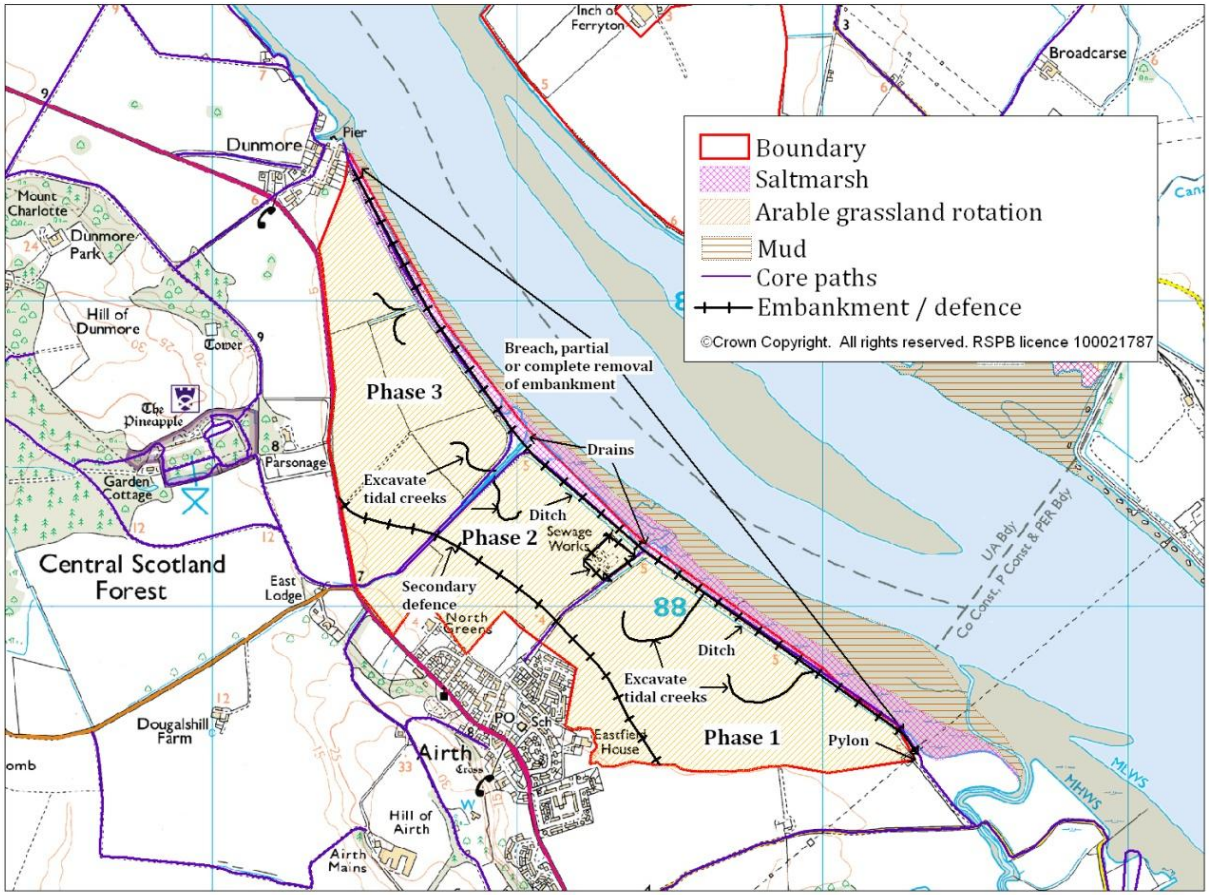


Figure 6: Current habitats and proposed management

Management Activities and Options

The majority of the land at Airth is currently in agricultural production comprising cereals, silage/ hay with sheep and cattle grazing in the vicinity. Other than evidence of recent work on a sluice near the sewage treatment works, there has been no maintenance of the embankment.

The site has been previously identified as a site suitable for managed realignment (GeoWise, 1999 & Hughes 2010) due to its middle estuary location, salinity, naturalness (ie the bay shape), and natural secondary defence (carse cliff) and fulfils the criteria outlined in Babtie (2003).

A managed realignment scheme at Airth could be approached in several ways as per standard techniques; breaching the embankment in one or two locations, a sequential programme of embankment removal or complete embankment removal. Hughes (2010) considered a staged reduction in height of the embankment and complete removal of the embankment.

A programme of sequential managed realignment, informed by detailed studies would be the most likely be the acceptable practical working scenario and would enable any potential technical problems to be identified and solutions found prior to work commencing

on a later phase of work. This phased approach would enable public confidence to develop as the scheme progresses although would add considerably to the overall cost of the project.

A scheme would require the construction of a secondary defence to provide protection to residencies in Airth and potentially further work to existing embankments at the sewage treatment works. Complete removal of the embankment from the southern end of the site to the sewage treatment works would involve backfilling the existing drainage ditches with surplus material regraded in the fields. Several low lying islands could be created using spoil from the embankment which would provide nesting and roosting site for waders and wildfowl.

The existing drainage at the site is a critical factor in determining the design of a scheme and regrading and re-profiling of low lying areas within the site may be necessary to avoid ponding. To facilitate development of intertidal habitats excavation of a creek system would be advantageous following historic routes if these can be established. Exact ratio of habitats created would be determined by results of hydrological and geomorphological studies.

Table 3: Options Available for Future Management

	Option A - Do Nothing	**Option B – Maintain Embankment**	**Option C – Phased Managed Realignment**	**Option D - Managed Realignment**
Description	Maintain current situation	Maintenance and repair of embankment	Managed realignment	Managed realignment
Works needed	n/a	Raise and widen existing 3km earth embankment to provide protection to 1:250 year flood event standard. Maintenance and repair drainage infrastructure.	Partial embankment removal (or breach), earth moving, rubble and waste removal, re-grading of material into field, construction of secondary defence, re-instatement of creek system, removal and replacement of control structures, re-routing of right of way and footpath.	Complete embankment removal, earth moving, rubble and waste removal, re-grading of material into field, construction of defence/ keyed in to carse cliff, re-instatement of creek system, removal and replacement of control structures, re-routing of right of way and footpath.
Constraints	n/a	The embankment is adjacent to SPA/SSSI.	The properties at the north eastern edge of Airth are a	The properties at the north eastern edge of Airth are a

			constraint and construction of a defence would be necessary to provide protection at the eastern edge of the village. The 380kV electricity pylon and associated infrastructure present a constraint to a managed realignment programme and any design would have to be acceptable to Scottish Power Energy Networks. The Scottish Water treatment station is a major constraint and a managed realignment scheme would either have to be designed around the water treatment plant or the treatment plant would have to be relocated to a new location. The embankment is adjacent to SPA/SSSI. There is a public right of way. Almost the entire site lies within the Coal Authority referral area and a coal mining	constraint and construction of a defence would be necessary to provide protection at the eastern edge of the village. The 380kV electricity pylon and associated infrastructure present a constraint to a managed realignment programme and any design would have to be acceptable to Scottish Power Energy Networks. The Scottish Water treatment station is a major constraint and a managed realignment scheme would either have to be designed around the water treatment plant or the treatment plant would have to be relocated to a new location. The embankment is adjacent to SPA/SSSI. There is a public right of way. Almost the entire site lies within the Coal Authority referral area and a coal mining

			report would be required as part of a detailed feasibility study.	report would be required as part of a detailed feasibility study.
Site assessment needed	n/a	Assessment of condition of embankment. Assessment of drainage infrastructure.	A full feasibility report including a study of the effects of a managed realignment scheme in the area, technical feasibility, future management and monitoring, and economic implications (cost benefit analysis). A managed realignment / management plan detailing works proposed would need to be drawn up, including all work prior to construction, follow up works and monitoring required. A geotechnical investigation regarding material for secondary defence/ embankment fill and a local drainage study would be necessary. Baseline ecological information would be required A flood risk assessment would	A full feasibility report including a study of the effects of a managed realignment scheme in the area, technical feasibility, future management and monitoring, and economic implications (cost benefit analysis). A managed realignment / management plan detailing works proposed would need to be drawn up, including all work prior to construction, follow up works and monitoring required. A geotechnical investigation regarding material for secondary defence/ embankment fill and a local drainage study would be necessary. Baseline ecological information would be required

			be necessary.	A flood risk assessment relating to secondary defence and any retained embankments would be necessary.
Timescale	n/a	Immediately	10-20 years	10-30 years
Demonstration site potential	n/a	n/a	A phased approach as part of a larger managed realignment scheme would provide an ideal opportunity to demonstrate the multi-functional benefits of landscape scale conservation to local communities, statutory agencies and MP's and MSP's.	The development of a managed realignment scheme at Airth would provide an opportunity to demonstrate the benefits of a landscape scale approach to conservation and flood management to a wide audience from local communities, statutory agencies, MP's and MSP's .
Threats to conservation interest /potential	n/a	n/a	New developments leading to the loss of habitat creation opportunities. A change in land use which may compromise future opportunities. Community engagement regarding a managed realignment scheme at Airth would require sensitive and considered handling with a	New developments leading to the loss of habitat creation opportunities. A change in land use which may compromise future opportunities. Community engagement regarding a managed realignment scheme at Airth would require sensitive and considered handling with a

			suitable investment of time and expertise – similar to the Coastal Futures Project - a partnership of the RSPB, Environment Agency, Natural England and Defra to support communities dealing with coastal change and sea level rise on the Humber. Public perception of managed realignment is the major issue and potential stumbling block to any such project. Engagement with landowners at an early stage is essential.	suitable investment of time and expertise – similar to the Coastal Futures Project - a partnership of the RSPB, Environment Agency, Natural England and Defra to support communities dealing with coastal change and sea level rise on the Humber. Public perception of managed realignment is the major issue and potential stumbling block to any such project. Engagement with landowners at an early stage is essential.
Consents required	n/a	Initial consultation with local planners would determine planning consent requirements. As the area is adjacent to the SPA any works would require consent from SNH A Marine Licence is likely to be required for works.	Works would require Environmental Impact Assessment, Appropriate Assessment and full planning consents. CAR & FEPA licenses may be required As the site is adjacent to an SSSI and SPA, consent would be required from SNH. A Marine Licence would be required. A full public consultation	Works would require Environmental Impact Assessment, Appropriate Assessment and full planning consents. CAR & FEPA licenses may be required As the site is adjacent to an SSSI and SPA, consent would be required from SNH. A Marine Licence would be required. A full public consultation

			would be required and communications plan produced	would be required and communications plan produced
Capital costs	n/a	The costs of upgrading and repairing the embankment to a recommended standard would be considerable and would have to be borne by the landowner unless carried out as a grant-aided flood defence scheme. >£500,000	Capital costs will involve removal (or partial removal) of existing embankment and regrading of material into fields, construction of secondary defence, provision of new drainage structures, land purchase and associated legal costs. >£1m	Capital costs will involve removal of existing embankment and regrading of material into fields, construction of secondary defence, provision of new drainage structures, land purchase and associated legal costs. >£1m
Set up costs	n/a	n/a	Design of scheme, manufacture of water control structures, specialised machinery and staff >£100,000	Design of scheme, manufacture of water control structures, specialised machinery and staff >£100,000
Management costs	n/a	Inspection, maintenance and repair costs.	Ideally, the project will be designed to minimise future management requirements other than routine maintenance of drainage control structures, secondary defences and any other earthworks. A monitoring programme to	Ideally, the project will be designed to minimise future management requirements other than routine maintenance of drainage control structures, secondary defences and any other earthworks. A monitoring programme to

			evaluate the outcome of the project would be necessary over at least 5 years and at appropriate intervals beyond.	evaluate the outcome of the project would be necessary over at least 5 years and at appropriate intervals beyond.
Immediate actions required	n/a	Assessment of embankment.	See liabilities	See liabilities
Funding opportunities	n/a	Individual landowners. Scottish Government. Falkirk Council.	The scope and range of potential benefits of the project would make this proposal an attractive proposition. Given the scope and scale of the project funding would have to come from Scottish Government, future agri-environment schemes, local and national industrial concerns, trusts, statutory agencies and European sources with contributions from private capital and NGOs.	The scope and range of benefits of the project would make this proposal an attractive proposition. Given the scope and scale of the project funding would have to come from Scottish Government, future agri-environment schemes, local and national industrial concerns, trusts, statutory agencies and European sources with contributions from private capital and NGOs.

Access and Interpretation Opportunities

There is generally good existing access via core paths and rights of way around the area although other than basic directional signposting no other provision is present. There is no interpretation present.

There is potential for creating an upgraded footpath network coupled with low key interpretation linking to other sites in the area and enabling the local community to access areas comfortably and safely.

Table 4: Current and potential access and interpretation

Facility	Current	Potential
Vehicular	Vehicular access via Shore Road in Airth and unclassified road from A905	No change anticipated unless large scale managed realignment scheme proceeds.
Pedestrian	Public right-of-way (Core Path 010/121) along embankment from Higgins' Neuk to Dunmore. Currently maintained as far as sewage treatment works. Core paths 010/88 and 010/100 run adjacent to the site utilising the minor road	Rights of way along foreshore would require relocating incorporating viewpoints and
Cycle Route	Round the Forth cycle route utilises minor roads to the south of the site.	No change
Footpath direction	Public right of way fingerposts	High quality branded signage 'Inner Forth trail'
Interpretation	None	Interpretation of the area and its wildlife

Recommendations

With predicted sea level rise and increased rainfall leading to increased chance of flood events, Option A is unsustainable in the long-term with any flood events having potentially serious consequences for land, property and infrastructure in the area should existing embankments fail. Option B requires a significant investment on behalf of landowners if alternative funding is not available and is entirely dependant on goodwill and financial ability. Flood management in the Inner Forth requires a strategic and equitable approach which this option does not provide.

This is a significant managed realignment proposal and it should be assumed that there would be concern about such a significant change to land management from the local community, particularly those living in Airth.

Coupled with the practical, logistical and financial aspects of Option D, Option C is therefore the preferred option. This would mean a phased approach would enable relationships to be built with the local community and the project designed and taken forward with their input. A phased scheme also means that confidence in the approach would grow as the scheme progressed and on-going benefits could be demonstrated.

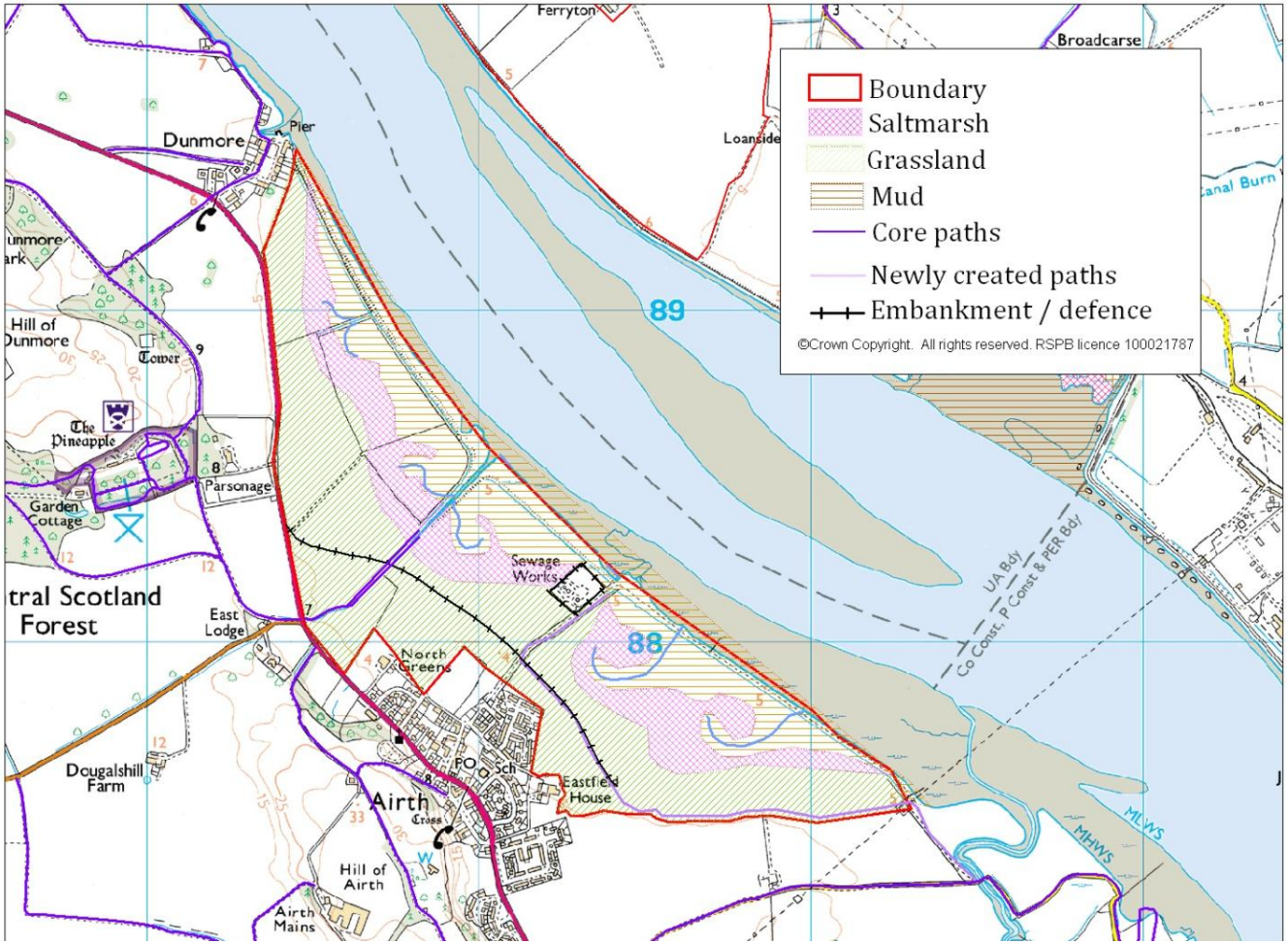


Figure 7 : Outcome map for Airth to Dunmore

Table 5: Options Appraisal

Strengths				Weaknesses			
Option A	**Option B**	**Option C**	**Option D**	**Option A**	**Option B**	**Option C**	**Option D**
No cost	Increased short-term flood protection in local area. Maintenance of agricultural production. Maintenance of public footpath	Flexibility in design of scheme Positive public/ community perception more likely Reduced long-term maintenance & repair costs to embankment Contribute to WFD	Cost effective Maximum contribution to estuarine functionality Reduced long-term maintenance costs Contribute to WFD & Flood risk management	Increased likelihood of coastal flood event due to embankment failure	High cost to landowner/s Maintenance/ repair costs Maintain conditions leading to coastal squeeze Inefficiencies in local drainage system will be accentuated with sea level rise.	Extra cost in mobilisation of equipment Perceived loss of public access along foreshore Increased opportunity for disturbance through wildfowling	High initial cost Perceived loss of public access Increased opportunity for disturbance through wildfowling
Opportunities				**Threats**			
Option A	**Option B**	**Option B**	**Option D**	**Option A**	**Option B**	**Option C**	**Option D**
n/a	n/a	Community involvement Trial habitat creation techniques	Community involvement Increased public access	n/a	n/a	Landowner and community concerns Consents re Habitats Regulations,	Landowner and community concerns

		Increased public access Development of visitor infrastructure Development of demonstration & study site	Development of visitor infrastructure Development of demonstration & study site			planning Access issues	Lack of funding Access issues

Appendix 5: Dunmore to South Alloa Site Assessment

Introduction

This site assessment has been produced following a desktop review of available information, site visits and initial discussions with stakeholders and land managers. The recommendations made are based on current knowledge. Further consultation with communities and landowners and detailed technical assessments will be required to develop and confirm proposals.

Site Description

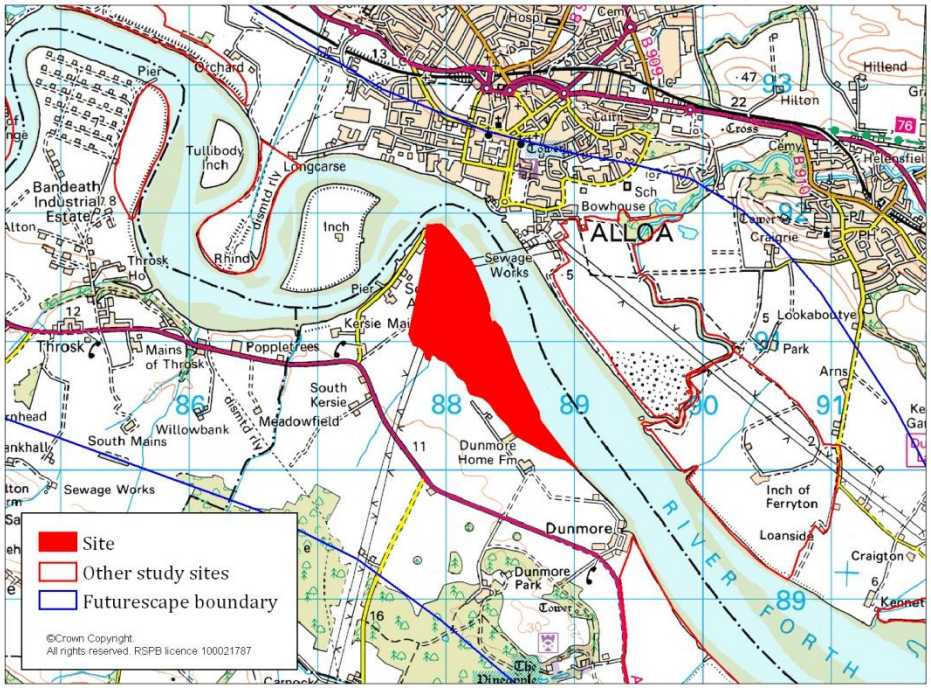


Figure 1: Location of Dunmore to South Alloa

The site is situated on the south bank of the Forth between the villages of Dunmore and South Alloa and is part of a larger area of reclaimed land between Airth and South Alloa. The small village of Dunmore is built around a natural inlet where there was formerly a harbour. South Alloa lies 2.5km to the north west and the large farmstead of Dunmore Home Farm is 1 km north west of Dunmore. The A905 bounds the site to the west running roughly parallel to higher ground.

The area is low-lying with the 5 m contour and carse cliff following the shoreline from Dunmore then heading inland in a north westerly direction before rejoining the shoreline south west of South Alloa.

The carse cliff north of Dunmore is tree-lined with some large veteran trees present. Where the carse cliff veers inland, a 5m high vegetated earth and rubble embankment continues along the riverbank from Dunmore Home Farm to South Alloa for 1.2 km. A drainage ditch runs parallel, landward of the embankment.

A track which is embanked on the landward side for part of its length runs parallel to the embankment north from Dunmore Home Farm to South Alloa. The site is bisected by the South Kersie drain which empties into the Forth 750 m south east of South Alloa.

The drain is embanked by a 300 m embankment on the north bank and by a 100 m embankment on the southern bank. A drain empties into the Forth through the embankment at the western end of a shelter belt near Dunmore Home Farm

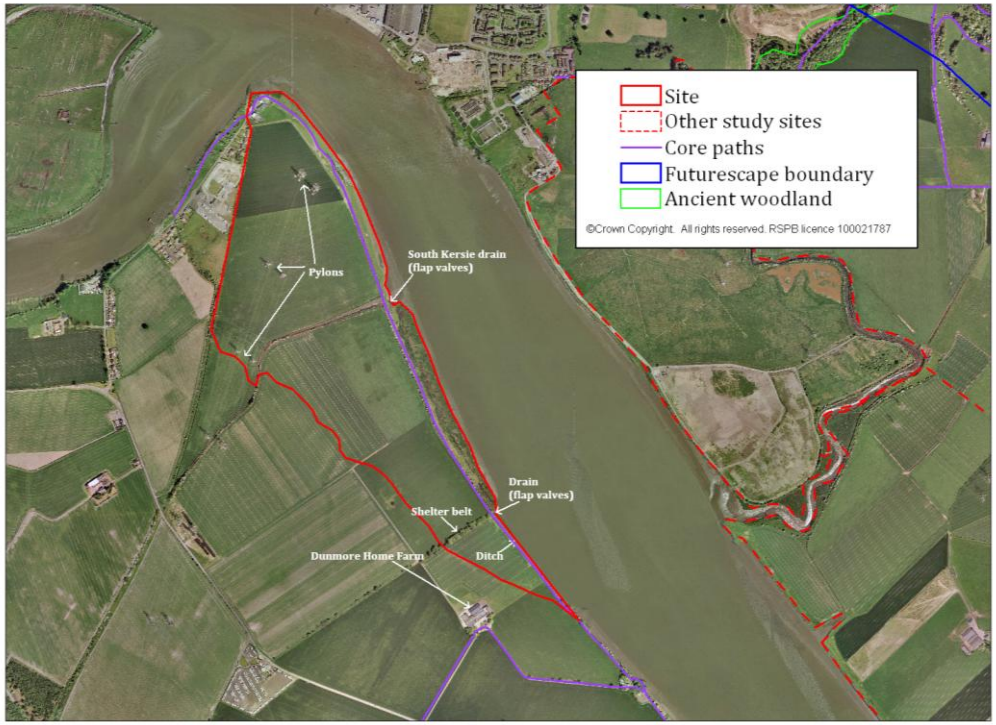


Figure 2: Overview of Dunmore to South Alloa

Figure 3.Looking south towards Dunmore

Figure 4.Shelter belt and carse cliff at Dunmore Home Farm

Two field drains empty into the South Kersie drain on the landward side of the embankment. The area is predominantly in agricultural production with cereal (barley and wheat) and silage around Dunmore Home Farm. Sheep graze a rough improved pasture at South Alloa which is dominated by tufted hair grass.

A narrow strip of saltmarsh starting at the shoreline at Dunmore Home Farm widens as it approaches the South Kersie drain outfall then narrows again as it nears South Alloa. Beyond the South Kersie drain the saltmarsh is grazed by sheep, resulting in a close cropped sward. The saltmarsh has a low cliff which shows evidence of erosion, particularly toward South Alloa.

Figure 5. South Kersie drain

Figure 6.Grazed saltmarsh, South Alloa

Figure 7. Looking towards South Alloa along embankment

Two parallel rows of pylons cross the Forth 320 m south of South Alloa and traverse the site from north west to south east heading inland to Denny. The pylons nearest the river stand on four substantial concrete piers.

The site is within a Potentially Vulnerable Area as identified within the National Flood Risk Assessment (The draft, 'Flooding in Scotland: A consultation on Potentially Vulnerable Areas and Local Plan Districts' published in June 2011, identifies areas for flood risk management planning.) with flooding causing potential limited impacts to a small number of residential and commercial properties, transport links and agricultural land. The area has a medium rating in the flood risk category as assessed by infrastructure, historic flooding, groundwater, climate change and flood defences.

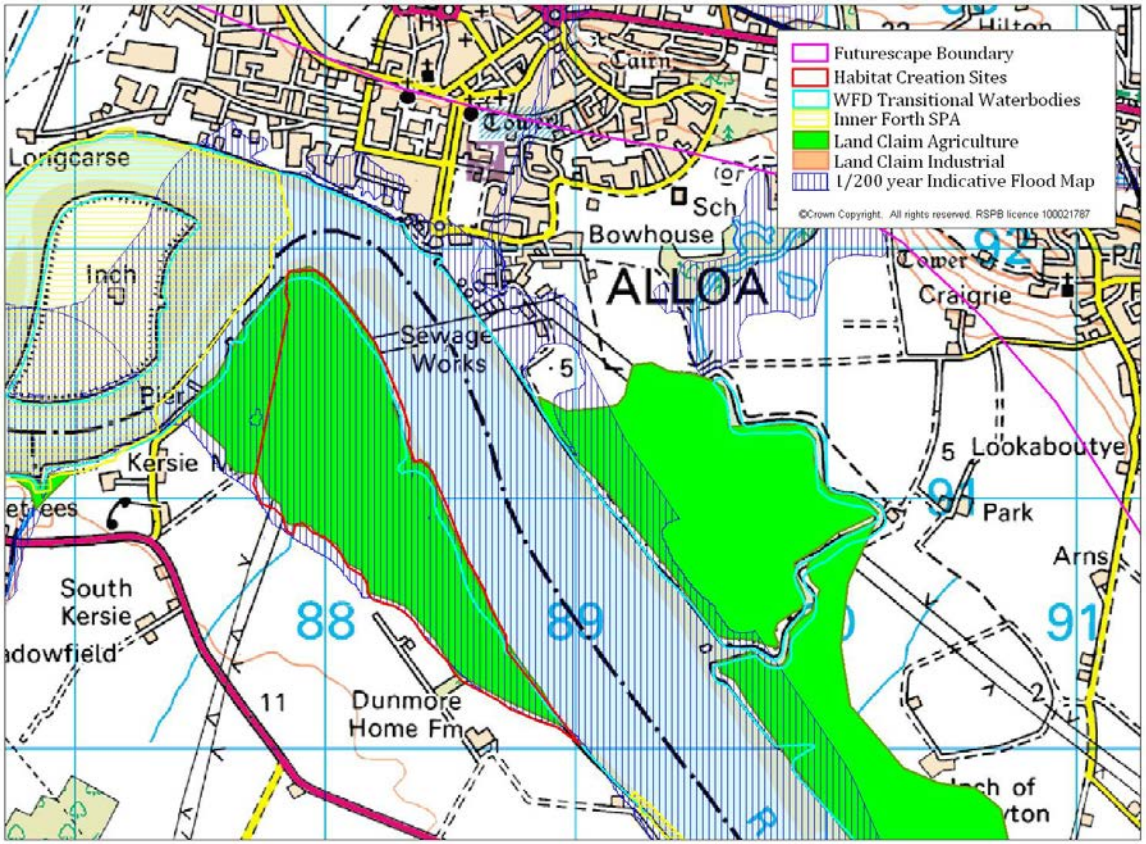


Figure 8: Land claim and flood risk at Dunmore to South Alloa

The Weighted Annual Average Damages to the area are estimated at over £700,000 (this figure gives an indicative estimate of direct costs to residential properties, non-residential properties and agriculture). The known source of flooding in the area is predominantly coastal at 40% with 39% from surface water and 21% from rivers.

Future Vision

The Dunmore to South Alloa site has become an important area of new intertidal habitats with associated enhanced wetland areas and is now an area rich in biodiversity on the southern shore of the Forth. It complements the nearby areas of Black Devon Wetlands, Alloa and Tullibody Inches to form a network of wetland habitats. Access in the form of a high quality footpath around the site links it to others projects undertaken by Stirling Council and provides an opportunity for visitors and locals alike to enjoy the area.

Table 1: Site summary

Site name	Dunmore to South Alloa
Location and Local Authority Area	Dunmore, Falkirk
Grid Reference	NS8890
Area	60 ha
Ownership	Dunmore Estate
Access	A signposted footpath runs from Dunmore to South Alloa. A track accessing Dunmore Home Farm, Pyetrees cottages and Dunmore village leaves the A905 south east of Dunmore Home Farm. A rough track runs parallel landward of the embankment from South Alloa to the shoreline near Dunmore Home Farm
Buildings and services	Dunmore Home Farm is within the site and residencies at Dunmore and South Alloa lie adjacent. There are several features of archaeological interest on the foreshore near Dunmore relating to harbours and salmon fishing infrastructure.
Designations	None
Liabilities and health and safely issues	A parallel row of pylons cross the site near South Alloa. The embankment along the shoreline would need to be assessed as to condition and long-term viability. The drainage infrastructure on the site would need to be investigated as to condition and effects of it failing or being altered. There is a as pipeline infrastructure contained with a compound immediately north east of Dunmore relating to a gas pipeline which crosses the Forth at Dunmore. The area is outside the Falkirk Coal Mining Development referral area but any works would have to refer to standing advice.

Conservation – Current interest and potential

The area lies between the Firth of Forth SSSI and SPA areas at Airth and south of the Scottish Wildlife Trusts reserves at Alloa and Tullibody Inch but is currently of limited conservation interest. The conservation potential of the area could be realised through habitat creation, enhancement or restoration which would add considerably to the area's conservation and flood management value, complementing the SSSI and SPA and 'futureproofing' this area of the Inner Forth against the effects of climate change.

The site is adjacent to the area designated as the Upper Forth Estuary as part of the River Basin Management Plan process, which covers 9.67 km^2 from Kincardine Bridge to Stirling on the south shore and from Stirling to Kincardine on the north shore, and has been classified as a Heavily Modified Water Body, having Poor Ecological Potential with a current ecological status of Poor and an overall chemical status as Pass.

SEPA have established an ongoing programme of monitoring to identify pressures and measures which will protect or improve the status of water bodies in order that good status is achieved over successive RBMP cycles. Targets and environmental objectives have been set for the Upper Forth Estuary to maintain Poor ecological potential for the RBMP cycles in 2015 and 2021 with Good Ecological Status achieved by 2027. Pressures identified in the Upper Forth Estuary include morphological alterations in the form of historical land reclamation, point source pollution in the form of inputs and sewage treatment

Table 2: Habitats

Habitat (in hectares)	Current	Potential
Intertidal	0	15
Saltmarsh	0	5
Grassland	25	5

Current and potential bird numbers

Little is known about bird numbers on the site although the grazed areas will be used by waders such a curlew and lapwing. Pink-footed and greylag geese will use stubble fields in the winter and populations of farmland birds are present. Creation of wetland habitats through either enhancement or managed realignment would increase the value of the area to a wide variety of bird species and other biodiversity, by providing feeding and roost sites.

Other biodiversity

Little information is available about other biodiversity in the area.

Management Activities and Options

The area between Dunmore Home Farm and South Alloa meets the established criteria for a managed realignment scheme but there are major constraints as South Alloa lies below the 5m contour and would require substantial secondary defences. This would leave South Alloa exposed as a headland and an artificial obstruction to water flow where there is considerable turbulence and velocities.

It would be feasible to carry out a smaller managed realignment of around 25ha between Dunmore Home Farm and the South Kersie drain which would result in the creation of intertidal, saltmarsh and higher marsh habitats.

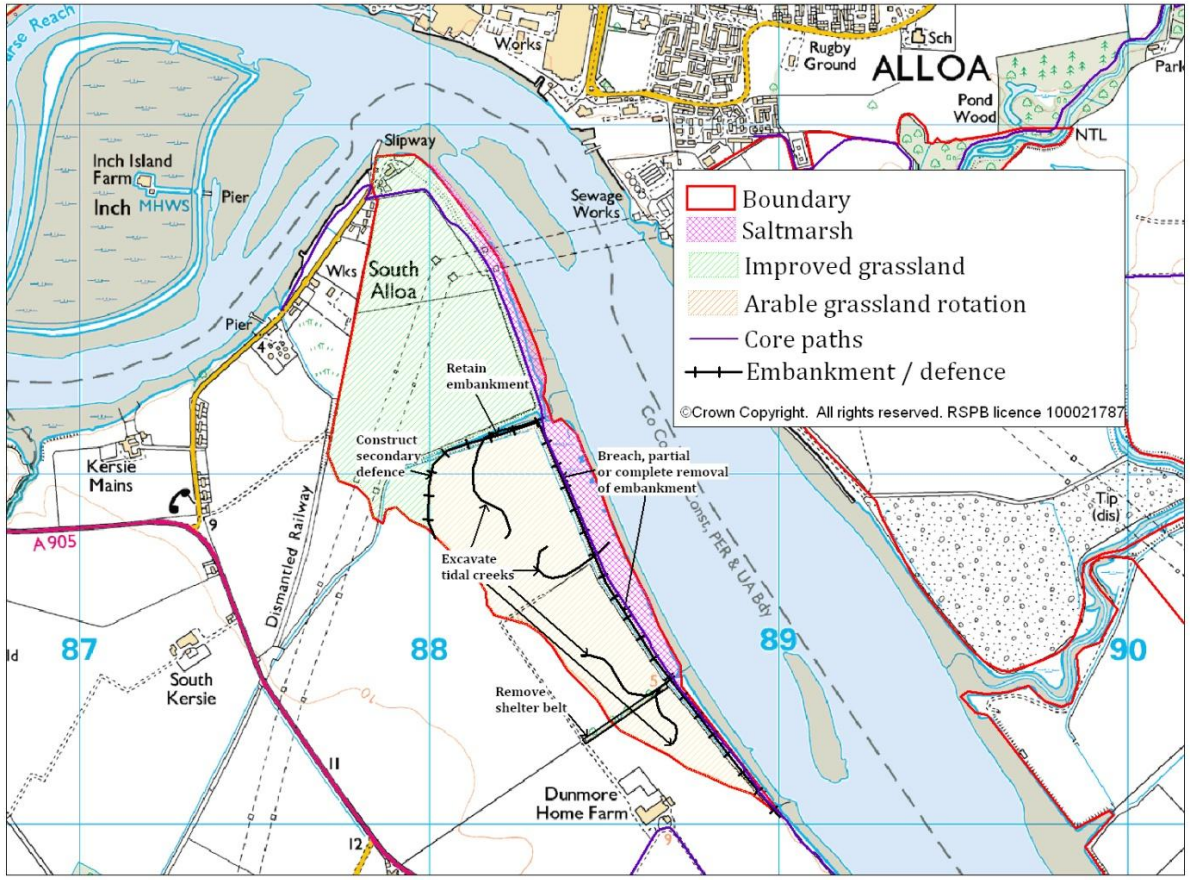


Figure 8 Current habitats and proposed management

A managed realignment scheme could be carried out here in conjunction with habitat enhancement work, involving wetland creation and enhancement. Detailed feasibility studies would inform the technical viability of managed realignment scheme and exact areas of habitat potential. The embankment would be removed completely or breached in one or two places with the resulting material regarded into the fields, used as backfill to fill the drainage ditch.

The short length of embankment on the south side of the South Kersie drain would have to be extended to tie in with the 5m contour and a considerable amount of rubble removed. Outside of the potential managed realignment area the adjacent low lying fields could be enhanced by the creation of wetland features, possibly involving creating a meander in the South Kersie drain before it reaches the outfall and expanding the transitional brackish to freshwater habitats. Scrapes and a pool with a small area of reedbed could be considered. If the opportunity arose, similar habitat creation could be employed in the area south of the South Kersie drain to Dunmore Home Farm.

Table 3 Options Available for Future Management

	Option A - Do Nothing	**Option B – Maintain Embankment**	**Option C - Habitat Enhancement and Creation**	**Option D - Managed Realignment**
Description	Maintain current situation.	Maintenance and repair of embankment.	Freshwater/ brackish habitat creation and enhancement.	Managed realignment.
Works needed	n/a	Raise and widen existing 1.2km earth embankment to provide protection to 1:250 year flood event standard. Maintenance and upgrade drainage system.	Hydrological management works, as determined by results of ecological, hydrological and geomorphological surveys – earthworks, ditch clearance and the installation of water control structures. Vegetation control – mechanical or by grazing – install or relocate necessary infrastructure eg fencing, crossing points, watering facilities for livestock. Removal of existing water control and drainage	Embankment removal, earth moving, rubble and waste removal, tree removal, re-grading of material into field, construction of secondary defence, re-instatement of creek system and the removal and relocation of control structures.

			infrastructure.	
Constraints	n/a	n/a	The area is within a Coal Authority Development Referral Area and would require a non-residential mining report from the Coal Authority before any works or investigations commenced. Two parallel power lines traverse the site connecting Longannet Power Station to a substation at Denny. Issues relating to the degree of protection required for the foundations and likelihood of relocating pylons surrounding wayleaves in respect of the pylons require further investigation.	The area is within a Coal Authority Development Referral Area and would require a non-residential mining report from the Coal Authority before any works or investigations commenced. Two parallel power lines traverse the site connecting Longannet Power Station to a substation at Denny. Issues relating to the degree of protection required for the foundations and likelihood of relocating pylons surrounding wayleaves in respect of the pylons require further investigation.
Site assessment needed	n/a	Assessment of the condition of the embankment.	Detailed ecological, topographic, hydrological and geomorphological assessments will be needed to inform future habitat creation and management, including assessment of current water control system. Baseline ecological	A full feasibility report, including a study of the effects of a managed realignments scheme in the area, technical feasibility, future management and monitoring, and economic implications (cost benefit analysis). A managed realignment /

			information including invertebrate populations, botanical interest. Flood risk assessment focusing on embankment.	management plan detailing works proposed should be drawn up, including all work prior to construction, follow up works and monitoring required. A geotechnical investigation regarding material for secondary defence/ embankment fill and a local drainage study would be necessary.
Timescale	n/a	Immediately	Within 5 years	10 - 20 years
Demonstration site potential	n/a	n/a	The site would be a good location on the south shore of the Inner Forth to develop understanding and build awareness of landscape scale conservation and wetland creation to local communities, statutory agencies, NGOs etc.	The site would be a good location on the south shore of the Inner Forth to develop understanding and build awareness of landscape scale conservation and flood management/ managed realignment to local communities, statutory agencies, MSP's, NGOs etc.
Threats to conservation interest/potential	n/a	n/a	New developments leading to loss of habitat creation opportunities, change in land use which may compromise future opportunities.	New developments**,** leading to loss of habitat creation opportunities, change in land use which may compromise future opportunities.

Consents required	n/a	Initial consultation with local planners would determine planning consent requirements. As the site is adjacent to a SSSI and SPA, consent would be required from SNH for any works. A Marine Licence is likely to be required.	Works would require a Environmental Impact Assessment, Appropriate Assessment and full planning consents. As the site is adjacent to an SSSI and SPA, consent would be required from SNH. A Marine Licence might be required.	Works would require a Environmental Impact Assessment, Appropriate Assessment and full planning consents. As the site is adjacent to an SSSI and SPA, consent would be required from SNH. A Marine Licence would be required.
Capital costs	n/a	The costs of upgrading and repairing the embankment could potentially be considerable and would be borne by the landowner >£500,000	The costs of implementing a freshwater habitat creation scheme would be considerable involving earthworks, regrading of material, construction of bunds, provision of new drainage structures, land purchase and associated legal costs. >£300,000	Capital costs will involve removal (or partial removal) of existing embankment and regrading of material into fields, possible enhancement of secondary defence, provision of new drainage structures, land purchase and associated legal costs. £500k-£1m
Set up costs	n/a	n/a	Design of scheme, Manufacture of water control structures, specialised machinery and staff –included	Design of scheme, Manufacture of water control structures, specialised machinery and staff –included

			in cost above	in cost above
Management costs	n/a	Inspection, maintenance and repair costs.	Ideally the project will be designed to minimise future management requirements other than routine maintenance of drainage control structures, secondary defences and any other earthworks A monitoring programme to evaluate the outcome of the project would be necessary over at least 5 years and at appropriate intervals beyond	Ideally the project will be designed to minimise future management requirements other than routine maintenance of drainage control structures, secondary defences and any other earthworks A monitoring programme to evaluate the outcome of the project would be necessary over at least 5 years and at appropriate intervals beyond
Immediate actions required	n/a	Assessment of embankment	See constraints	See constraints
Funding opportunities	n/a	Individual landowner. Scottish Government. Falkirk Council.	The scope and potential benefits of the project would make the proposals an attractive proposition. Funding streams from local and national industrial concerns, trusts, statutory agencies, the Scottish Government and European sources.	The scope and potential benefits of the project would make the proposals an attractive proposition. Funding streams from local and national industrial concerns, trusts, statutory agencies, the Scottish Government and European sources.

Access and Interpretation Opportunities

Access opportunities in the area are currently limited with Core Path 010/71 from Dunmore to South Alloa along the riverbank and Core Path 010/77 Dunmore Home Farm crossing the area. The area appears to be little visited by walkers with infrastructure along

the footpath overgrown and in poor condition. There is currently no interpretation in the area but given the social and historical significance of the area there is great potential to develop interpretation and signage.

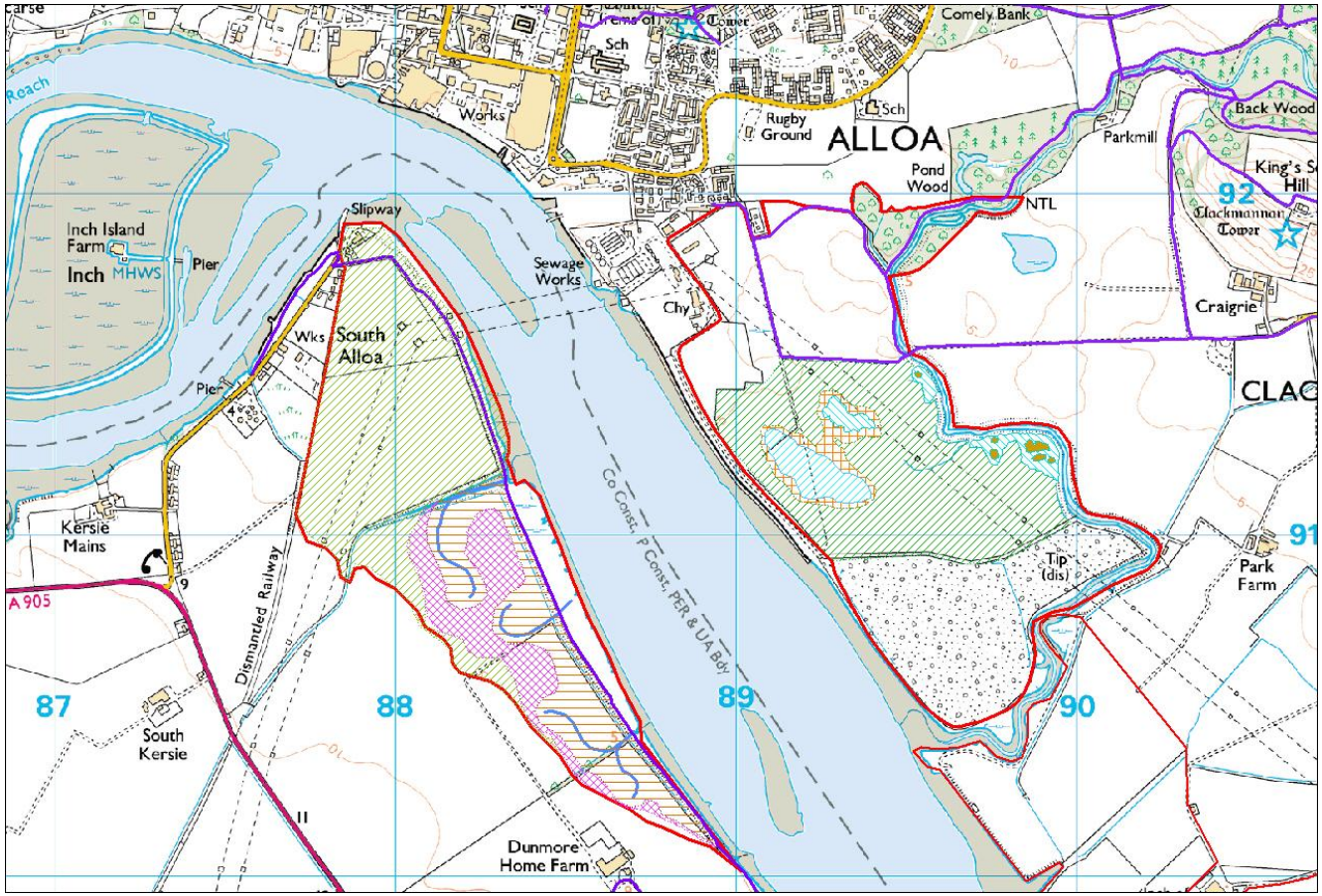
Table 4: Current and potential access and interpretation

Facilities	Current	Potential
Footpath	Core Path	If managed realignment project were to proceed, Core Path 010/71 would have to be realigned.
Vehicular	Access to Dunmore, Dunmore Home Farm via A905. Access to South Alloa via Ferry Road at A905.	No change.
Interpretation	None	Low key information on the area and its wildlife
Signage	Directional fingerposts	High quality functional themed signage

Recommendations

With predicted sea level rise and increased rainfall leading to increased chance of flood events through coastal and fluvial sources, Option A is unsustainable in the long-term with any flood events having potentially serious consequences for land, property and infrastructure in the area should the existing embankment fail.

Option B requires a significant investment on behalf of landowners and is entirely dependant on goodwill and financial ability. Flood management in the Inner Forth requires a strategic and equitable approach which this option does not provide.



There is an opportunity to create habitats in this area but topography and infrastructure may determine exactly what would be the most advantageous but a carefully planned small managed realignment scheme would bring the most sustainable and multi-functional benefits to the area. The costs of upgrading the 1.2 km embankment to provide a level of protection would be considerable and would have to be borne in mind when considering options.

Figure 9: Outcome map for Dunmore to South Alloa

Table 5: Options Appraisal

Strengths				Weaknesses			
Option A	**Option B**	**Option C**	**Option D**	**Option A**	**Option B**	**Option C**	**Option D**
n/a	Increased short-term flood protection in local area. Maintenance of agricultural production. Maintenance of current access	Low cost	Meets managed realignment criteria Contribution to flood risk management Enhance SSSI & SPA features Provide additional feeding, roosting areas for birds	Increased chance of coastal flood event due to embankment failure	High cost to landowner Maintenance/ repair costs Maintain conditions leading to coastal squeeze Inefficiencies in local drainage system will be accentuated with sea level rise.	Increased opportunity for disturbance	High initial cost Cost benefits Proximity of infrastructure Technical issues re location in estuary Small size of area
Opportunities				**Threats**			
Option A	**Option B**	**Option C**	**Option D**	**Option A**	**Option B**	**Option C**	**Option D**
n/a	n/a	Community involvement Increased public access	Community involvement Increased public access	n/a	n/a	Landowner and community concerns	Landowner and community concerns

Appendix 6: Bandeath Site Assessment

Introduction

This site assessment has been produced following a desktop review of available information, site visits and initial discussions with stakeholders and land managers. The recommendations made are based on current knowledge. Further consultation with communities and landowners and detailed technical assessments would be required to develop and confirm proposals.

Site Description

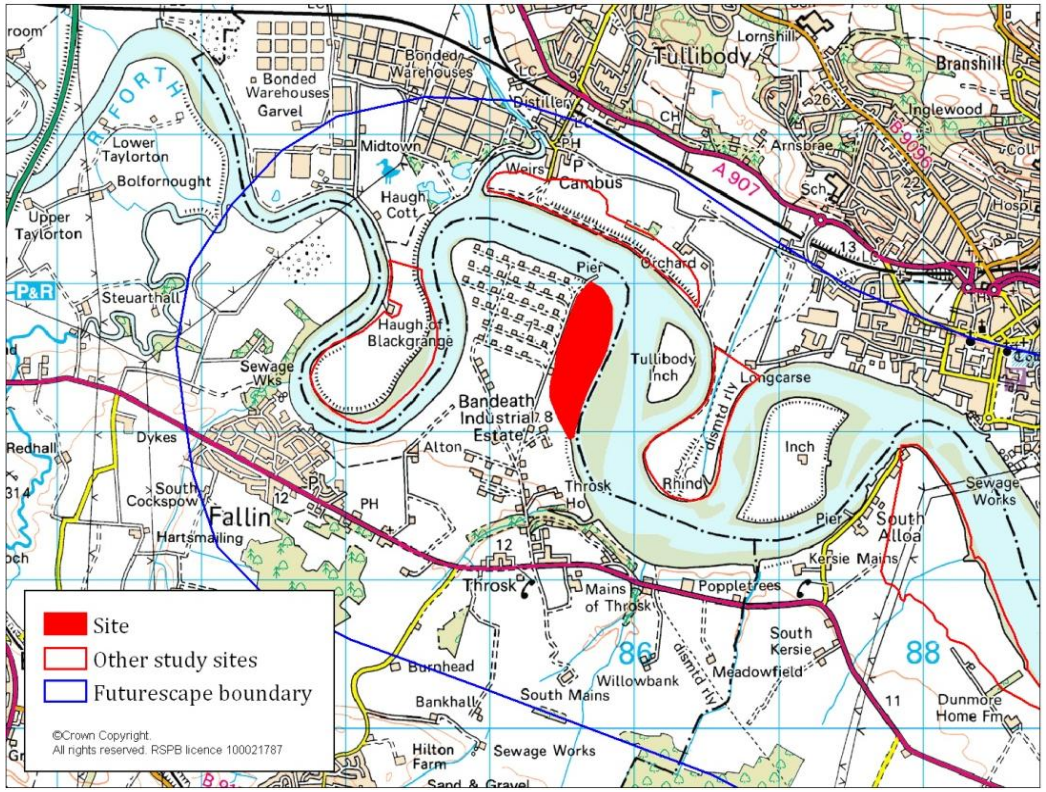


Figure 1: location of Bandeath

The small 25 ha site at Bandeath lies within an extensive meander loop of the river on the south bank of the Forth. The buildings and infrastructure of a former Ministry Of Defence Munitions Store dominate the area and to the south an industrial estate has been developed. The village of Throsk lies immediately south and is Fallin 1.5 km to the west.

The area is mainly above the 5m contour but the eastern side (this site) is low lying and embanked from its south eastern boundary to the northern point of the Haugh.

The 2 km, 5 m high embankment is a substantial structure, constructed with earth, mining spoil and rocks topped with a palisade fence.

An extensive area of common reed fringes the site between the embankment and the river particularly at the north east corner. The low lying area is currently divided into two; an 8 ha field in barley (2011 growing season) at the northern end of the site and a larger area comprising 16ha of rank and

wet grassland grazed by sheep. There is a naturally raised area to the west of the site, which coincides with the 5m contour. This appears to be a natural cliff, which rises relatively steeply at the southern end of the site but rises more gradually at the northern end.

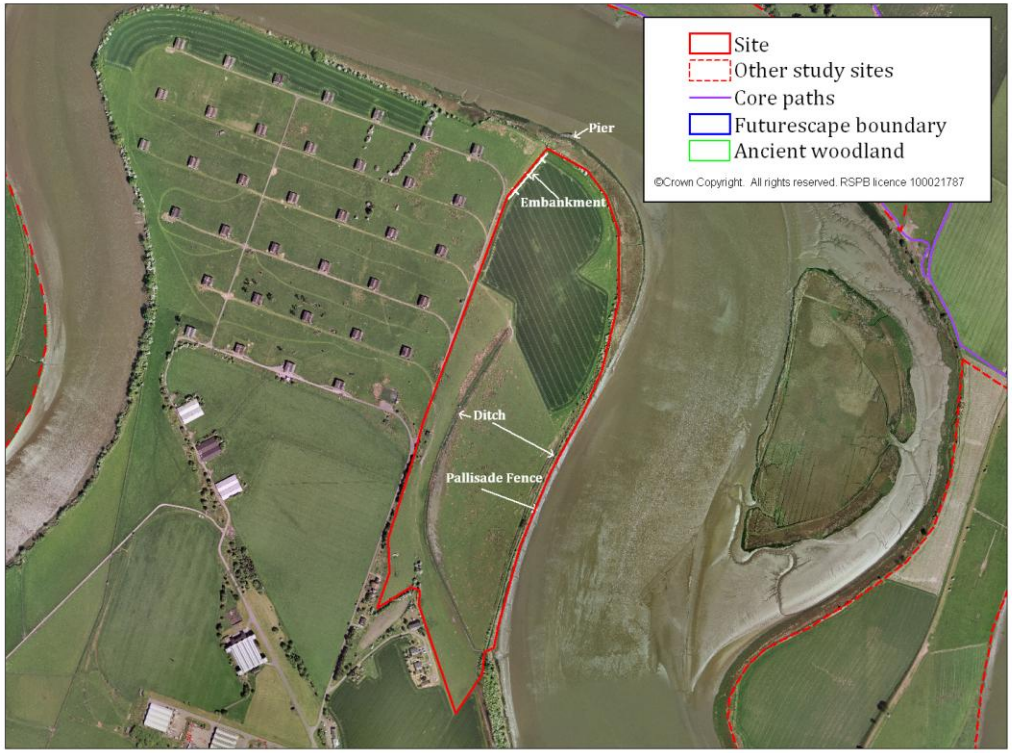


Figure 2: Overview of Bandeath

Figure 3 Palisade fence on top of embankment

Figure 4 View looking South East

An embankment located between a derelict pier and track serves to enclose the site at the northern end. A 700 m blind drainage ditch runs along the base of the elevated area from the southern end of the embankment to the boundary with the arablefield and is fed by water draining from the surrounding higher land. The ditch is fringed with common reed and reed sweet-grass and is fenced off, presumably to prevent access by livestock. This area floods during periods of high rainfall and during winter months.

A smaller, overgrown 780 m long ditch runs parallel to the embankment between the arable field to the southern end of the site. A further overgrown ditch crosses the site from south west to north east for 180 m. The southern area of the site is poorly drained and dominated by over 50% soft rush. The slope rising up from the wetter area comprises rank vegetation; mainly thistles. Immediately to the south of the site a stray dog pound is located and a fenced off derelict building lies on the eastern boundary with an underground building located in higher ground where the arable field is located.

The site is adjacent to the area designated as the Upper Forth Estuary as part of the River Basin Management Plan process, which covers 9.67 km^2 from Kincardine Bridge to Stirling on the south shore and from Stirling to Kincardine on the north shore. It has been classified as a Heavily Modified Water Body and as having Poor Ecological Potential with a current status as Pass.

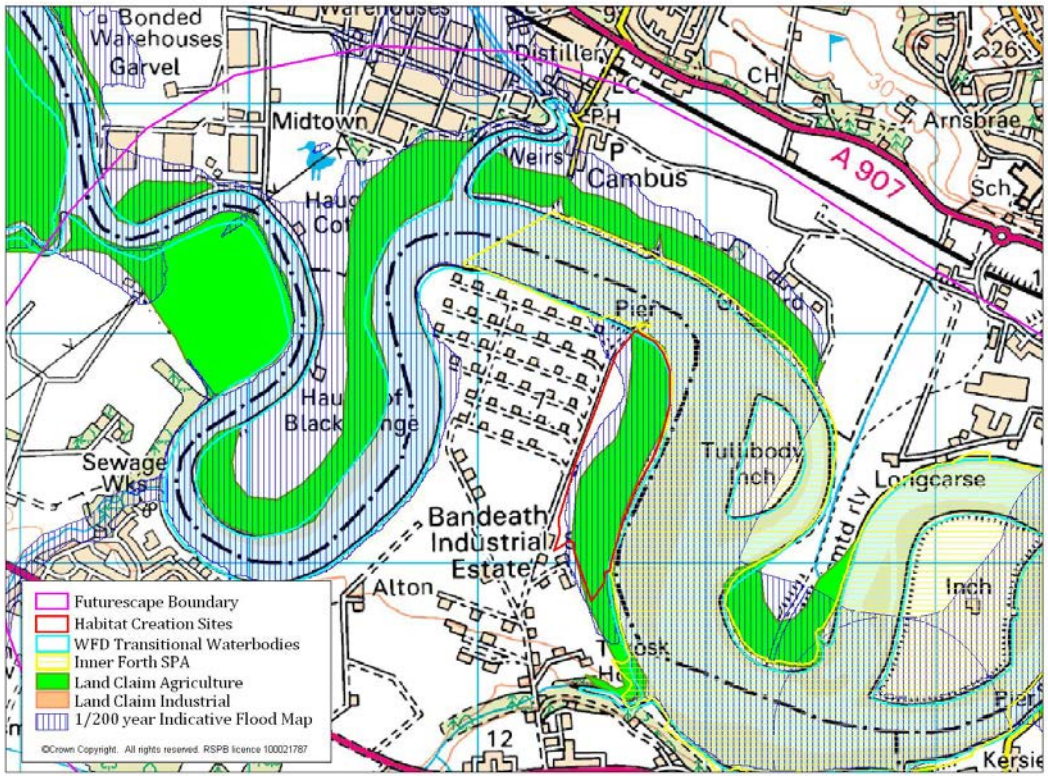


Figure 6: Land claim and flood risk at Bandeath

SEPA have established an ongoing programme of monitoring to identify pressures and measures which will protect or improve the status of water bodies in order that good status is achieved over successive RBMP cycles. Targets and environmental objectives have been set for the Upper Forth Estuary to maintain Poor ecological potential for the RBMP cycles in 2015 and 2021 with Good Ecological Status achieved by 2027. Pressures identified in the Upper Forth Estuary include morphological alterations in the form of historical land reclamation, point source pollution in the form of inputs and sewage treatment.

Figure 5 View from natural high ground looking east

The site is within a Potentially Vulnerable Area as identified within the National Flood Risk Assessment (The draft, 'Flooding in Scotland: A consultation on Potentially Vulnerable Areas and Local Plan Districts' published in June 2011, identifies areas for flood risk management planning) with flooding causing potential limited impacts to a small number of residential and commercial properties, transport links and agricultural land. The area has a medium rating in the flood risk category as assessed by infrastructure, historic flooding, groundwater, climate change and flood defences.

The Weighted Annual Average Damages to the area are estimated at over £700,000 (this figure gives an indicative estimate of direct costs to residential properties, non-residential properties and agriculture). The known source of flooding in the area is predominantly coastal at 40% with 39% from surface water and 21% from rivers.

Future Vision

The site at Bandeath will be a small but integral part of a larger wetland complex in the Inner Forth area. The site will be transformed into a high quality wetland with breeding and wintering waders and wildfowl using the site in good numbers. Habitat restoration and creation will enable the landscape and estuary to return to a more natural appearance and removal of the embankment will contribute to the Upper Forth water body achieving Good Ecological Potential by 2027.

Table 1: Site Summary

Site name	Bandeath
Location and Local Authority Area	Bandeath, Throsk, Stirling
Grid Reference	NS8592
Area	30 ha
Ownership	Stirling Council
Access	The area is accessed via Bandeath Industrial Estate from the A905. A surfaced track in poor condition runs along the western boundary linking with other tracks, which service the former ammunition stores. A rough track enters the site between the rough pasture and arable areas.
Buildings and services	There are several dilapidated buildings immediately adjacent to the site and an underground structure within the site.
Designations	None
Liabilities and health and safely issues	Potential ordnance present on site Possible asbestos contamination relating to adjacent buildings Dangerous buildings immediately adjacent Part of the site lies within the Coal Authority referral area and a coal mining report would be required as part of a detailed feasibility study.

Conservation – Current interest and potential

Little is known about the current conservation value of the site although the relatively large expanse of grazed grassland is attractive to kestrels, barn owls, lapwing, curlew and farmland species such as tree sparrow and yellowhammer.

The potential of the site lies with the development of the wetland habitats either through management of the existing habitats or by implementing a managed realignment project to create intertidal mud and saltmarsh.

Table 2: Habitats

Habitat	Current	Potential
Intertidal	0	10
Saltmarsh	0	5
Grassland	16	5

Current and potential bird numbers

There is little information of bird numbers at Bandeath but the grazed grassland and weedy areas prove attractive to curlew, lapwings and passerines such as starlings, goldfinches, tree sparrows and yellowhammers. The relative undisturbed nature of the area provides a roost site for waders and other species.

Other biodiversity

Little information is available on other biodiversity at Bandeath.

Management Activities and Options

The site at Bandeath is currently in agricultural use with an 8 ha arable field at the north of the site and a 11.5 ha wetter area to the south grazed by sheep. The sheep access the area via an open gate on the higher ground. The large ditch draining the wetter area has recently been cleared with the slubbings spread to the east of the ditch. It is unclear whether this ditch drains into the Forth at the southern end or whether it is a blind ditch, storing water in times of high rainfall. The vegetation in the wetter area is dominated by soft rush and appears to be lightly grazed by the sheep who seem to prefer the higher ground. In the short-term, there is considerable potential at Bandeath for creation and enhancement of wetland habitat through vegetation and water management control plus creation of shallow pools and scrapes within the current area of wet grassland. Introduction of a more intensive grazing regime preferably using cattle would be advantageous. Despite the limited size, the enhanced area would be attractive to breeding waders and provide a relatively undisturbed feeding and roosting site.

In the long-term, the area fits the criteria for a managed realignment scheme involving partial or complete removal of the embankment, although the cost of implementing such a scheme at this location would be extremely expensive, given the size and scale of the embankment and amount of material which would be required to be removed from the site. The flood management benefits gained from a managed realignment scheme at Bandeath may be of limited value and this may dictate the outcome of any decision to be made regarding the potential viability of a managed realignment project, although this could proceed as part of a future area wide strategy.

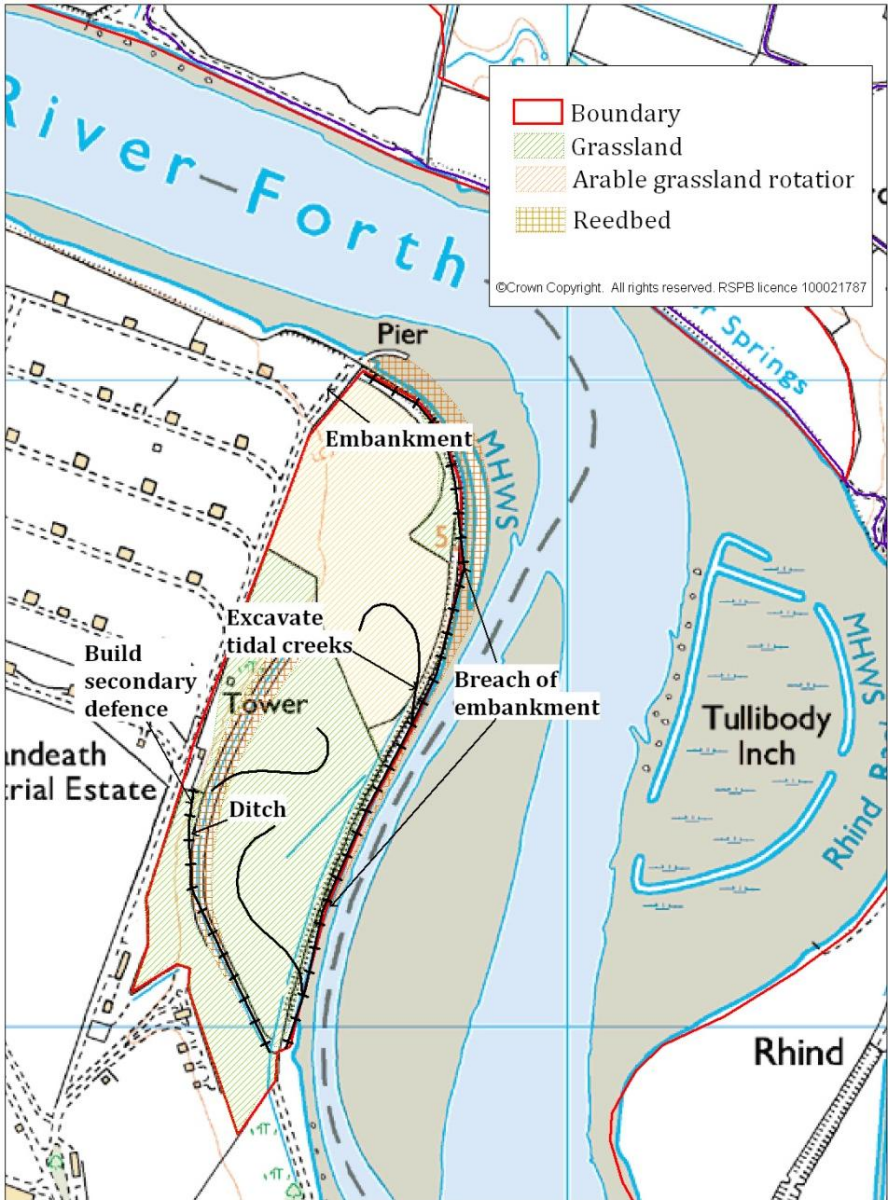


Figure 6. Current habitat and proposed management

Table 3: Options Available for Future Management

	Option A – Do Nothing	Option B – Maintain Embankment	Option C - Habitat Enhancement and Creation	Option D - Managed Realignment
Description	No change to current management.	Maintenance and repair embankment	Freshwater habitat creation and enhancement	Managed realignment involving one or two breaches or complete removal of embankment
Works needed	n/a	The condition of the embankment is relatively good therefore unlikely to require much work.	Hydrological management works as determined by results of ecological, hydrological and geomorphological surveys – earthworks, ditch clearance, installation of water control structures. Vegetation control – mechanical or by grazing – install or relocate necessary infrastructure eg fencing, crossing points, watering facilities for livestock.	Embankment removal, earth moving, rubble and waste removal, tree removal, re-grading of material into field possible construction of secondary defence if necessary.
Constraints	n/a	n/a	The area is within a Coal Authority Development Referral Area and would require a non-residential mining report from the Coal Authority before any works or investigations commenced. Potential ordnance present on site Possible asbestos contamination	The area is within a Coal Authority Development Referral Area and would require a non-residential mining report from the Coal Authority before any works or investigations commenced. Potential ordnance present on site Possible asbestos contamination

			relating to adjacent buildings Dangerous buildings immediately adjacent	relating to adjacent buildings Dangerous buildings immediately adjacent
Site assessment needed	n/a	Assessment of condition of embankment	Detailed ecological, topographic, hydrological and geomorphological assessments will be needed to inform future habitat creation and management including assessment of current water control system. Baseline ecological information including invertebrate and botanical interest. Flood risk assessment focusing on embankment	A full feasibility report including a study of the effects of a managed realignments scheme in the area, technical feasibility, future management and monitoring, and economic implications (cost benefit analysis) A managed realignment / management plan detailing works proposed should be drawn up including all work prior to construction, follow up works and monitoring required A geotechnical investigation regarding material for secondary defence/ embankment fill and a local drainage study would be necessary.
Timescale	n/a	Ongoing	Within 5 years	10 - 20 years
Demonstration site potential	n/a	n/a	The site would be a good location on the north shore of the Inner Forth to develop understanding and build awareness of landscape scale conservation and wetland creation to local communities, statutory agencies.	The site would be an good location on the north shore of the Inner Forth to develop understanding and build awareness of landscape scale conservation and flood management/ managed realignment to local communities and decision makers.

Threats to conservation interest/ potential	n/a	n/a	New developments, unplanned flood events, change in land use which may compromise future opportunities.	New developments, unplanned flood event, change in land use which may compromise future opportunities.
Consents required	n/a	As the area is adjacent to the SPA any works would require consent from SNH SEPA regarding RBMP Marine Scotland re FEPA licence	Works would require a Scoping report, Environmental Impact Assessment, Appropriate Assessment and full planning consents. A CAR licence may be required. As the site is adjacent to an SSSI and SPA, consent would be required from SNH for any works and it is envisaged that SNH would be involved in the planning, development and management of the project	Works would require a Scoping report, Environmental Impact Assessment, Appropriate Assessment and full planning consents. A FEPA licence may be required for works in the marine environment. As the site is adjacent to an SSSI and SPA, consent would be required from SNH for any works and it is envisaged that SNH would be involved in the planning, development and management of the project.
Capital costs	n/a	In the long-term, the costs of upgrading and repairing the embankment to provide a recommended standard of protection could be considerable and would be borne by	The costs of implementing a freshwater habitat creation scheme would be relatively low as desired habitat enhancements could be carried out by standard agricultural operations – vegetation control, grazing and creation of shallow pools.	Capital costs will involve removal (or partial removal) of existing embankment and regrading of material into fields, possible enhancement of secondary defence, provision of new drainage structures, land purchase and associated legal costs.

		the landowner unless carried out as a grant-aided flood defence scheme. Cost = medium/high	Cost = low	Cost = medium
Establishment costs	n/a	n/a	Design of scheme, manufacture of water control structures, and staff time.	Design of scheme, manufacture of water control structures, specialised machinery and staff, included in cost above
Management costs	n/a	Inspection, maintenance and repair costs	Ideally the project will be designed to minimise future management requirements other than routine maintenance of drainage control structures and vegetation control. A monitoring programme to evaluate the outcome of the project would be necessary over at least 5 years and at appropriate intervals beyond	Ideally the project will be designed to minimise future management requirements other than routine maintenance of drainage control structures, secondary defences and any other earthworks. A monitoring programme to evaluate the outcome of the project would be necessary over at least 5 years and at appropriate intervals beyond
Immediate actions required	n/a	n/a	See constraints	See constraints
Funding opportunities	n/a	Individual landowner.	Funding streams may come from local and national industrial concerns, trusts, statutory agencies and European sources	Funding streams may come from local and national industrial concerns, trusts, statutory agencies and European sources

Access and Interpretation Opportunities

There is no formal access to Bandeath other than the existing roads and tracks used by vehicles related to the industrial and business premises in the area. There is currently no interpretation but given the historical significance of the area, there is great potential to create low key interpretation and signage at key points.

Table 4: Current and potential access and interpretation

Facility	Current	Potential
Footpath	No formal footpaths but network of roads throughout adjacent area	Circular route around entire area
Vehicular	Vehicle access via existing roads and tracks on adjacent area	No change
Interpretation	None	Low key information on project and wildlife
Signage	Directional fingerposts	High quality functional themed signage

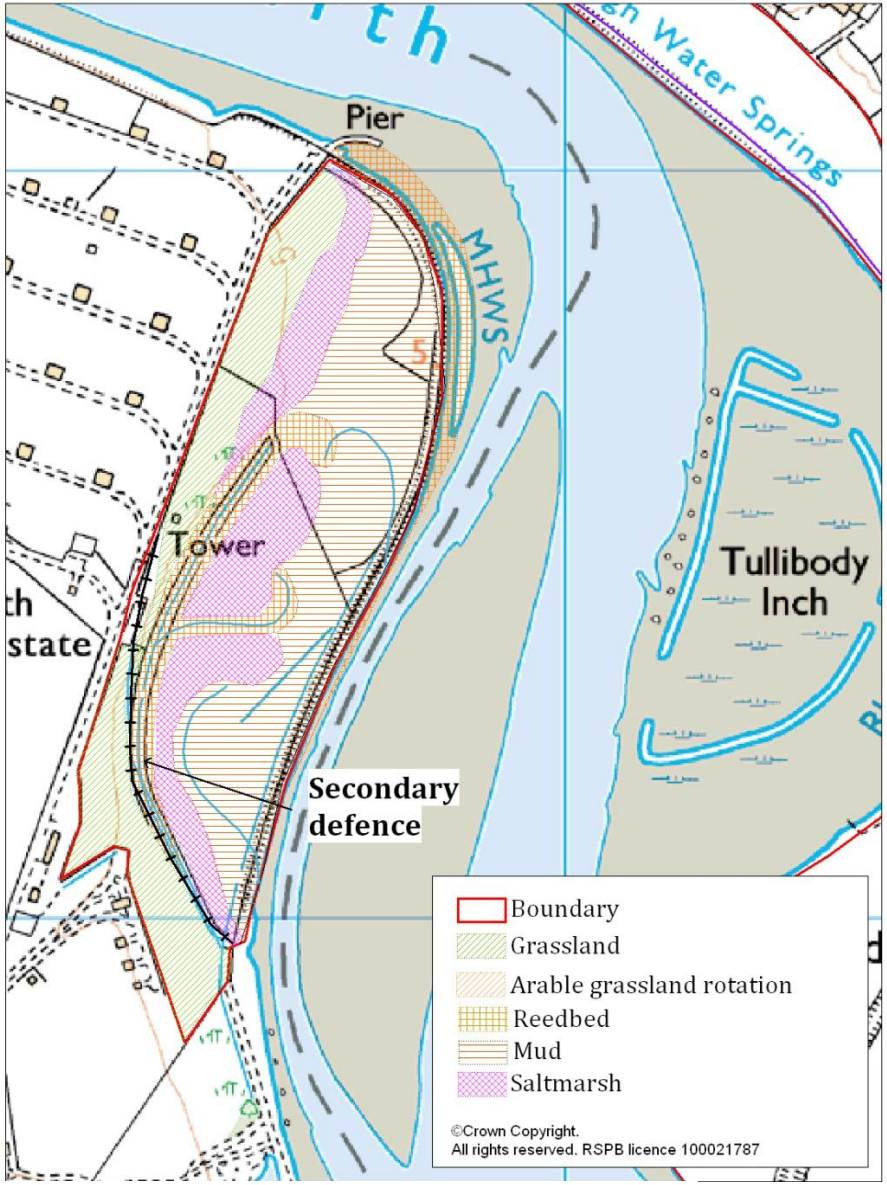


Figure 7 : Outcome map for Bandeath

Recommendations

This is an interesting site with potential for either the creation of freshwater habitats and wet grassland or a small managed realignment project. In the long-term a managed realignment scheme would be the most sustainable option as sea level rise and pressure to implement flood management schemes in the Inner Forth arise in the future but costs relating to the removal or breaching of the embankment may prove prohibitive.

Table 5: Options Appraisal

Strengths				**Weaknesses**			
Option A	**Option B**	**Option C**	**Option D**	**Option A**	**Option B**	**Option C**	**Option**
n/a	Increased short-term flood protection in local area. Maintenance of agricultural production	Low cost Habitat gains	Meets managed realignment criteria Contribution to Flood risk management Enhance SSSI & SPA features Provide additional feeding, breeding and roosting areas for birds	Unsustainable in long-term	High cost to landowner Maintenance/ repair costs Maintain conditions leading to coastal squeeze	Increased opportunity for disturbance.	High initial cost Relative benefit re cost Small size of area
Opportunities				**Threats**			
Option A	**Option B**	**Option C**	**Option D**	**Option A**	**Option B**	**Option C**	**Option D**

n/a	n/a	Community involvement Increased public access	Community involvement Increased public access Develop saltmarsh grazing	n/a	n/a	n/a	Landowner and community concerns

Appendix 7: Haugh of Blackgrange Site Assessment

Introduction

This site assessment has been produced following a desktop review of available information, site visits and initial discussions with stakeholders and land managers. The recommendations made are based on current knowledge. Further consultation with communities and landowners and detailed technical assessments will be required to develop and confirm proposals.

Site Description

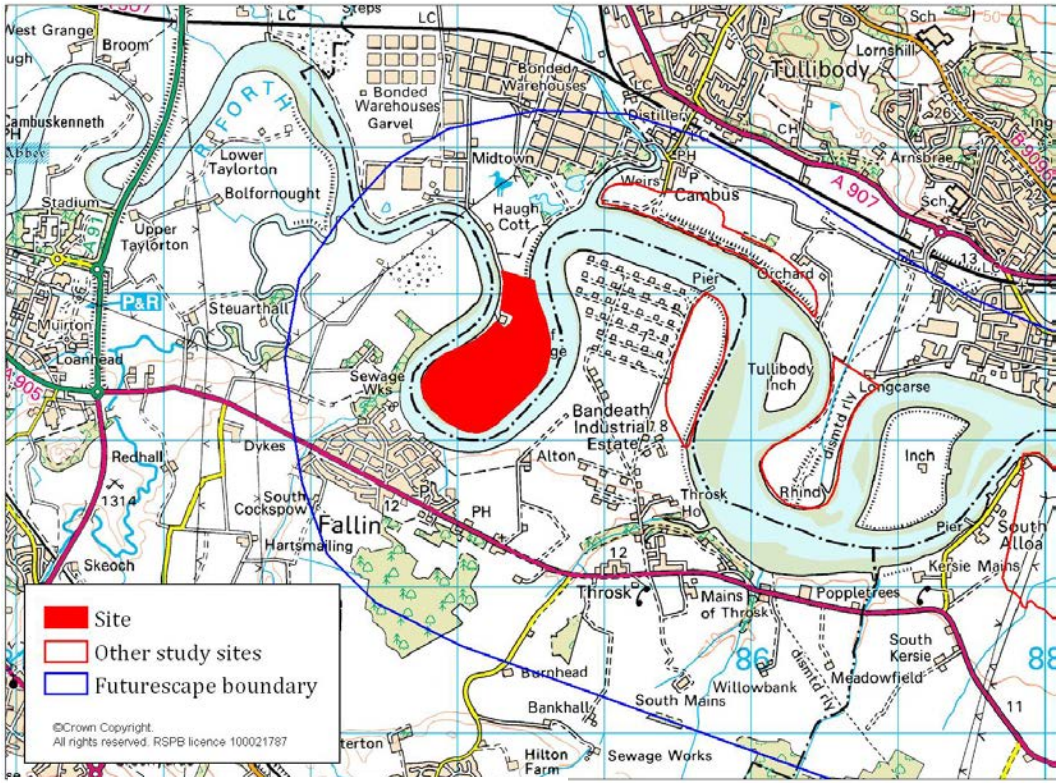


Figure 1: Location of Haugh of Blackgrange

The Haugh of Blackgrange is a large, low-lying area of reclaimed embanked intertidal marsh, contained within a meander loop on the north bank of the Forth, west of the confluence of the River Devon and the Forth and south of the Diageo bonded warehouse complex and poultry farm.

The area has an isolated, dramatic and wild feel with a backdrop of the Ochil Hills to the north and the Gargunnock hills to the west yet Stirling is only 4.5 km to the east, Alloa 4.5 km to the west with the village of Fallin immediately opposite on the south bank of the river.

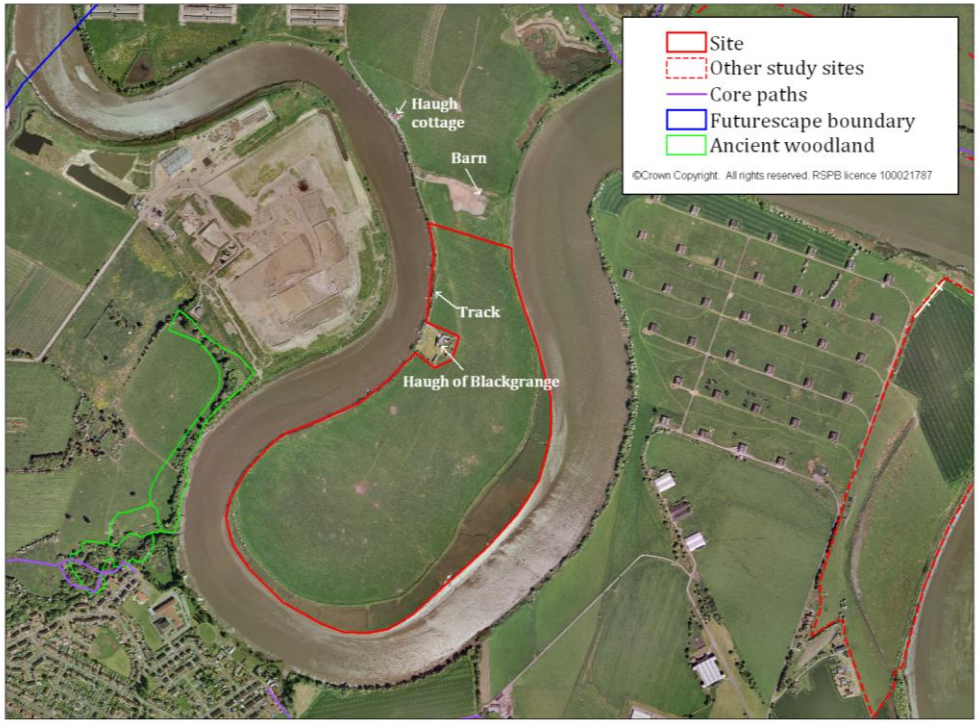


Figure 2: Overview of Haugh of Blackgrange

Figure 3: Haugh of Blackgrange looking north east

Figure 4: New barn and access track

To the north east of the site is the Scottish Wildlife Trust's (SWT) Cambus Pools nature reserve, consisting of reedbed, brackish pools, scrub and wet grassland. The area is almost entirely in agricultural production (oats and rape in 2011) with two residencies, Haugh Cottage and Haugh of Blackgrange, located on the western shore of the Haugh.

A recently constructed barn, accessed via a track from Haugh Cottage with an extensive area of hard standing reclaimed from a wet area of the Haugh is located towards the western edge of the neck of the Haugh at NS844932.

The embankment surrounding the Haugh originates at the north bank of the River Devon at Cambus and is continuous until 500 m south of the Haugh of Blackgrange farmhouse, where it joins a raised access track. The embankment lies at 4 m OD but has several low points particularly on the southern edge and has been crudely reinforced with building waste and rubble in places. There is evidence of erosion and subsequent reinforcement work in two places on the eastern shore of the Haugh. A track runs parallel to the embankment from the site of the recently constructed barn and continues around the southern edge of the Haugh.

The 5 m contour, which coincides with a high terrace, runs from south of the bonded warehouse complex, traverses the neck of the Haugh just north of Cambus Pools and continues to south of the poultry farm in the east. A lower carse cliff line at 3.5 m OD occurs along

the western edge of the Haugh to 500 m south of the Haugh lies below this level.

The 2009 Ordnance survey map shows several pools at the south eastern corner of the Haugh but no evidence of these pools was noted and it is assumed drainage work or infilling had taken place. On the river side of the embankment and almost surrounding the Haugh is a fringe of intertidal reedbed and mud, with the reedbed at the southern end being most extensive.

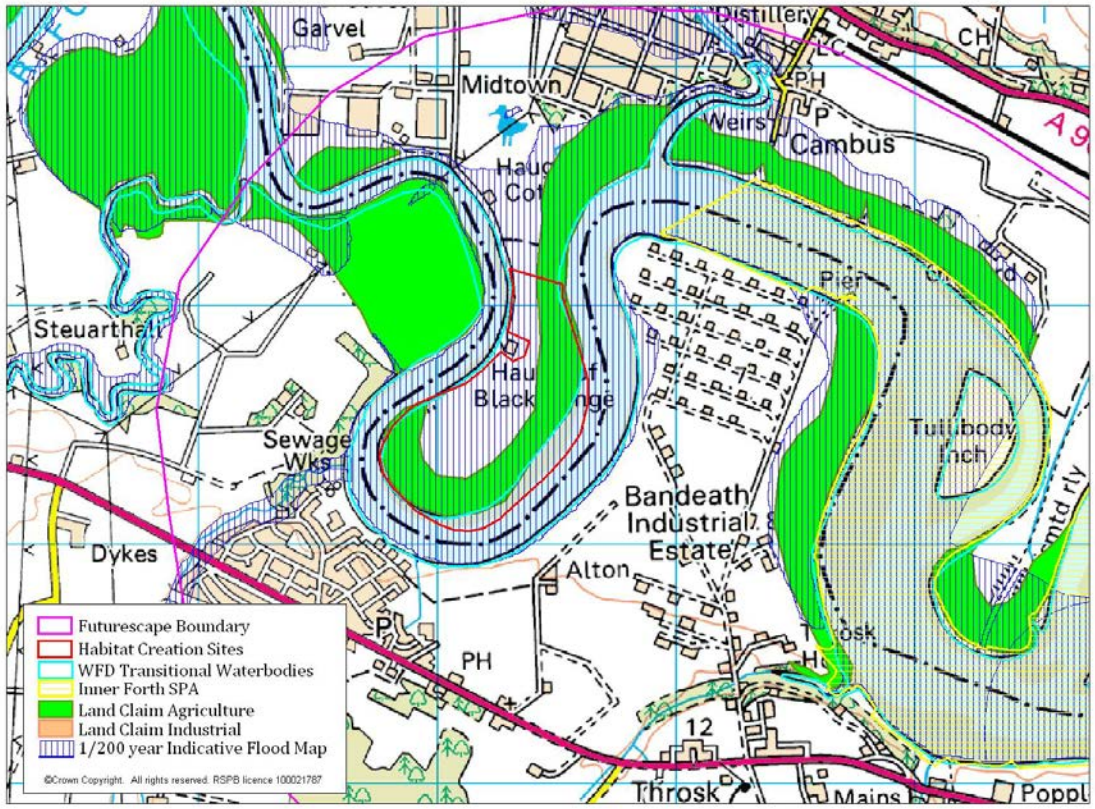


Figure 6: Land claim and flood risk at Haugh of Blackgrange

Figure 5: Site of breach, East side Haugh of Blackgrange

At the eastern neck of the Haugh, between the access track from the barn and the embankment and south west of the SWT Cambus Pools reserve, is an area of improved grassland, which is currently grazed and is obviously poorly drained. Remedial work to the drainage system was in progress in July and August 2011.

The site is adjacent to the area designated under the River Basin Management Planning (RMBP) process as the Upper Forth Estuary, which covers 9.67 km^2 from Kincardine Bridge to Stirling on the south shore and from Stirling to Kincardine on the north shore. It has been classified as a Heavily Modified Water Body with Poor Ecological Potential, with a current ecological status of Poor and an overall chemical status of Pass.

SEPA have established an ongoing programme of monitoring to identify pressures and measures, which will protect or improve the status of water bodies in order that good status is achieved over successive RBMP cycles. Targets and environmental objectives have been set for the Upper Forth Estuary to maintain Poor ecological potential for the first, second and third RBMP cycles, with Good Ecological Status achieved by 2027. Pressures identified in the Upper Forth Estuary include morphological alterations in the form of historical land reclamation, point source pollution in the form of inputs and sewage treatment.

Figure 6: Reedbed, Haugh of Blackgrange

Figure 7: Phragmites fringing River Forth, Haugh of Blackgrange

Figure 8: Drainage works Cambus/ Haugh of Blackgrange

The site is within a Potentially Vulnerable Area as identified within the National Flood Risk Assessment (The draft, 'Flooding in Scotland: A consultation on Potentially Vulnerable Areas and Local Plan Districts' published in June 2011, identifies areas for flood risk management planning) with flooding causing potential limited impacts to a small number of residential and commercial properties, transport links and agricultural land. The Weighted Annual Average Damages to the area are estimated at over £5 million (this figure gives an indicative estimate of direct costs to residential properties, non-residential properties and agriculture). The known source of flooding in the area is predominantly river at 70% with 13% from surface water and 17% from coastal.

Future Vision

The Haugh of Blackgrange is an extensive area of intertidal and wetland habitat providing a high quality and undisturbed area for feeding and roosting waders and wildfowl, providing a key link in a complex of sites along the Inner Forth. The site complements and adds to the conservation interest in the area, including the nearby Scottish Wildlife Trust's Cambus Pools reserve immediately to the north, Tullibody and Alloa Inches further downstream and other managed realignment sites in the area. The resulting area of

wetland habitat helps offsets the effects of climate change and contributes to flood management and achieving Good Ecological Potential by 2027 by removing morphological pressures. The site has been carefully developed and managed in a partnership with landowners and other conservation bodies with local community involvement including schools. The river and its newly developed and expanded habitats has become an integral feature of the area and a source of community pride. Footpaths and interpretation have been developed, allowing people to explore more of the landscape.

Table 1: Site Summary

Site name	Haugh of Blackgrange
Location and Local Authority Area	Haugh of Blackgrange, Cambus, Clackmannanshire
Grid Reference	NS8492
Area	41.7 ha
Ownership	Private
Access	Footpath from Cambus starting at north bank of River Devon. Access track to Haugh of Blackgrange Farmhouse via single track road at Midtown Industrial Estate, Blackgrange
Buildings and services	Building at Haugh of Blackgrange Farmstead at the western edge of the Haugh. Haugh cottage lies immediately to the north of the Haugh Services to Haugh of Blackgrange
Designations	None
Liabilities and health and safety issues	The area is within a Coal Authority Development Referral Area and would require a non-residential mining report from the Coal Authority before any works or investigations commenced. There appears to have been mining activity in the area below the Haugh. Giant Hogweed present amongst *phragmites* at eastern side of Haugh, south of farmhouse

Conservation Interest and Potential

The area is in agricultural production, mostly arable crops, with a small herd of beef cattle grazing an area at the neck of the Haugh to the east of Haugh Cottage.

The area is currently of conservation interest, as it supports locally significant numbers of feeding pink-footed geese and is a feeding and roosting area for waders, especially curlew and lapwing, which are present in large flocks during the winter months. Breeding

birds using the reedbeds include water rail, sedge warbler and reed bunting. The reedbeds may also be used as a staging post by migrating passerines and as a roost by hirundines and wintering passerines. Several other species of geese have frequented the Haugh in recent years in small numbers, including barnacle, white-fronted and the only record of red-breasted goose (a rare vagrant to the UK) in the Upper Forth recording area in February and April 2007.

The embankment and the area between it and the access track is well vegetated with ruderal plant species, arable weeds and isolated small hawthorn and elder trees providing habitat for butterflies and other invertebrates. Immediately beyond the embankment lies an extensive stand of *phragmites* reedbed, which extends almost continuously from the riverbank at Cambus to the Haugh of Blackgrange farmhouse, covering an area of approximately 6 ha.

The development of intertidal, wetland and reedbed habitat at Haugh of Blackgrange via a managed realignment scheme would prove attractive to wildfowl, waders and passerines and considerably enhance and safeguard the conservation value of the site.

Table 2: Habitats

Habitat	**Current**	**Potential**
Intertidal mud	0	20 ha
Saltmarsh	0	10 ha
Reedbed	6 ha	8 ha

Table 3: Current and potential bird numbers

Species	**Current**	**Potential**
Breeding (prs)		
Water rail	Present	Increase
Sedge warbler	Present	Increase
Reed bunting	Present	Increase
Wintering		
Pink-footed goose	Present	Maintain
Lapwing	111 (Nov 08); 260 (Feb 07)	Increase
Curlew	256 (Nov 08); 450 (Mar 07)	300
Potential colonists		

Bittern	Potential wintering
Bearded tit	Potential breeding if area of reedbed increased
Twite	Possible wintering if saltmarsh extended

Table 4: Other biodiversity

Species	Current	Potential
Otter	Present	Increase
Brown hare	Present	Increase
Water Vole	Status unknown	Establish or increase

Figure 9 & 10:Building waste dumped in reedbed and on access track, Haugh of Blackgrange

Figure 11 Drainage at boundary with Cambus Pools

Management Activities and Options

The area is currently in agricultural production mainly cultivation of cereals with two extensive fields of oil-seed rape and oats being grown in 2011. There is an area of improved grassland at the north eastern end of the Haugh currently being grazed by cattle and in previous years when the Haugh was under a grass lay it was grazed by sheep. The embankment is actively maintained, albeit crudely with rubble and waste material dumped at several locations along its length.

There is potential at the site to develop freshwater and brackish wetland habitats utilising existing drainage systems and a sluice mechanism to allow a controlled amount of saline water from the river to enter the Haugh supplying a network of ditches, which

would feed shallow scrapes and pools. This would create a mosaic of scarce habitats, which would prove attractive to wildfowl and waders and would maintain an area in arable/ grassland production.

Given the location and physical characteristics of the site, the area would be suitable for a managed realignment scheme involving partial or complete removal of the embankment to allow the river to flood the Haugh. The topography of the site suggests allowing the river to flood the southern area of the Haugh up to the low terrace, which crosses the site may require construction of a secondary defence for Haugh of Blackgrange Farmhouse. Haugh Cottage would be adequately protected by the raised access track to the barn on the eastern side of the Haugh.

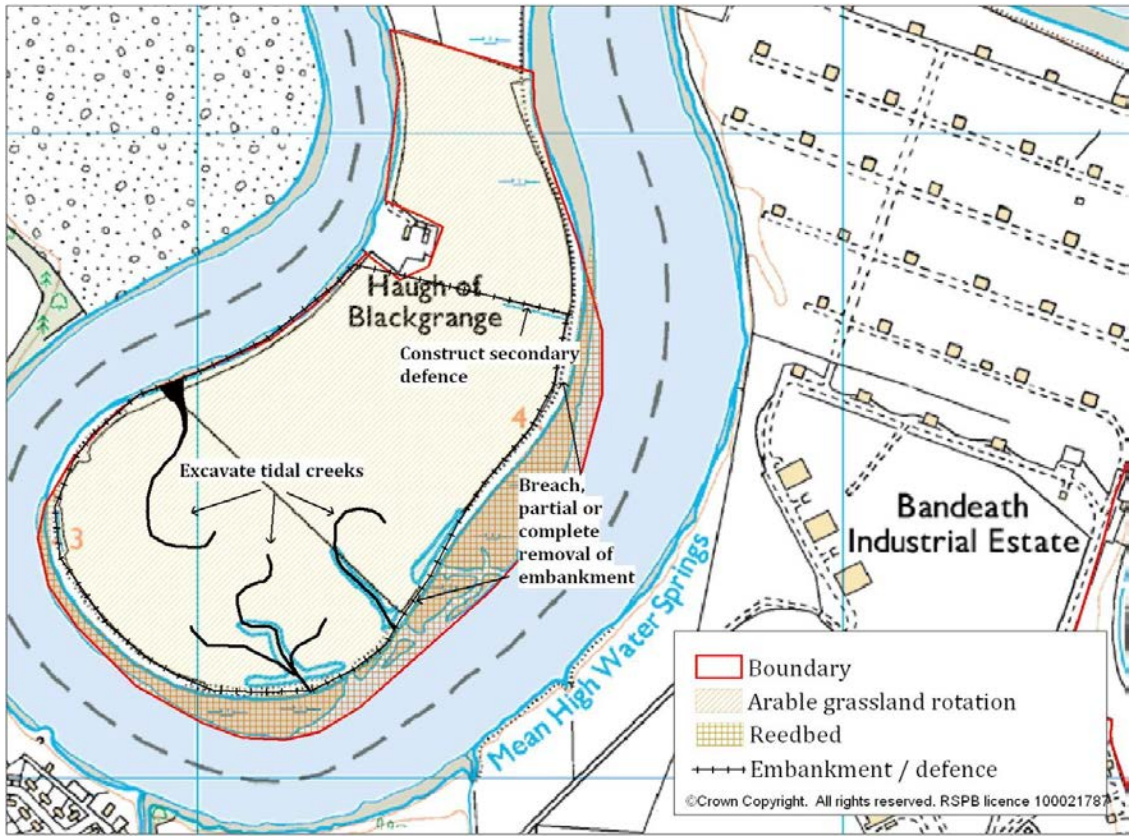


Figure 12 Current habitats and proposed habitat management

A managed realignment scheme would result in development of intertidal habitats at the site and an expansion of reedbed as previously identified in the GeoWise report. There is sufficient salinity at this point in the river plus saltmarsh plants in the vicinity to enable development of saltmarsh on the Haugh. With sea level rise and corresponding salinity increase , estuarine flora and fauna will be likely to move upstream in the future,. The extent of habitat created would be determined by a detailed feasibility study and particular care would have to be taken to ensure the extensive area of reedbed and area used by waders and geese are not compromised. The value of winter stubbles should be recognised and some form of spring sown arable cultivation could be maintained or developed. There would be potential for grazing livestock on higher marsh areas once initial works are completed and habitats established.

Table 5: Options Available for Future Management

	Option A – Do Nothing	Option B – Maintain Embankment	Option B – Habitat Enhancement and Creation	Option C – Managed Realignment
Description	No active management	Maintain, repair and upgrade embankment	Freshwater/ wet grassland/habitat creation and enhancement.	Managed realignment
Works needed	n/a	Remedial and repair work will be required to upgrade and raise embankment to provide the recommended level of protection to the surrounding area eg 1:250 year flood event	Hydrological management works as determined by results of ecological, hydrological and geomorphological surveys – earthworks, ditch clearance and construction, installation of water control structures within embankment. Repair and upgrade of embankment, Installation or relocation of necessary infrastructure eg fencing, crossing points, watering facilities for livestock.	Removal or breach of earth embankment, earth moving, re-grading of material into fields or off-site, construction of secondary defence, re-instatement of creek system if appropriate, relocation of control structures if necessary.
Constraints	n/a	n/a	The three buildings on site would all be in the immediate vicinity of the project site. Haugh of Blackgrange is mentioned on the Royal Commission on the Ancient and Historical Monuments of Scotland, Canmore website in	The three buildings on site would all be in the immediate vicinity of the project site. Haugh of Blackgrange is mentioned on the Royal Commission on the Ancient and Historical Monuments of

			relation to a Haugh Cottage, Haugh of Blackgrange Farmstead and rig and furrow markings noted during an aerial survey in 1996.	Scotland, Canmore website in relation to a Haugh Cottage, Haugh of Blackgrange Farmstead and rig and furrow markings noted during an aerial survey in 1996.
Site assessment needed	n/a	Assessment of condition of embankment	A full feasibility report including a study of the effects of a wetland creation scheme in the area, technical feasibility, future management and monitoring, and economic implications (cost benefit analysis). A management plan detailing works proposed should be drawn up including all work prior to construction, follow up works and monitoring required. A geotechnical investigation regarding material for secondary defence and a local drainage study would be necessary. Baseline ecological information would be required.	A full feasibility report including a study of the effects of a managed realignments scheme in the area, technical feasibility, future management and monitoring, and economic implications (cost benefit analysis). A managed realignment / management plan detailing works proposed should be drawn up including all work prior to construction, follow up works and monitoring required. A geotechnical investigation regarding material for secondary defence/ embankment fill and a local drainage study would be necessary.

			A flood risk assessment would be necessary.	Baseline ecological information would be required. A flood risk assessment would be necessary.
Timescale	n/a	Immediately	5 – 10 years	20 -30 years
Demonstration site potential	n/a	n/a	Haugh of Blackgrange would be an ideal location on the north shore of the Inner Forth to develop understanding and build awareness of landscape scale conservation and wetland creation to local communities, statutory agencies, MSP's	Haugh of Blackgrange would be an ideal location on the north shore of the Inner Forth to develop understanding and build awareness of landscape scale conservation and wetland creation to local communities, statutory agencies, MSP's
Threats to conservation interest/potential	n/a	n/a	New developments involving renewable energy on or nearby, flood events may damage short-term repairs to embankment and loss of habitat creation opportunities from possible inappropriate subsequent works and change in land use may compromise future opportunities.	New developments involving renewable energy on or nearby, flood events may damage short-term repairs to embankment and loss of habitat creation opportunities from possible inappropriate subsequent works, change in land use which may compromise future opportunities.

Consents required	n/a	Initial consultation with local planners would determine planning consent requirements. As the site is adjacent to a SSSI and SPA, consent would be required from SNH for any works. SEPA regarding RBMP Marine Scotland re FEPA licence	Depending on the scale of proposed habitat creation, works would require a Scoping report, Environmental Impact Assessment, Appropriate Assessment and full planning consents. A CARS/ FEPA licence may be required. As the site is adjacent to an SSSI and SPA, consent would be required from SNH for any works and it is envisaged that SNH would be involved in the planning, development and management of the project. A full public consultation would be required and communications plan produced.	Works would require a Scoping report, Environmental Impact Assessment, Appropriate Assessment and full planning consents. A FEPA licence may be required for works in the marine environment. As the site is adjacent to an SSSI and SPA, consent would be required from SNH for any works and it is envisaged that SNH would be involved in the planning, development and management of the project. A full public consultation would be required and communications plan produced.
Capital costs	n/a	The costs of upgrading and repairing the embankment could potentially be considerable and would be borne by the landowner unless carried out as a grant-aided flood defence scheme. Costs = medium	Capital costs will involve repair and upgrade of existing embankment, earthworks to create scrapes and pools, provision of new drainage structures, land purchase and associated legal costs. Cost = Low	Capital costs will involve removal of existing embankment and regrading of material, construction of secondary defence, provision of new drainage structures, land purchase and associated legal costs. Cost = medium.

Set up costs	n/a	n/a	Design of scheme, manufacture of water control structures, machinery and staff time, >£50k.	Design of scheme, manufacture of water control structure if necessary
Management costs	n/a	Inspection, maintenance and repair costs.	Ideally the project will be designed to minimise future management requirements other than routine maintenance of drainage control structures. A monitoring programme to evaluate the outcome of the project would be necessary over at least 5 years and at appropriate intervals beyond.	Ideally the project will be designed to minimise future management requirements other than routine maintenance of drainage control structures, secondary defences and any other earthworks. A monitoring programme to evaluate the outcome of the project would be necessary over at least 5 years and at appropriate intervals beyond.
Immediate actions required	n/a	Assessment of embankment	See constraints	See constraints
Funding opportunities	n/a	Individual landowner.	Funding may come from local and national industrial concerns, trusts, statutory agencies and European sources.	Funding may come from local and national industrial concerns, trusts, statutory agencies and European sources.

Access and Interpretation Opportunities

The Haugh of Blackgrange can be accessed via a single track road in Midtown, which leads to Haugh Cottage and Haugh of Blackgrange Farmhouse. A track leads off the road towards the barn at the eastern edge of the Haugh before continuing around the landward side of the embankment. A Core Path (Cambus/ Blackgrange 26) originates in Cambus at the Bonded Warehouse complex on the north bank of the River Devon and follows a riverside route overlooking the SWT reserve at Cambus Pools, before carrying on northwards along a raised path toward the warehouses. The footpath is obviously maintained along its length until it reaches the boundary of Cambus Pools and the Haugh. From here it continues along the riverbank on the western shore of the Haugh and then follows a rough track until it meets the access track leading from the barn. This continues around the Haugh but is little used.

Figure 13: Access track

There is an opportunity to develop a footpath in the area but it would have to be designed and managed sensitively in order to minimise disturbance to birds, ensure it does not become a constraint to any future management options on the site and in accordance with the needs of residents and land managers. Access from Cambus Pools could be enhanced with a loop utilising existing paths and development of a new path traversing the Haugh joining up with the access track from Midtown.

There is no interpretation in the area except for the SWT signage at Cambus Pools.

Table 6: Current and Potential Access and Interpretation

Facility	Current	Potential
Footpath	3.5km	3.5km
Vehicular	1km	No change
Signage (directional)	One signpost at Cambus	Quality branded signage
Interpretation	None	Low key managed realignment info & bird identification panels

Recommendations

With predicted sea level rise and increased rainfall leading to increased chance of flood events, Option A is unsustainable in the long-term with any flood events having potentially serious consequences for land, property and infrastructure in the area should existing embankment fail : Option B requires a significant investment on behalf of the landowner and is entirely dependant on goodwill and financial ability. Flood management in the Inner Forth requires a strategic and equitable approach which this option doesn't provide.

The Haugh of Blackgrange offers habitat creation and flood management possibilities. A freshwater/ brackish habitat creation scheme would be advantageous in terms of cost and conservation benefits but contribution to flood management or WFD targets would be limited. The long-term viability and sustainability of a freshwater habitat creation scheme would be in doubt as sea level rise would necessitate costly maintenance and upgrade of the embankment for decades.

A managed realignment scheme would be the most cost effective, sustainable option and would 'futureproof' the area. It would also result in the creation of scarce habitats, while contributing to the wider landscape scale conservation objectives, flood management and RBMP/ WFD targets.

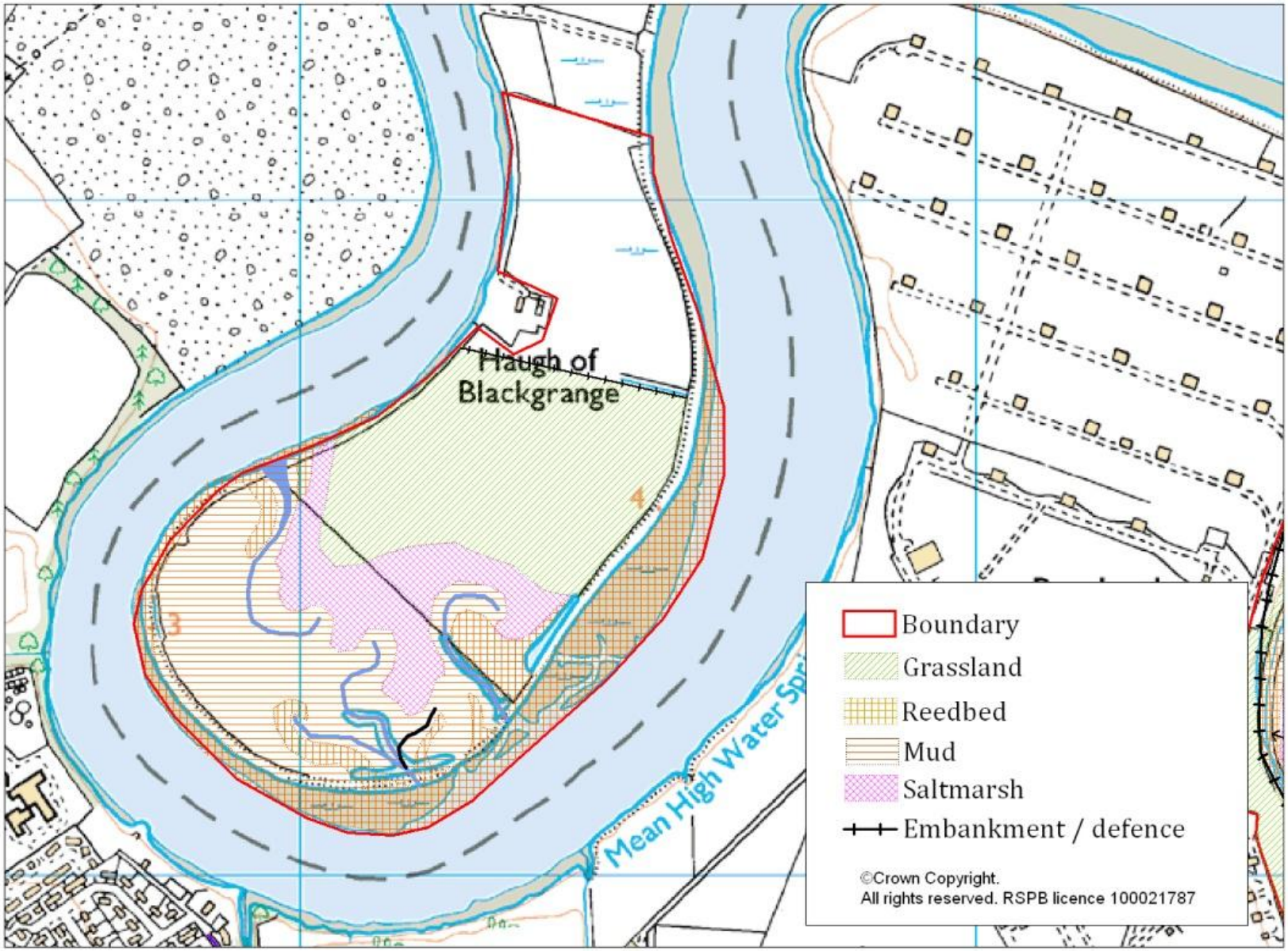


Figure 14 : Outcome map for Haugh of Blackgrange

Table 7: Options Appraisal

Strengths				Weaknesses			
Option A	**Option B**	**Option C**	**Option D**	**Option A**	**Option B**	**Option C**	**Option D**
n/a	Increased short-term flood protection in local area. Maintenance of agricultural production/ grazing Existing interest maintained	Positive public/ community perception more likely	Fits MR criteria Maximum contribution to estuarine functionality Reduced long-term maintenance costs Flood risk management Contribute to WFD Maximise habitat creation	Unsustainable in long-term Leaves site vulnerable to unplanned events eg flooding	Unsustainable in long-term Potential cost to landowner Maintenance/ repair costs Maintain conditions leading to coastal squeeze	Unsustainable in long-term Site vulnerable to unplanned events eg flooding	High initial cost Possible impact on existing habitats & conservation interest Loss of agricultural production/ grazing
Opportunities				**Threats**			
Option A	**Option B**	**Option C**	**Option D**	**Option A**	**Option B**	**Option C**	**Option D**
n/a	n/a	Community involvement Development of visitor	Community involvement Development of visitor	n/a	n/a	Landowner and community concerns	Lack of funding Landowner and

		infrastructure Development of demonstration & study site	infrastructure Development of demonstration & study site Links with SWT reserves				community concerns Consents re, planning Access issues

Appendix 8: Cambus Site Assessment

Introduction

This site assessment has been produced following a desktop review of available information, site visits and initial discussions with stakeholders and land managers. The recommendations made are based on current knowledge. Further consultation with communities and landowners and detailed technical assessments will be required to develop and confirm proposals.

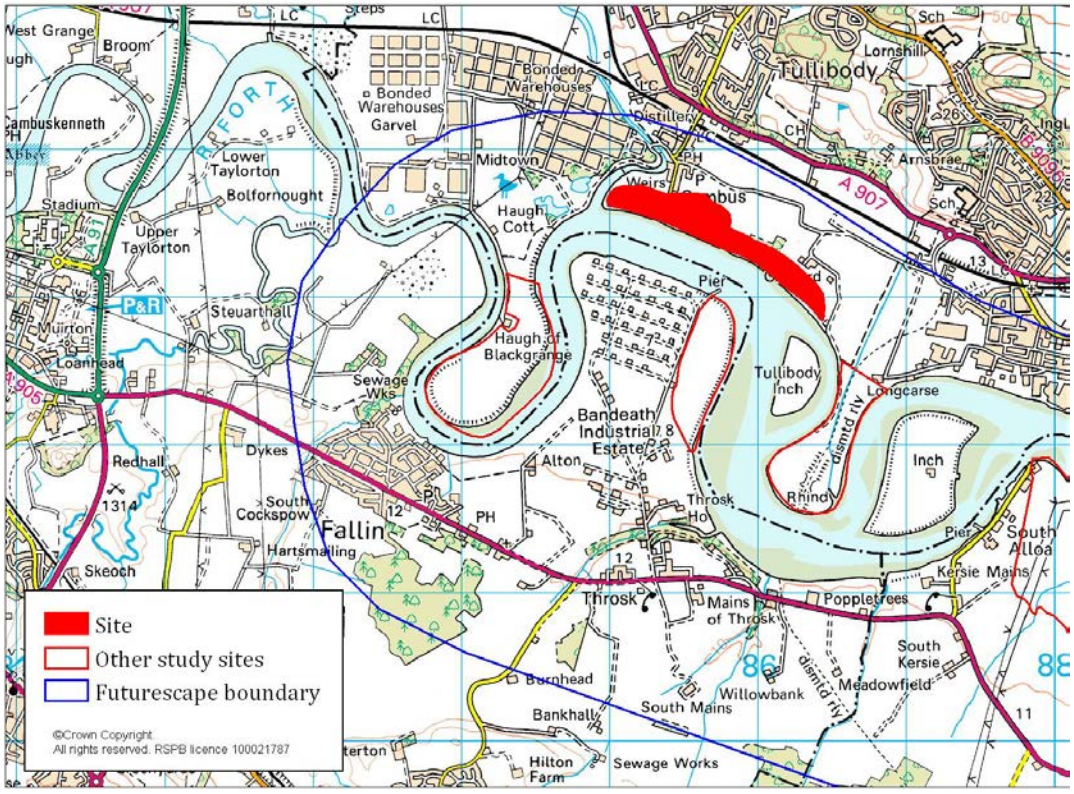


Figure 1: Location of Cambus

Site Description

The site lies south of the village of Cambus on the north shore of the Forth and forms a long, thin area of reclaimed intertidal land bisected by two drains effectively dividing the area into three separate compartments bounded to the south by a 1.5 km earth embankment.

The area lies below the 5 m contour line between the confluence of the Rivers Devon and Forth to the west and by the track leading from Orchard House to the east. The western section immediately adjacent to the confluence of the River Devon and Forth is a 9.7 ha improved grassland field and a 0.5 ha reed-fringed freshwater/ brackish pool, presumably originating from a malfunctioning drainage system. This field is bounded by a drain to the east, which has been sealed from the river and exits via two pipes through the embankment.

The middle section comprises 15.8 ha and is bisected by the 5 m contour line and is

Figure 2: Overview of Cambus

The Diageo bonded warehouse complex is located to the north west and immediately west of the River Devon is the Scottish Wildlife Trust Cambus Pools nature reserve, a complex of reedbed, brackish pools, scrub and wet grassland.

The site is adjacent to the area designated as the Upper Forth Estuary as part of the River Basin Management Plan process, which covers 9.67 km² from Kincardine Bridge to Stirling on the south shore and from Stirling to Kincardine on the north shore. It has been classified as a Heavily Modified Water Body and has Poor Ecological Potential with a current ecological status of Poor and an overall chemical status as Pass.

similarly bounded by a drain to the east which also has been sealed. The eastern section is a long thin area comprising 10.3 ha of a grass field directly below Orchard Farm and Orchard House and bounded to the south by a 4 m earth and rubble embankment. This area is drained by electric pumps and water is pumped through pipes to exit into the Forth.

Figure 3: Pool at Cambus looking west

Figure 4: Outfall into Forth at Cambus

SEPA have established an ongoing programme of monitoring to identify pressures and measures which will protect or improve the status of water bodies in order that good status is achieved over successive RBMP cycles. Targets and environmental objectives have been set for the Upper Forth Estuary to maintain Poor ecological potential for the RBMP cycles in 2015 and 2021 with Good Ecological Status achieved by 2027. Pressures identified in the Upper Forth Estuary include morphological alterations in the form of historical land reclamation, point source pollution in the form of inputs and sewage treatment.

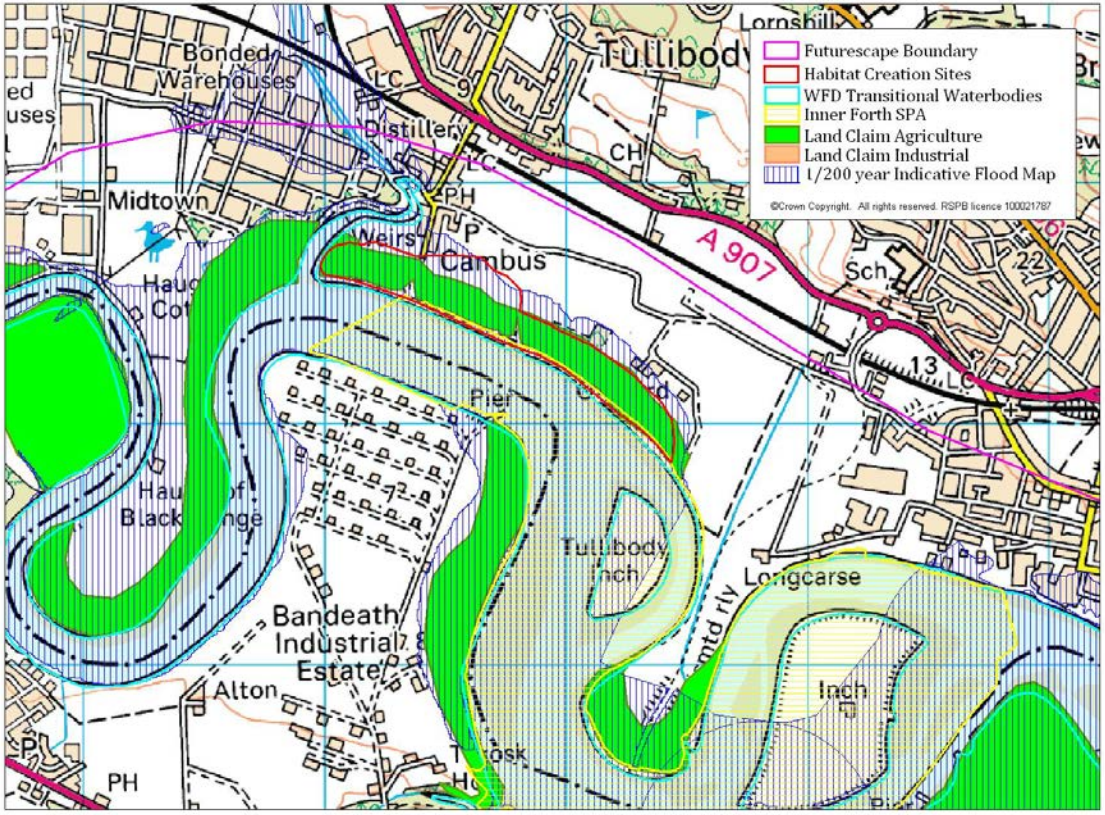


Figure 6: Land claim and flood risk at Cambus

Figure 5: Embankment looking east

The site is within a Potentially Vulnerable Area as identified within the National Flood Risk Assessment (The draft, 'Flooding in Scotland: A consultation on Potentially Vulnerable Areas and Local Plan Districts' published in June 2011, identifies areas for flood risk management planning.) with flooding causing potential limited impacts to a small number of residential and commercial properties, transport links and agricultural land. The area has a high rating in the flood risk category as assessed by infrastructure, historic flooding, groundwater, climate change and flood defences.

The Weighted Annual Average Damages for the area are estimated at over £1.5 million (this figure gives an indicative estimate of direct costs to residential properties, non-residential properties and agriculture). The known source of flooding in the area is predominantly via rivers at 65% with 19% from surface water and 11% from coastal.

Future Vision

The Cambus site is a key managed realignment site on the north shore of the Forth and its proximity to other areas of conservation value at Cambus Pools and Alloa and Tullibody Inches as well other managed realignment sites, makes this an important component of a wetland network. Partnership working with Scottish Wildlife Trust, local communities, land managers and industry has resulted in an exciting and innovative approach to land management with significant biodiversity and flood alleviation opportunities. Access to the area has been enhanced with interpretation of the project and the wildlife of the area.

Table 1: Site summary

Site name	Orchard Farm, Cambus
Location and Local Authority Area	Cambus, Clackmannanshire
Grid Reference	NS8593
Area	25 ha
Ownership	Private
Access	Core path 23 runs for 2.91km from Cambus and follows the route of the grass embankment east towards Orchard farm where core path 24 from Orchard Farm meets path 23. The initial section of this path is surfaced and is part of a Diageo funded initiative. Core path 20 runs to the north of the site and links to core path 23.
Buildings and services	Small buildings housing electric pumps. Electrical supply to pumps.
Designations	None but adjacent to the Firth of Forth Special Protection Area (SPA)
Liabilities and health and safely issues	The embankment has been reinforced with rubble in places and this would need to be assessed for the presence of any hazardous waste prior to any removal. The site lies within the Coal Authority referral area and a coal mining report would be required as part of a detailed feasibility study. There are several structures associated with drainage present on the site.

Conservation Interest and Potential

The site at Cambus is currently of limited conservation interest, ebing predominately improved grassland. The area is immediately adjacent to the Firth of Forth SSSI and SPA, which is internationally important, and the Scottish Wildlife Trust nature reserve at Cambus Pools, which are of significant local importance. To the south west are the Scottish Wildlife Trust reserves of Tullibody Inch and Alloa Inch, both important wildlife areas in the Inner Forth.

Table 1: Habitats

Habitat	Current	Potential
Improved grassland	20 ha	0
Saltmarsh / inter-tidal	0	14 ha
Reedbed (brackish/ tidal)	0.5 ha	1.5 ha
Grassland	0	5 ha

Current and potential bird numbers

Little information known is known about current bird populations at Orchard Farm although it is not of high conservation interest. The creation of intertidal mud, saltmarsh and associated habitats will prove attractive to waders and wildfowl and provide additional feeding and roosting areas close to existing sites.

Other biodiversity

There appears to be little information on other biodiversity recorded at Cambus at present, although otters are thought be present.

Management Activities and Options

The three fields within the area are currently in grass and grazed by sheep and cattle. The sward is short and the fields are bounded by scrub. The field below Orchard Farm requires pumping via electric pumps to keep it drained and work has been carried out to embankment at the eastern end, where the farm track meets the river to provide protection from high tides.

Opportunities for habitat creation would involve managed realignment either by a breach in the existing embankment or by complete removal to create areas of intertidal mud and saltmarsh. There is sufficient salinity in the river and saltmarsh vegetation nearby to aid

colonisation of invertebrates and plants. The exact method of managed realignment would be determined by a detailed feasibility survey comprising ecological, hydrological and geomorphological surveys. A feasibility survey would also inform and determine any opportunities for creation or enhancement of brackish habitat utilising the existing pools at the eastern end of the site adjacent to the confluence of the Devon and the Forth and other areas within the site. Drainage of the site may require installation of structures at new locations to replace the current drains or drains/ creeks excavated according to hydrological and topographical survey results. An assessment of flood risk at the confluence of the Devon and the Forth may be necessary to determine the risk of inundation via the Devon overtopping the eastern embankment.

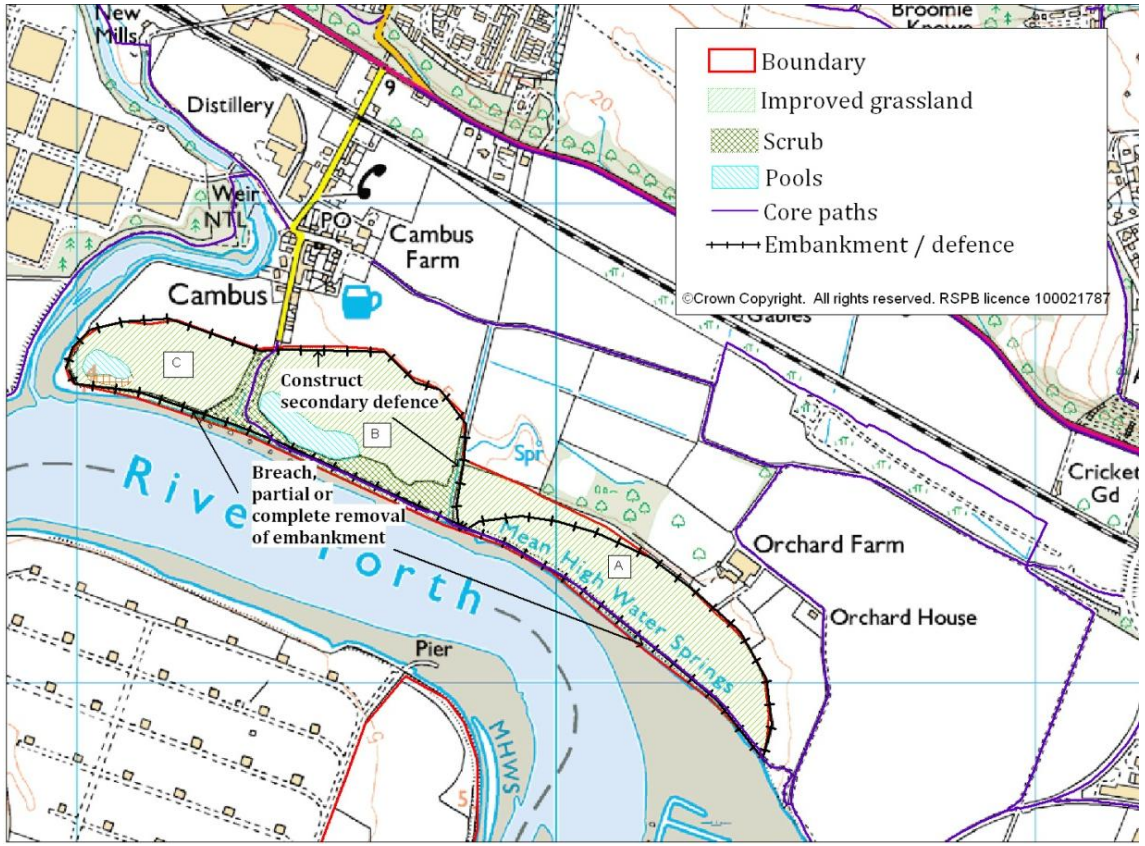


Figure 6: Current habitats and proposed management

Given the proximity of residential housing to the site, the western section of the site may be the least suitable for managed realignment and a secondary defence would be required.

A phased or partial programme of realignment could be implemented from the eastern end of the site and working back and involving one, two or all compartments; a partial or phased approach would build confidence and support for what would be a potentially significant project requiring substantial public consultations and community engagement.

This approach would be expensive; requiring mobilisation of machinery and equipment two or three times to the same area and given the relatively small area involved a cost benefit analysis will need to be carried out. A complete managed realignment programme would be cost effective and would obviously make a bigger overall contribution to habitat creation, biodiversity and flood alleviation.

Table 2: Options Available for Future Management

	Option A – Do Nothing	Options B – Maintain Embankments/ Drainage	Option B – Phased Managed Realignment	Option C - Managed Realignment
Description	n/a	Maintenance or remedial work will be required to maintain the embankment and work will be required to raise the current height as a result of rising sea level in future.	Managed realignment/ wetland creation scheme carried out in three phases. Phase 1 would involve breach in or removal of embankment in area C, construction of secondary defence and drainage if necessary and footpath relocation. Phase 2 would involve further breach in or removal of embankment and associated earthworks.	Managed realignment over entire site involving removal of 1.6 km of earth embankment, earth moving, possible re-grading of material into fields or removal off-site of material , construction of secondary defence, re-instatement of creek system if appropriate, relocation of control structures if necessary
Works needed	n/a	Remedial and repair work will be required to upgrade and raise 1.5 km embankment to provide the recommended level of protection to the surrounding area eg 1:250 year flood event	Embankment removal or breach including rubble and building waste, tree removal, earth moving, possible re-grading of material, construction of secondary defence, possible re-instatement of creek system, relocation of drainage	Embankment removal including rubble and building waste, tree removal, earth moving, possible re-grading of material, construction of secondary defence, possible re-instatement of creek system, relocation of drainage structures and electric pumps.

		Assuming current pumping operations are continuing, the running cost of pumping operations and maintenance of equipment will be necessary to maintain drainage of site.	structures and electric pumps. Removal of shoreline debris prior to work commencing.	Removal of shoreline debris prior to work commencing.
Constraints	n/a	n/a	Proximity of residences at Cambus village, core path/ public right-of-way running through site along embankment.	Proximity of residences at Cambus village, core path/ public right-of-way running through site along embankment.
Site assessment needed	n/a	Assessment of condition of embankment	Detailed ecological, hydrological, topographical, geological, land-use and historical surveys would be required. Hydrological study to include effect of ceasing pumping operations and local drainage. Flood risk assessment focusing on embankments at River Devon.	Detailed ecological, hydrological, topographical, geological, land-use and historical surveys would be required. Relevant engineering studies such as a geotechnical investigation would be required. Flood risk assessment focusing on embankments at River Devon.
Timescale	n/a	Within 5 years	10 – 20 years	20 -30 years
Demonstration site potential	n/a	n/a	Potential to demonstrate a small management	Potential to demonstrate a small management

			realignment site in a relatively constrained area.	realignment site in a relatively constrained area.
Threats to conservation interest/potential	n/a	n/a	The proposals would almost certainly attract a great deal of interest and potential significant negative reaction.	The proposals would almost certainly attract a great deal of interest and potential significant negative reaction.
Consents required	n/a	Initial consultation with local planners would determine planning consent requirements. As the site is adjacent to a SSSI and SPA, consent would be required from SNH for any works. SEPA regarding RBMP Marine Scotland re FEPA licence	As the site is adjacent to a designated site, consent would be required from SNH and an Environmental Impact Assessment required. Planning permission would be required for any habitat creation works ie island/ pool creation and any associated visitor infrastructure. CARS would be required and consultations with Marine Scotland and other relevant agencies would be necessary. Public consultation would be essential at an early stage.	As the site is adjacent to a designated site, consent would be required from SNH and an EIA required. Either of these works would require EIA, Appropriate Assessment and full planning consents. Planning permission would be required for any habitat creation works ie island/ pool creation and any associated visitor infrastructure. CARS would be required and consultations with Marine Scotland and other relevant agencies would be necessary. Public consultation would be essential at an early stage
Capital costs	n/a	The costs of upgrading and repairing the embankment to a recommend standard of protection could potentially be	Proposed works would require a significant level of funding. Minimum cost of managed realignment £30k per ha = £750k although considerably more given additional	Capital costs will involve removal of existing embankment and regrading of material, construction of secondary defence, provision of new drainage structures,

		considerable and would be borne by the landowner. Cost = medium	mobilisation costs. Cost = high	land purchase and associated legal costs. Cost = high
Set up costs	n/a	n/a	>£50k.	Design of scheme, manufacture of water control structure if necessary.
Management costs	n/a	Inspection, maintenance and repair costs.	Ideally, ongoing management would be undertaken by Scottish Wildlife Trust given their established presence in the area. The project will be designed to minimise future management requirements other than routine maintenance of drainage control structures, secondary defences and any other earthworks A monitoring programme to evaluate the outcome of the project would be necessary over at least 5 years and at appropriate intervals beyond	Ideally, ongoing management would be undertaken by Scottish Wildlife Trust given their established presence in the area. The project will be designed to minimise future management requirements other than routine maintenance of drainage control structures, secondary defences and any other earthworks A monitoring programme to evaluate the outcome of the project would be necessary over at least 5 years and at appropriate intervals beyond.
Immediate actions required	n/a	Assessment of embankment	None	None

Funding opportunities	n/a	Individual landowner. Scottish Government flood and coastal defence	The scope and potential benefits of the project would make the proposals an attractive proposition. Funding streams from local and national industrial concerns, trusts, statutory agencies and European sources.	The scope and potential benefits of the project would make the proposals an attractive proposition. Funding streams from local and national industrial concerns, trusts, statutory agencies and European sources.

Access and Interpretation Opportunities

A core path runs from Forth Street in Cambus and follows tarmac path east along embankment to track at Orchard House. There is an information board and bench.

Table 4: Current and potential access

Facility	Current	Potential
Footpath	A 2.9km path runs from Forth Street in Cambus to footpath at Orchard House. Part of Core Paths network in area.	Existing paths are in good condition. Should Option A or B proceed paths and access would require re-routing and careful consideration/planned
Cycle Path	Cycle route 76 passes close by	No change
Car Park	Car parking near Diageo warehouses and in Forth Street	There would be appear to be available space to develop formal car parking facilities
Interpretation	One at start of footpath	Interpretation of area, project and its wildlife

Recommendations

Option B is the preferred option due to combination of strong likelihood of potential being realised. Option A (Do Nothing) would ultimately result in inundation of site without reinforcing and extending current embankment. Option C would be a prohibitively expensive option, with costs outweighing any potential benefit regarding estuarine functionality.

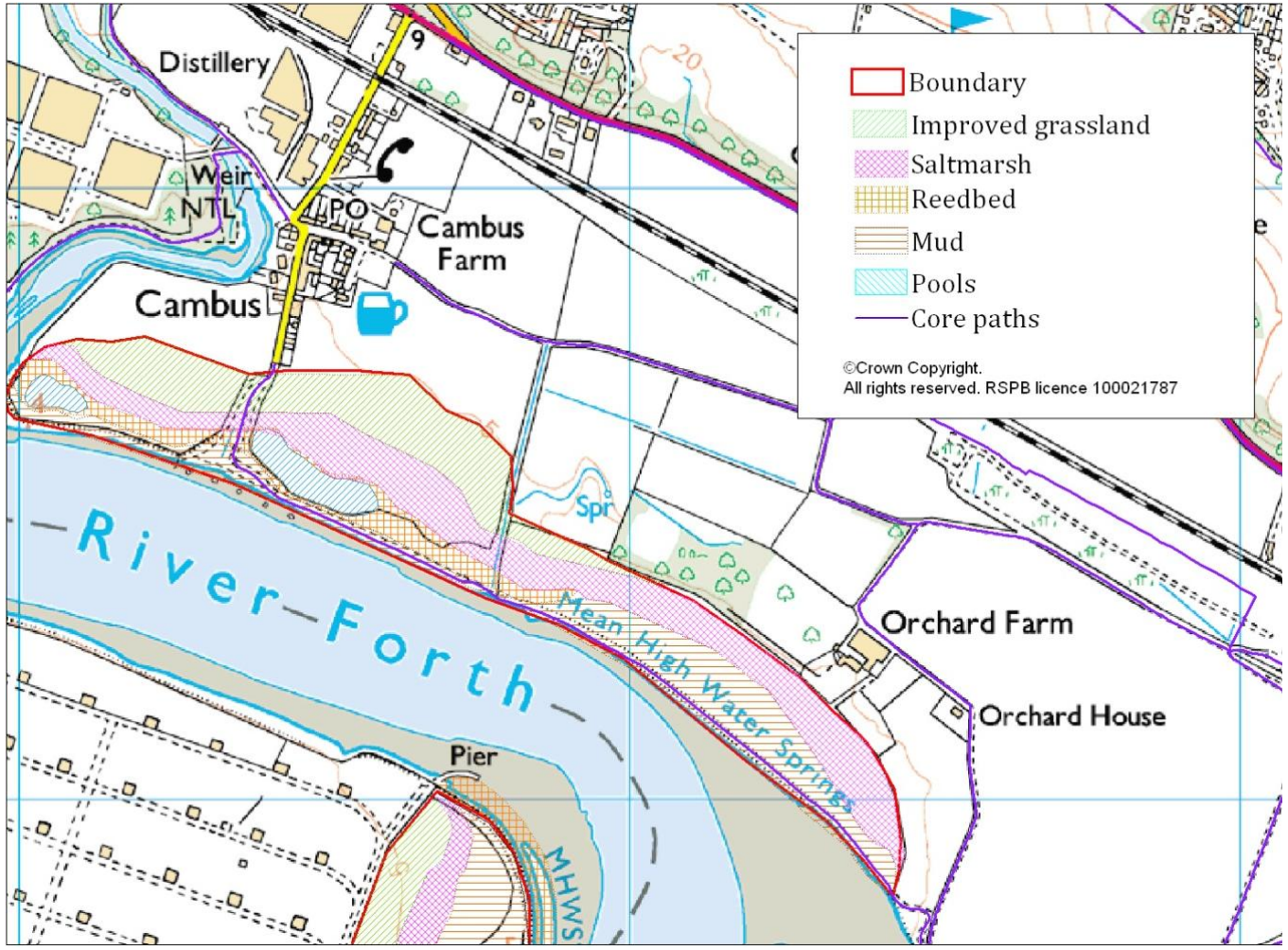


Figure 7: Outcome map

Table 5: Options Appraisal

Strengths				Weaknesses			
Option A	**Option B**	**Option C**	**Option D**	**Option A**	**Option B**	**Option C**	**Option D**
No cost	Increased short-term flood protection in local area. Maintenance of grazing	Moderate cost Will create nationally scarce habitats and increase estuary functionality/ flood alleviation Contribute to WFD Reduce maintenance cost on existing embankment	Maximum benefit Will contribute to a small increase in estuarine functionality. Contribute to flood alleviation Contribute to WFD Reduce maintenance cost on existing embankment	Area will become increasingly vulnerable to future flood events	Unsustainable in long-term Potential cost to landowner Maintenance/ repair costs Maintain conditions leading to coastal squeeze	Relatively small area High cost Proximity of River Devon increases potential for secondary flooding	Relatively small area High cost Proximity of River Devon increases potential for secondary flooding
Opportunities				**Threats**			
Option A	**Option B**	**Option C**	**Option D**	**Option A**	**Option B**	**Option C**	**Option D**
n/a	n/a	Create new habitat Increase in visitors to area Increases opportunity	Create new habitat Reduced cost re mobilisation of plant, prep time etc.	n/a	n/a	Landowner and community concerns	Landowner and community concerns

		for conservation messages & interpretation Increases opportunities for guided walks/ events	Opportunities to work with local industry				

Appendix 9: Rhind Site Assessment

Introduction

This site assessment has been produced following a desktop review of available information, site visits and initial discussions with stakeholders and land managers. The recommendations made are based on current knowledge. Further consultation with communities and landowners and detailed technical assessments will be required to develop and confirm proposals.

Site Description

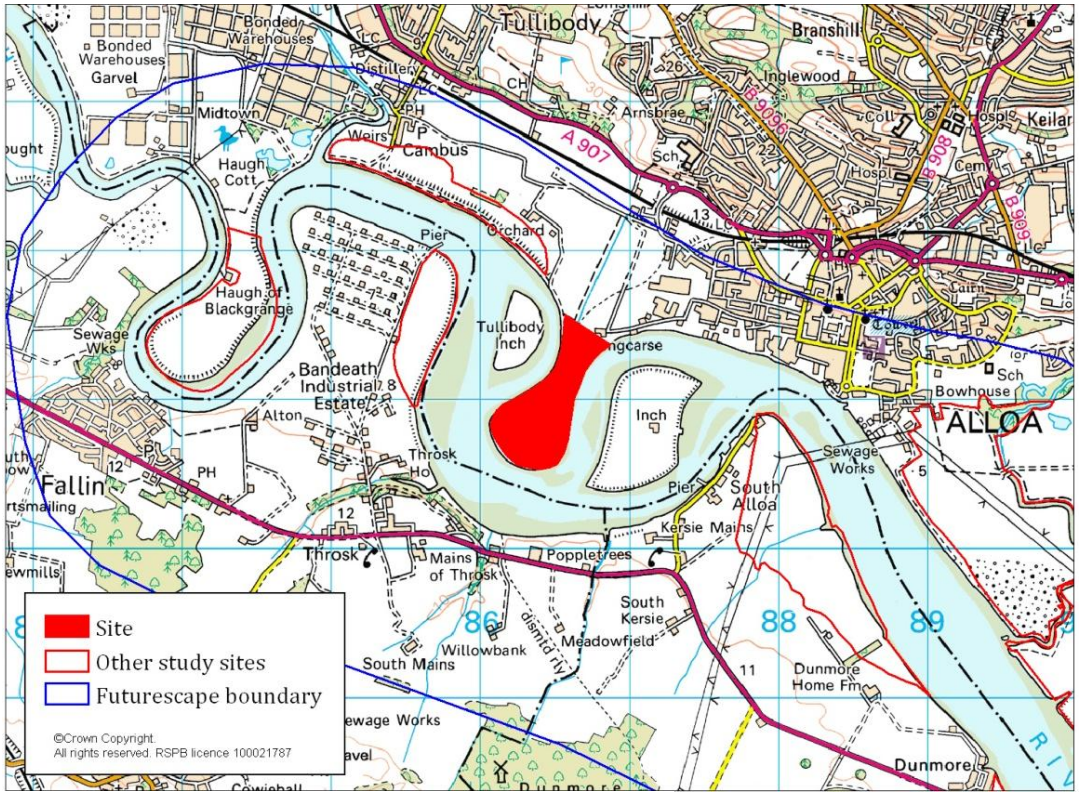


Figure 1. Location of Rhind

The Rhind is on the north bank of the Forth and forms a meander loop of the river between Cambus to the west and Alloa to the east and flanked to the north west by Tullibody Inch and to the south east by Alloa Inch. Between Tullibody Inch and the haugh is a channel known as the Rhind Rack.

The dominant feature of the site is the presence of an elevated disused railway line which bisects the area into two compartments. The eastern one is 11.5 ha and the western one is 12 ha. The railway line once crossed the Forth to Throsk via the Alloa Bridge of which only the stone piers remain. A substantial culvert running under the line linking the east and west compartments is located in the south eastern corner of the Haugh.

The area is low lying with the entire site (with the exception of the railway line) below the 5m contour, which runs across the northern part of

the site between Orchard Farm and Longcarse Farm. The site is embanked around its southern perimeter by a 4m OD high earth embankment, which begins 500m from the neck of the Haugh.

Figure 2: Looking south across eastern compartment

Figure 3: Western compartment

Figure 4: Elevated section of railway line in the distance.

The northern half of the site has little protection from high tides. The site is drained via a flap valve exiting into the Forth on the south east flank, although the eastern compartment is known to flood on high tides. The southern area of the western compartment is also known to be prone to alluvial flooding. The area is currently in agricultural production with the eastern compartment in grass and grazed with cattle and sheep, while the western compartment is divided into two fields, with a small field in grass at the south end and a larger field in oats at the north. The western compartment is accessed via a track originating from the access road to Orchard Farm.

The western flank of the site is fringed by an extensive area of common reed and has scattered mature hawthorn, ash and sycamore trees growing along the landward edge. The elevated section of the railway line features large mature sycamore and ash trees, while the eastern compartment has a different character with saltmarsh species present on the seaward edge of the eastern flank.

The site is adjacent to the area designated as the Upper Forth Estuary as part of the River Basin Management Plan process, which covers 9.67 km^2 from Kincardine Bridge to Stirling on the south shore and from Stirling to Kincardine on the north shore, has been

classified as a Heavily Modified Water Body and has Poor Ecological Potential with a current ecological status of Poor and an overall chemical status as Pass.

SEPA have established an ongoing programme of monitoring to identify pressures and measures which will protect or improve the status of water bodies in order that good status is achieved over successive RBMP cycles. Targets and environmental objectives have been set for the Upper Forth Estuary to maintain Poor ecological potential for the RBMP cycles in 2015 and 2021 with Good Ecological Status achieved by 2027. Pressures identified in the Upper Forth Estuary include morphological alterations in the form of historical land reclamation, point source pollution in the form of inputs and sewage treatment.

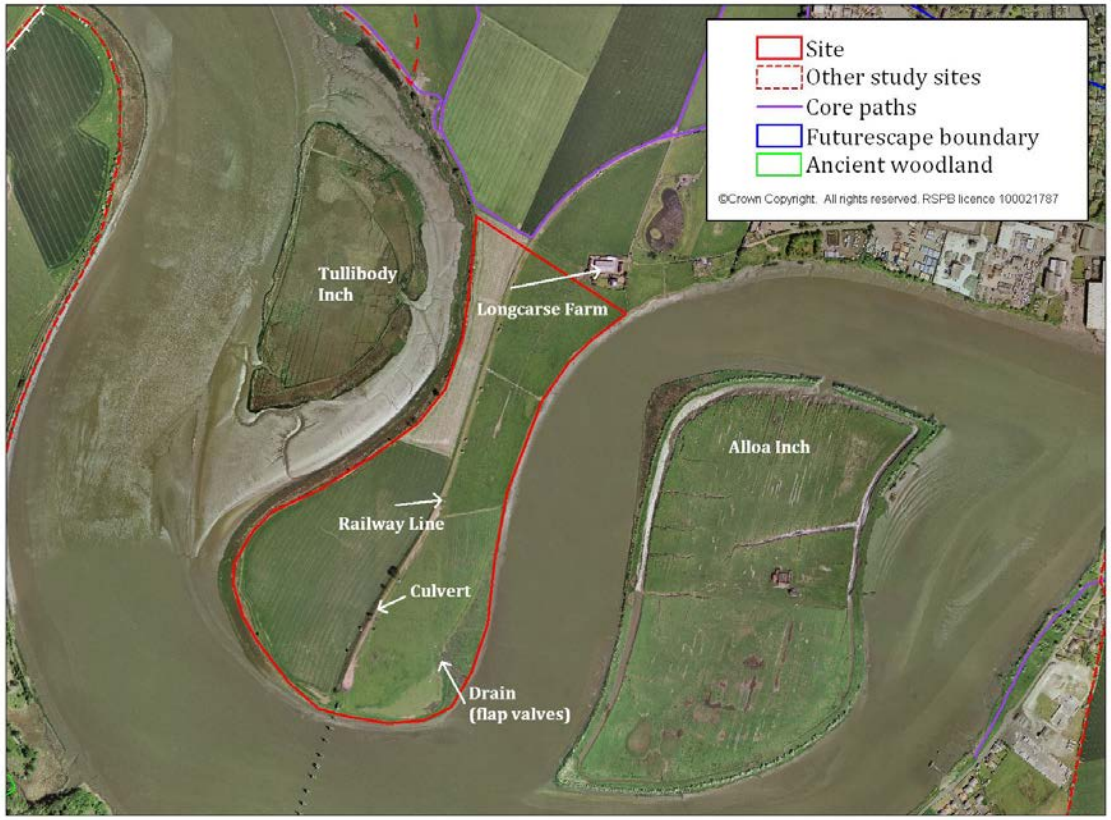


Figure 2: Overview of Cambus

The site is within a Potentially Vulnerable Area as identified within the National Flood Risk Assessment (The draft, 'Flooding in Scotland: A consultation on Potentially Vulnerable Areas and Local Plan Districts' published in June 2011, identifies areas for flood risk management planning) with flooding causing potential limited impacts to a small number of residential and commercial properties, transport links and agricultural land. The area has a high rating in the flood risk category as assessed by infrastructure, historic flooding, groundwater, climate change and flood defences.

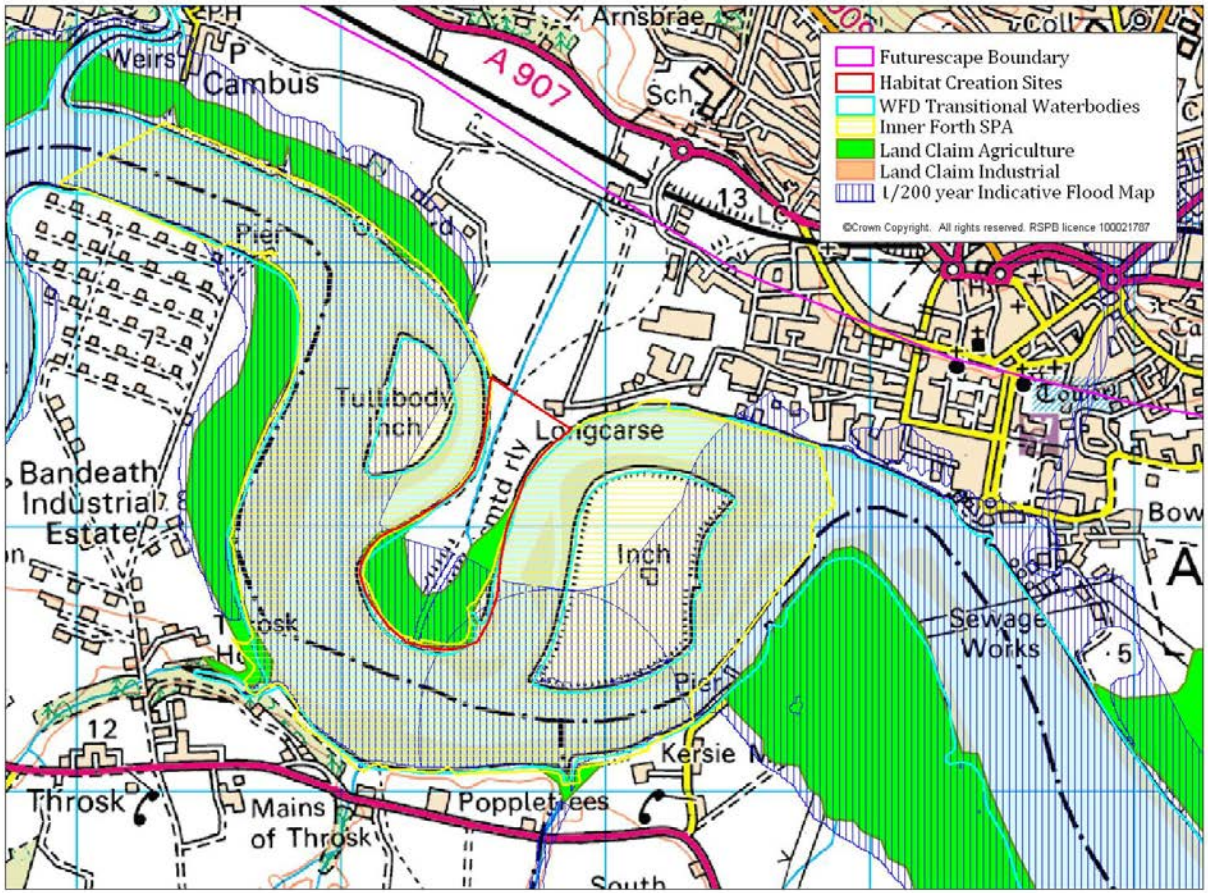


Figure 5: Land claim and flood risk at Rhind

The Weighted Annual Average Damages to the area are estimated at over £1.5 million (this figure gives an indicative estimate of direct costs to residential properties, non-residential properties and agriculture). The known source of flooding in the area is predominantly via rivers at 65% with 19% from surface water and 11% from coastal.

Table 1:Site Summary

Site name	Longcarse
Location and Local Authority Area	Alloa, Clackmannanshire

Grid Reference	NS8691
Area	25 ha
Ownership	Private
Access	Access is via a road to Longcarse farm and a track along the disused railway line.
Buildings and services	A substantial stone culvert connects the eastern and western compartments beneath the railway line. No services.
Designations	None
Liabilities and health and safely issues	Part of the site lies within the Coal Authority referral area and a coal mining report would be required as part of a detailed feasibility study.

Future Vision

Rhind is a small but important managed realignment site within a network of wetlands on the north shore of the Forth that also includes Alloa and Tullibody Inches, Black Devon Wetlands and other managed realignment sites. Rhind plays a significant role in developing the area's potential through an exciting and innovative approach to land management delivering significant biodiversity benefits, flood management opportunities and contributing to achieving Good Ecological Potential by 2027 in the Upper Forth Estuary. Partnership working with Scottish Wildlife Trust, local communities, land managers and industry has been crucial during development and management of the site.

Conservation Interest and Potential

Little is known about the current conservation value of the site although the current agricultural operations with a mix of grazing livestock and arable, combined with the occasional flooding, will mean the site is of moderate conservation interest . The site is immediately adjacent to the Firth of Forth SPA and SSSI and flanked by Tullibody and Alloa Inches, which are SWT reserves. The Inches are important sites within the Inner Forth for wildfowl, which increases the potential conservation value of Longcarse and surrounding area to provide a significant area of wetland. The potential of the site lies in implementing a managed realignment project to create intertidal mud, saltmarsh and brackish pools which would prove attractive to birds, fish and specialised invertebrates.

Table 2: Habitats

Habitat	Current	Potential
Intertidal	0	8 ha
Saltmarsh	0	4 ha
Wet Grassland/ brackish pools	0	4 ha

Current and potential bird numbers

There is little information on bird numbers at Rhind although the grazed grassland compartment is used by feeding and roosting lapwing and curlew. The extensive reedbed fringing the area currently has breeding water rail, sedge warbler and reed bunting present and the surrounding shore and intertidal mud of Tullibody are attractive to wildfowl. The creation of intertidal habitats plus brackish pools would result in an expansion of scarce habitat, which would provide further habitat attractive to wildfowl, waders and passerines. There is potential for colonisation of the reedbeds by bearded tit and marsh harrier and on the site itself, development of wet grassland would provide suitable nesting habitat for waders such as redshank, lapwing, curlew and snipe.

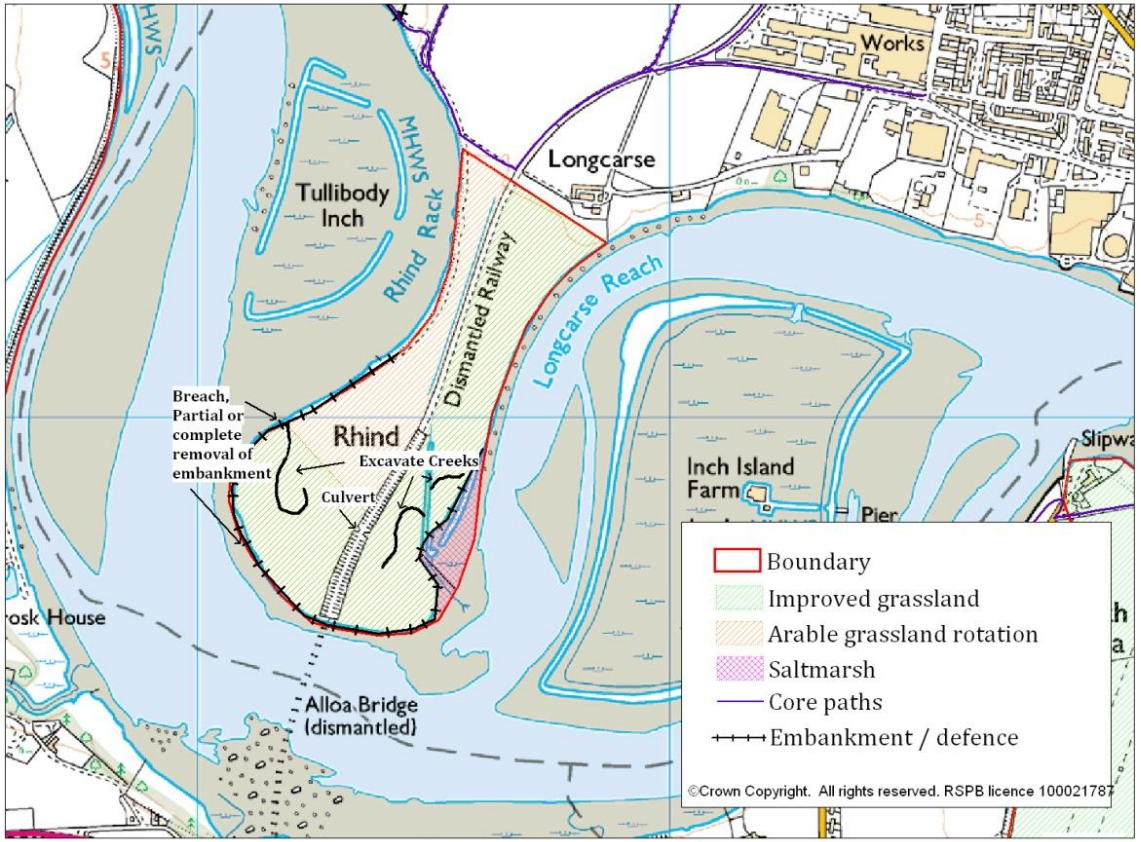


Figure 6: Existing habitat and proposed management

Other biodiversity

Little information is available on other biodiversity at Rhind.

Management Activities and Options

The area is currently in agricultural production with the eastern compartment in grass grazed by both cattle and sheep and the western section in grass and cereal production (oats in 2011).

The southern part of the Rhind is suitable for managed realignment, despite the constraints of the railway embankment, as the two compartments both fit the criteria for carrying out managed realignment and are linked by the culvert. The location within the Upper Estuary is suitable and the lack of buildings and services enhance the value of the site for habitat creation and flood management. The potential to create brackish pools and scrapes towards the northern section of the site would add to the diversity of the wetland habitats and would result in a significant site within the Inner Forth.

Table 3: Options Available for Future Management

	Option A - Do Nothing	Option B – Maintain Embankment	Option C - Habitat Enhancement and Creation	Option D - Managed Realignment
Description	Maintain current situation	Maintain embankment	Freshwater/ wet grassland/habitat creation and enhancement.	Managed realignment
Works needed	n/a	Remedial and repair work will be required to upgrade and raise embankment to provide the recommended level of protection to the surrounding area eg 1:250 year flood event. The embankment would possibly have to be extended northwards from its present limit to	Hydrological management works as determined by results of ecological, hydrological and geomorphological surveys – earthworks, ditch clearance, installation of water control structures. Vegetation control – mechanical or by grazing – install or relocate necessary	Embankment removal, earth moving, rubble and waste removal, tree removal, re-grading of material into field, construction of secondary defence, re-instatement of creek system.

		provide protection from incursion.	infrastructure eg fencing, crossing points, watering facilities for livestock.	
Constraints	n/a	n/a	The area is within a Coal Authority Development Referral Area and would require a non-residential mining report from the Coal Authority before any works or investigations commenced.	The area is within a Coal Authority Development Referral Area and would require a non-residential mining report from the Coal Authority before any works or investigations commenced.
Site assessment needed	n/a	Assessment of condition of embankment.	Detailed ecological, topographic, hydrological and geomorphological assessments will be needed to inform future habitat creation and management including assessment of current water control system. Baseline ecological information including invertebrate populations, botanical interest. Flood risk assessment focusing on embankment.	A full feasibility report including a study of the effects of a managed realignment scheme in the area, technical feasibility, future management and monitoring, and economic implications (cost benefit analysis). A managed realignment / management plan detailing works proposed should be drawn up including all work prior to construction, follow up works and monitoring required A geotechnical investigation

				regarding material for secondary defence/ embankment fill and a local drainage study would be necessary.
Timescale	n/a	Immediately	Within 5 years	10 - 20 years
Demonstration site potential	n/a	n/a	The site would be an good location on the north shore of the Inner Forth to develop understanding and build awareness of landscape scale conservation and wetland creation to local communities and decision makers.	The site would be an good location on the north shore of the Inner Forth to develop understanding and build awareness of landscape scale conservation and flood management/ managed realignment to local communities and decision makers.
Threats to conservation interest/potential	n/a	n/a	New developments, unplanned flood events, change in land use which may compromise future opportunities.	New developments, unplanned flood event, change in land use which may compromise future opportunities.
Consents required	n/a	Initial consultation with local planners would determine planning consent requirements. As the site is adjacent to a SSSI and SPA, consent	Works would require a Scoping report, Environmental Impact Assessment, Appropriate Assessment and full planning consents. A CARS licence may be required. As the site is adjacent to an	Works would require a Scoping report, Environmental Impact Assessment, Appropriate Assessment and full planning consents. A FEPA licence may be required for

		would be required from SNH for any works. SEPA regarding RBMP Marine Scotland re FEPA licence	SSSI and SPA, consent would be required from SNH for any works and it is envisaged that SNH would be involved in the planning, development and management of the project.	works in the marine environment. As the site is adjacent to an SSSI and SPA, consent would be required from SNH for any works and it is envisaged that SNH would be involved in the planning, development and management of the project.
Capital costs	n/a	The costs of upgrading and repairing the embankment to a recommended standard could be considerable and would have to be borne by the landowner/s unless carried out as a grant-aided flood defence scheme. Cost = medium	The costs of implementing a freshwater habitat creation scheme would be considerable involving earthworks, regrading of material, construction of bunds, provision of new drainage structures, land purchase and associated legal costs. Cost = low	Capital costs will involve removal (or partial removal) of existing embankment and regrading of material into fields, possible enhancement of secondary defence, provision of new drainage structures, land purchase and associated legal costs. Cost = low
Set up costs	n/a	n/a	Design of scheme, Manufacture of water control structures, specialised machinery and staff –included in cost above.	Design of scheme, Manufacture of water control structures, specialised machinery and staff –included in cost above.

Management costs	n/a	Inspection, maintenance and repair costs.	Ideally the project will be designed to minimise future management requirements other than routine maintenance of drainage control structures, secondary defences and any other earthworks. A monitoring programme to evaluate the outcome of the project would be necessary over at least 5 years and at appropriate intervals beyond.	Ideally the project will be designed to minimise future management requirements other than routine maintenance of drainage control structures, secondary defences and any other earthworks. A monitoring programme to evaluate the outcome of the project would be necessary over at least 5 years and at appropriate intervals beyond
Immediate actions required	n/a	Assessment of embankment	See constraints	See constraints
Funding opportunities	n/a	Individual landowner. Scottish Government flood and coastal defence.	The scope and potential benefits of the project would make the proposals an attractive proposition. Funding streams from local and national industrial concerns, trusts, statutory agencies and European sources.	The scope and potential benefits of the project would make the proposals an attractive proposition. Funding streams from local and national industrial concerns, trusts, statutory agencies and European sources.

Current and potential access and interpretation

There is no formal access to Longcarse other than the informal footpath on the disused railway line. A track access the western compartment at the neck of the Haugh. A surfaced road via the A907 and the Alloa West Business Park accesses Longcarse Farm.

Core Paths 23 and 24 both pass to the north of the site. The area is currently popular with walkers walking from Alloa and Cambus. Any change to access would require careful consideration taking into account disturbance to feeding/ roosting birds. The elevated railway line provides an opportunity to develop a spectacular viewpoint over the area although disturbance issues will have to be taken into account. There is currently no interpretation in the area but given the historical significance of the area there is great potential to create low key interpretation and signage in the area.

Table 4: Current and potential access and interpretation

Facility	Current	Potential
Footpath	Core Path 23 passes to the north of the site. Informal access along disused railway line.	No change
Vehicular	Access to Longcarse Farm and via track to west side of Haugh.	No change
Interpretation	None	Interpretation on wildlife and the project
Signage	Directional fingerposts	High quality functional themed signage

Recommendations

Predicted sea level rise affecting tidal range and height combined with increased rainfall and chance flood events means Option A is unsustainable in the long-term. Any flood events will have potentially serious consequences for land in the area should the existing embankment fail either through erosion, overtopping or natural breaching.

To maintain the current situation, the embankment will need to be upgraded and repaired as sea level rise affects tidal range in the Upper Estuary; otherwise the area will eventually become inundated. Option B requires investment on behalf of the landowner if alternative funding is not available and is entirely dependant on goodwill and financial ability. Flood management in the Inner Forth requires a strategic and equitable approach, which this option does not provide.

The site at Rhind lends itself to a managed realignment scheme, which would be the most cost effective, long-term and sustainable outcome. In addition to the biodiversity benefits offered by Option C, this would offer flood management benefits.

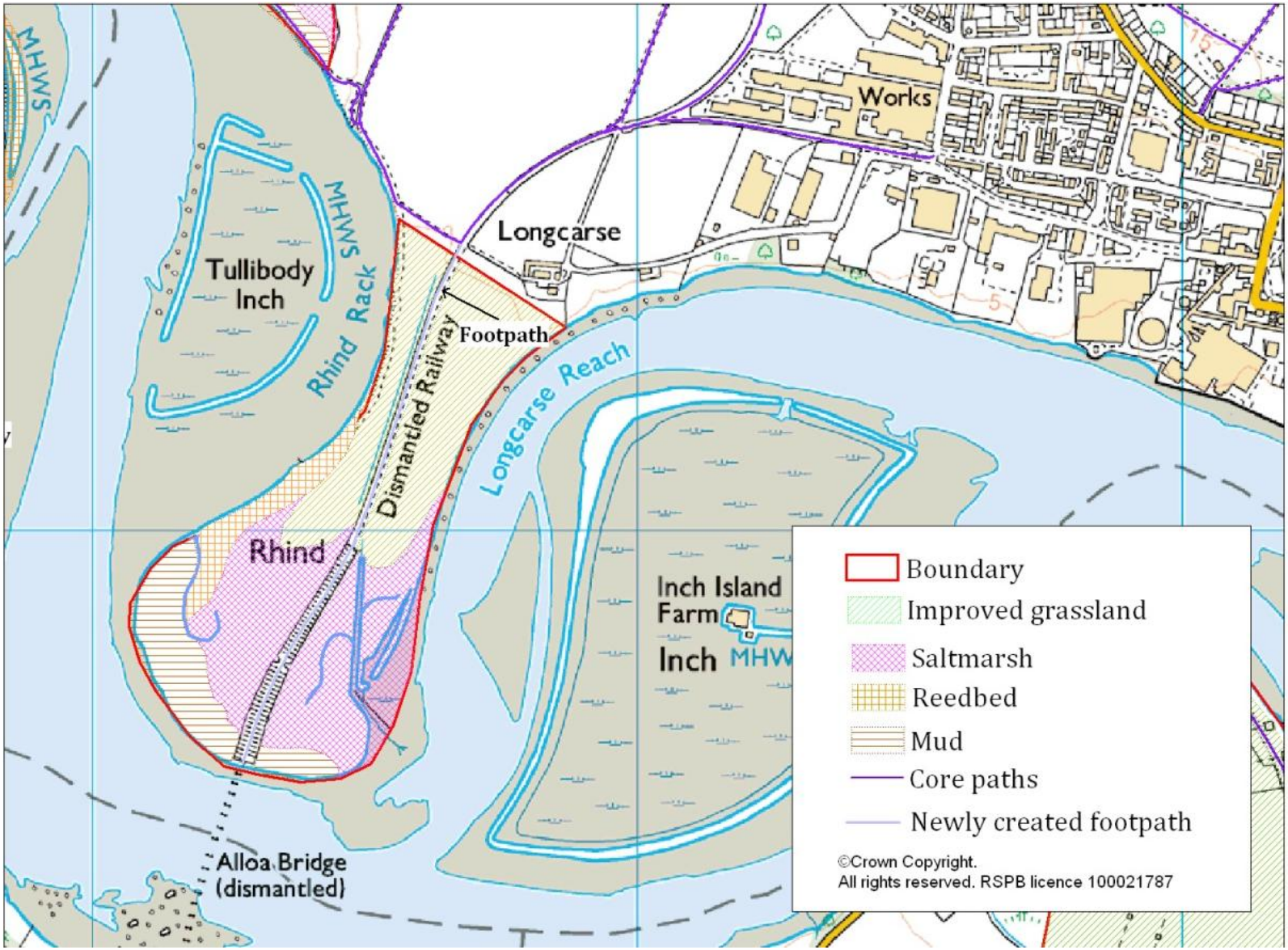


Figure 6. Outcome map for Rhind

Table 5: Options Appraisal

Strengths				Weaknesses			
Option A	**Option B**	**Option C**	**Option D**	**Option A**	**Option B**	**Option C**	**Option D**
n/a	Increased short-term flood protection in local area. Maintenance of agricultural production/ grazing	Low cost Habitat gains Good location within Inner Forth	Meets managed realignment criteria Long-term maintenance costs reduced No buildings nearby Contribution to flood risk management Enhance SSSI & SPA features	Unsustainable in long-term Likelihood of inundation of agricultural land	Unsustainable in long-term Potential cost to landowner Maintenance/ repair costs Maintain conditions leading to coastal squeeze	Increased opportunity for disturbance. Loss of agricultural production/ grazing	Railway embankment Small size of area
Opportunities				**Threats**			
Option A	**Option B**	**Option C**	**Option D**	**Option A**	**Option B**	**Option B**	**Option C**
n/a	n/a	Community involvement	Community involvement Develop saltmarsh grazing	n/a	n/a	Landowner & Community concerns	Obtaining funding and consents Landowner & Community concerns

Appendix 10: Black Devon Wetlands Site Assessment

Introduction

This site assessment has been produced following a desktop review of available information, site visits and initial discussions with stakeholders and land managers. The recommendations made are based on current knowledge. Further consultation with communities and landowners and detailed technical assessments will be required to develop and confirm proposals.

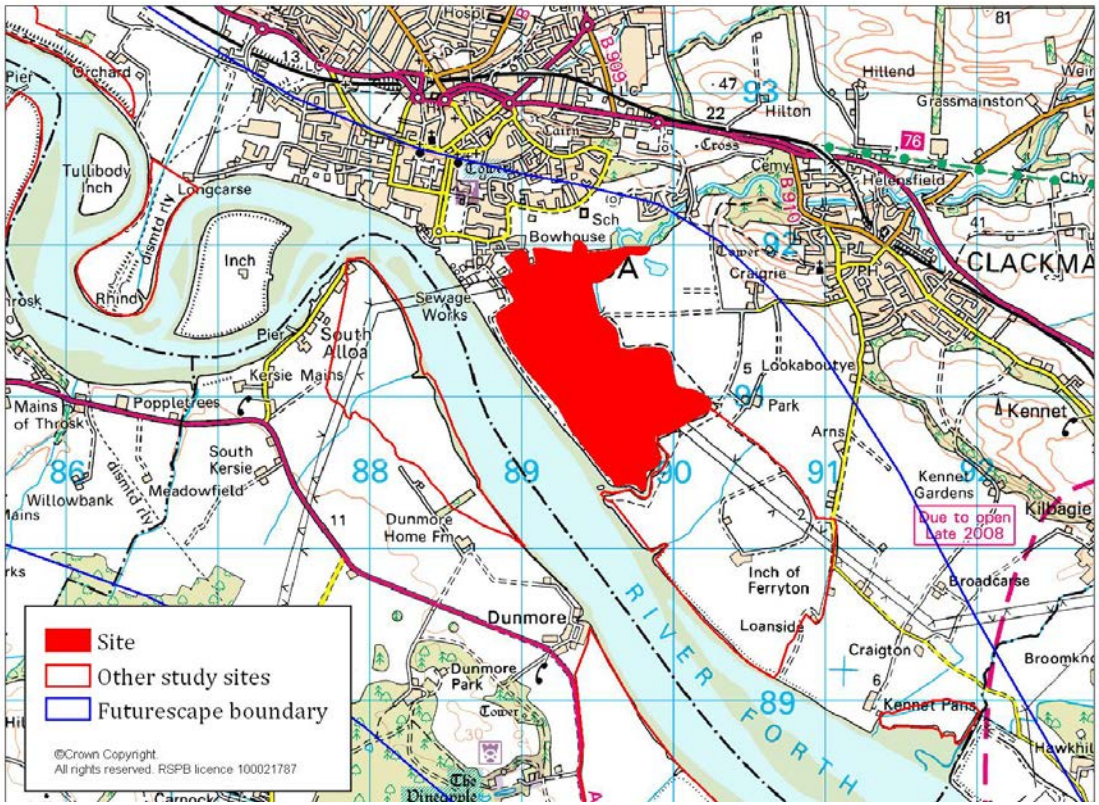


Figure 1: Location of Black Devon Wetlands

Site Description

Black Devon Wetlands are located on the north bank of the Forth to the south east of Alloa and bounded to the east by the River Black Devon at its confluence with the Forth. The area is a large site almost all on reclaimed land and is part of the former embayment that includes Inch of Ferryton immediately to the south east.

The main body of the site is low-lying and bounded and protected by a raised road and embankment along the western edge, which leads to a former landfill beyond the south west corner of the site and to the east by the River Black Devon, which forms the meandering eastern boundary. The River Black Devon is embanked along the northern and southern bank as far as the tidal limit. Pond Wood and the southern edge of Alloa form the northern boundary of the site. A native woodland was planted in 2010 by the Earl of Mar and Kellie on the

north east boundary of the site. The 5 m contour meets the river embankment at the north west corner of the site after a meandering route from Pond Wood forming a natural elevated boundary at the northern limit of the site.

The landscape surrounding Black Devon Wetlands is one of contrast, with the Ochil Hills dominating the vista to the north and the industrial infrastructure of Alloa and Longannet more immediately apparent.

The area has a mixed agricultural and industrial past, the latest evidence of which is the adjacent landfill site. This ceased operating in 2005 and occupies 19.6 ha and rises to an elevation of 6-7m OD.

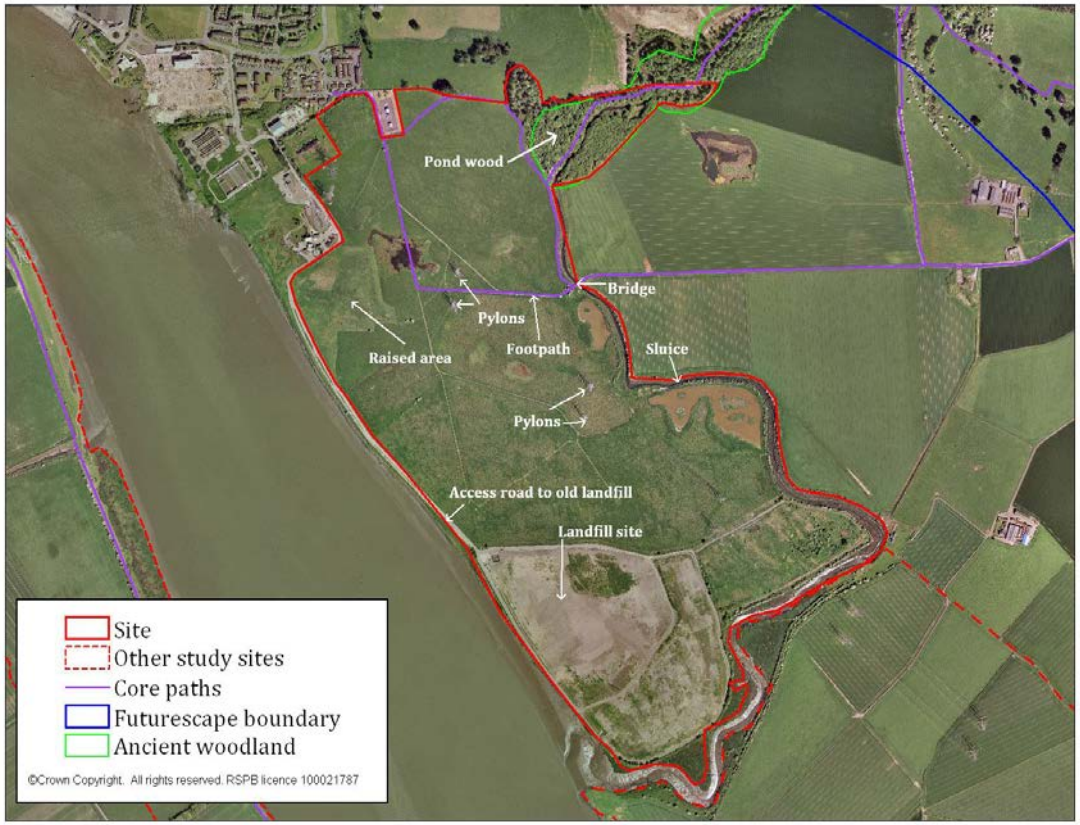


Figure 2: Overview of Black Devon Wetlands (image pre 2008)

A temporary anemometer mast is located at the north west edge of the site on an elevated area. This is to measure the wind resource as part of a proposed wind turbine development at the site.

One dominant feature within the site is the parallel rows of pylons originating from Longannet, which traverse the site from east to west before crossing the Forth at Alloa.

The dominant habitat is rank grassland with tufted hair grass abundant, resulting in an almost prairie like appearance in the summer and autumn months. A series of pools, scrapes and lagoons at the site are the legacy of two habitat creation and enhancement schemes, including a regulated tidal exchange scheme carried out in 1999 and an enhancement scheme in 2008, when the soil was excavated to cap the adjacent landfill site. A detailed description of the works are to be found in habitat review section of the accompanying feasibility study. Several subterranean structures

possibly relating to drainage are present in various locations around the site.

The more recently created pools are fringed with bulrush , soft-rush and willow scrub and it is presumed that the wet areas and pools created from mining subsidence elsewhere throughout the site (which appear on some older photographs), have become choked with vegetation and have almost disappeared. There are several fence lines running across the site and there are the remnants of a hawthorn hedge line in the north western corner.

The regulated tidal exchange is located at the north eastern edge of the site on the southern bank of the river. Lagoons formed as part of this project form a mosaic of habitats with soft-rush fringed pools and marshy areas.

Figure 3: Pylons at Black Devon wetlands

The banks of the River Black Devon are fringed with common reed, particularly on the northern bank and a line of hawthorn scrub follows the course of the river to the Forth on the southern bank, where there is a scattered stand of scrub. A bridge crosses the river and joins a farm track leading to Clackmannan.

Figure 4: Looking south east

Figure 5: Looking north west

Figure 6: Bridge over River Black Devon

The site is adjacent to the area designated as the Upper Forth Estuary as part of the River Basin Management Plan process, which covers 9.67 km^2 from Kincardine Bridge to Stirling on the south shore and from Stirling to Kincardine on the north shore. It has been classified as a Heavily Modified Water Body and has Poor Ecological Potential with a current ecological status of Poor and an overall chemical status as Pass.

SEPA have established an ongoing programme of monitoring to identify pressures and measures which will protect or improve the status of water bodies in order that good status is achieved over successive RBMP cycles. Targets and environmental objectives have been set for the Upper Forth Estuary to maintain Poor ecological potential for the RBMP cycles in 2015 and 2021 with Good Ecological Status achieved by 2027. Pressures identified in the Upper Forth Estuary include morphological alterations in the form of historical land reclamation, point source pollution in the form of inputs and sewage treatment.

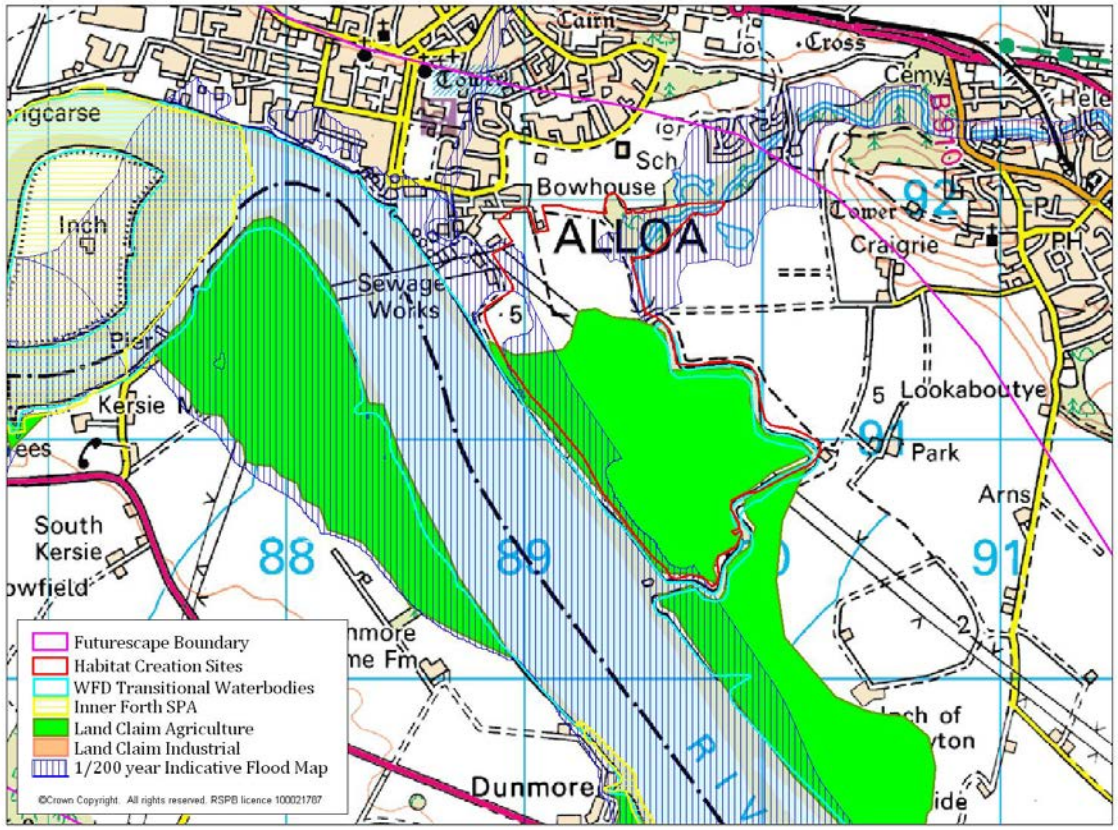


Figure 7: Land claim and flood risk at Black Devon Wetlands

The site is within a Potentially Vulnerable Area as identified within the National Flood Risk Assessment (The draft, 'Flooding in Scotland: A consultation on Potentially Vulnerable Areas and Local Plan Districts' published in June 2011, identifies areas for flood risk management planning) with flooding causing potential limited impacts to a small number of residential and commercial properties, transport links and agricultural land. The area has a high rating in the flood risk category as assessed by infrastructure, historic flooding, groundwater, climate change and flood defences.

The Weighted Annual Average Damages to the area are estimated at over £1.5m (this figure gives an indicative estimate of direct costs to residential properties, non-residential properties and agriculture). The known source of flooding in the area is predominantly via rivers at 65% with 19% from surface water and 11% from coastal.

Future Vision

Black Devon Wetlands is an important site in the Inner Forth with a range of freshwater and brackish habitats forming a mosaic of pools and wet grassland that are attractive to both breeding and wintering waterfowl and waders. The location of the site and it's proximity to other important areas of habitat and potential areas of habitat creation enhance its conservation value. Positive management of habitats complements the conservation interest of the SPA and contributes to a wetland landscape of regional and national significance. The wetlands are well used and well loved by the local community, with welcoming interpretation and access routes encouraging people to explore the area and its wildlife. Events and volunteering activities encourage this responsible use of the area.

Table 1: Site summary

Site name	Black Devon Wetlands
Location and Local Authority Area	Alloa, Clackmannanshire
Grid Reference	NS8991
Area	45ha
Ownership	Clackmannanshire Council
Access	A surfaced access road via Forthbank local amenity site runs parallel to the Forth along a strengthened embankment on the southern limit of the site. Access to vehicles is restricted. Several footpaths access the area from both Alloa and Clackmannan. A footpath accessing the northern end of the site starts in Riverside View, Alloa and traverses the site from north to south joining the track around the landfill area. A track leads off Craigrie Road, Clackmannan and crosses the site from east to west crossing over the Black Devon before meeting the path from Riverside View. There are several other informal trails around the site.
Buildings and services	No buildings.
Designations	None
Liabilities and health and safely issues	Bridge across the Black Devon Several subterranean structures possibly relating to drainage or mine workings on the site.

	A parallel row of pylons originating from Longannet cross the site from south east to north west before crossing the Forth at Alloa. Almost the entire site lies within the Coal Authority referral area and a coal mining report would be required as part of a detailed feasibility study.

Conservation – Current interest and potential

The site is strategically significant in the Inner Forth, located within 1.5 km of the Firth of Forth SPA and just downstream of Alloa and Tullibody Inches, both of which are Scottish Wildlife Trust reserves and part of the Firth of Forth SPA. The managed realignment site at Kennet Pans is 3.5 km downstream and Inch of Ferryton and Airth, two large sites with potential for habitat creation and restoration are immediately south and west respectively.

With its existing mosaic of pools and rank vegetation the area is of conservation interest although limited at present. The size and potential enhancements to habitats at Black Devon Wetlands makes this a significant and important site, although the habitats are currently degraded and in poor condition. Intervention and management is required in the near future to fully realise the ecological potential and benefits of the site. Freshwater habitats in the Inner Forth are relatively scarce, therefore development of freshwater habitats would be of conservation benefit. The potential to create suitable habitat for breeding waders on the site has already been demonstrated with lapwing and redshank responding positively to previous habitat creation in 2008. Restoration of favourable conditions across the wider site for waders is straightforward via vegetation control and reinstatement of grazing but maintaining the conditions is of course, equally important. The development and reinstatement of wetland habitats at the site would provide a relatively undisturbed loafing and roosting area for wildfowl, waders and gulls. The maintenance of the embankment on both banks of the Black Devon would be maintained to provide a level of protection from flood events.

Table 2: Habitats

Habitat	Current	Potential
Scrub	2 ha	1 ha (as screening)
Standing water	8 ha	Up to 13 ha in temporary pool systems
Wet grassland	11 ha	22 ha including transitional habitats in tidal exchange area
Dry grassland	21 ha	5 ha
Reedbed	3 ha	4 ha

The area currently attracts waterfowl and waders including locally significant species. Mute swan, shelduck, gadwall, teal shoveler, mallard and tufted duck have all bred and other waterbirds such as little grebe, moorhen and coot are also present. Water rail were present in winter 10/11. Eight pairs of lapwing and 3 pairs of redshank bred in 2008 and passage and wintering waders such as snipe, black-tailed godwit and greenshank are regular. A glossy ibis, the first for the Upper Forth was recorded in 2009. A hen harrier wintered in 2007; peregrine, short –eared owls and kestrel are regular visitors with passerines reasonably well represented with breeding skylark, grasshopper warbler and reed bunting.

Table 3: Current and potential bird numbers

Species	Current	Potential
Breeding (prs)		
Lapwing	8 (2008)	10
Snipe	0	2
Ringed Plover	0	2
Oystercatcher	0	2
Curlew	0	1
Redshank	3	5
Water rail	0	2
Wintering		
Whooper swan	Present	Increase
Pink-footed goose	Present	Increase
Wigeon	Present	Increase
Teal	Present	Increase
Lapwing	Present	Increase
Snipe	Present	Increase
Black-tailed godwit	Present	Increase
Curlew	Present	Increase

Potential colonists		
Marsh Harrier		
Avocet		

Other biodiversity

Otter, fox and roe deer are present at Black Devon Wetlands. Water voles could also be present.

Management activities and options

The area is currently unmanaged, with grazing ceasing in 2004 and the regulated tidal exchange system installed on the northern bank of the River Black Devon is not fully operational or maintained. The potential of the site could be realised by instigating a number of habitat management operations in the short-term. Reinstating grazing to the site, preferably by cattle, would considerably enhance the conservation value of the site, particularly if targeted to priority areas**.**

Given the conditions and proximity to Alloa using native or hardier breeds such as Highland cattle may prove beneficial and an added attraction to visitors. Prior to grazing commencing, topping of rank vegetation may have to take place to ensure conditions acceptable to prospective graziers and associated infrastructure installed eg fencing, cattle handling facilities and water troughs. The ground is rough and uneven over the majority of the site and would perhaps benefit from being levelled to permit easier operating conditions for machinery in future. A limited amount of earthworks may prove useful in re-profiling pools, removing rank vegetation and opening up choked pools and shallow scrapes. The possibility of developing a series of compartments with varying degrees of salinities could be explored, utilising the tidal exchange mechanism and small earth bunds, which would greatly enhance the attractiveness of the site for waders. A hydrological study of the site would inform this proposal. The role of Black Devon Wetlands in flood management should be investigated as the site could lend itself to storing water during flood events and the long-term

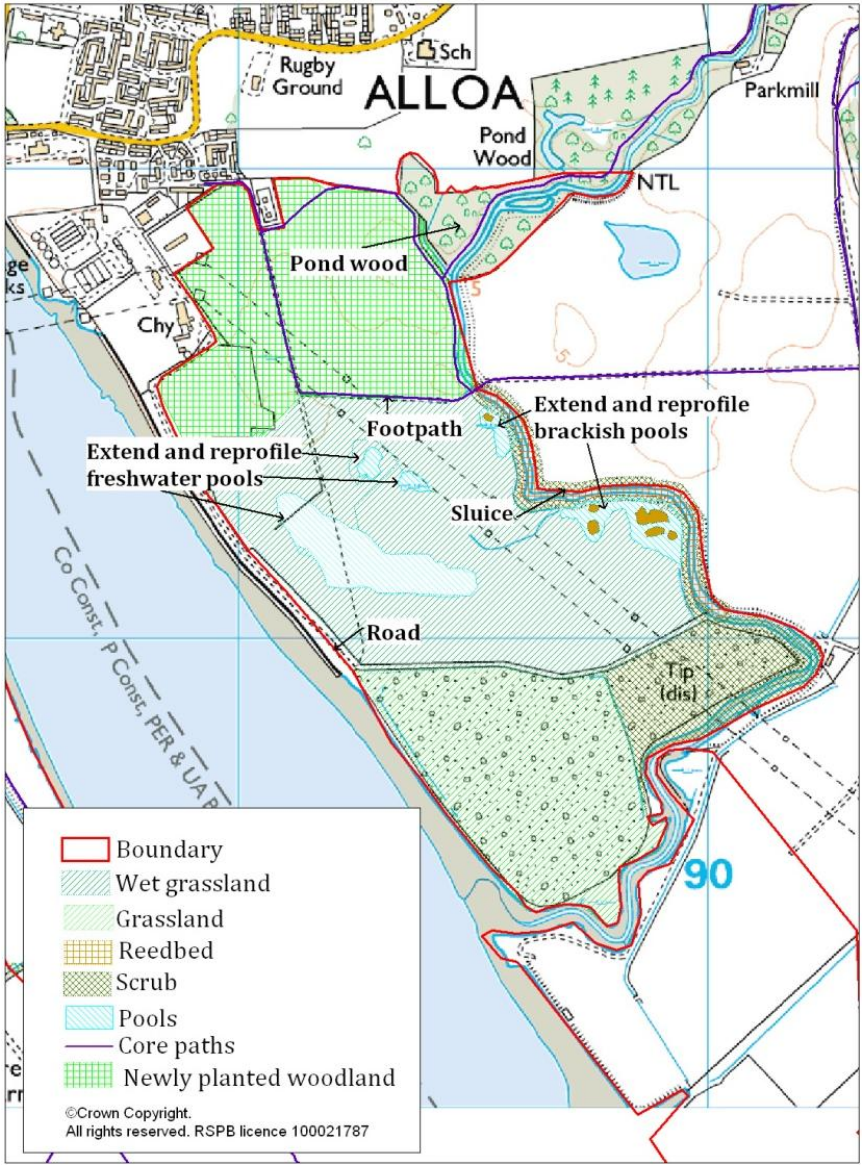


Figure 7 Current habitat and proposed management

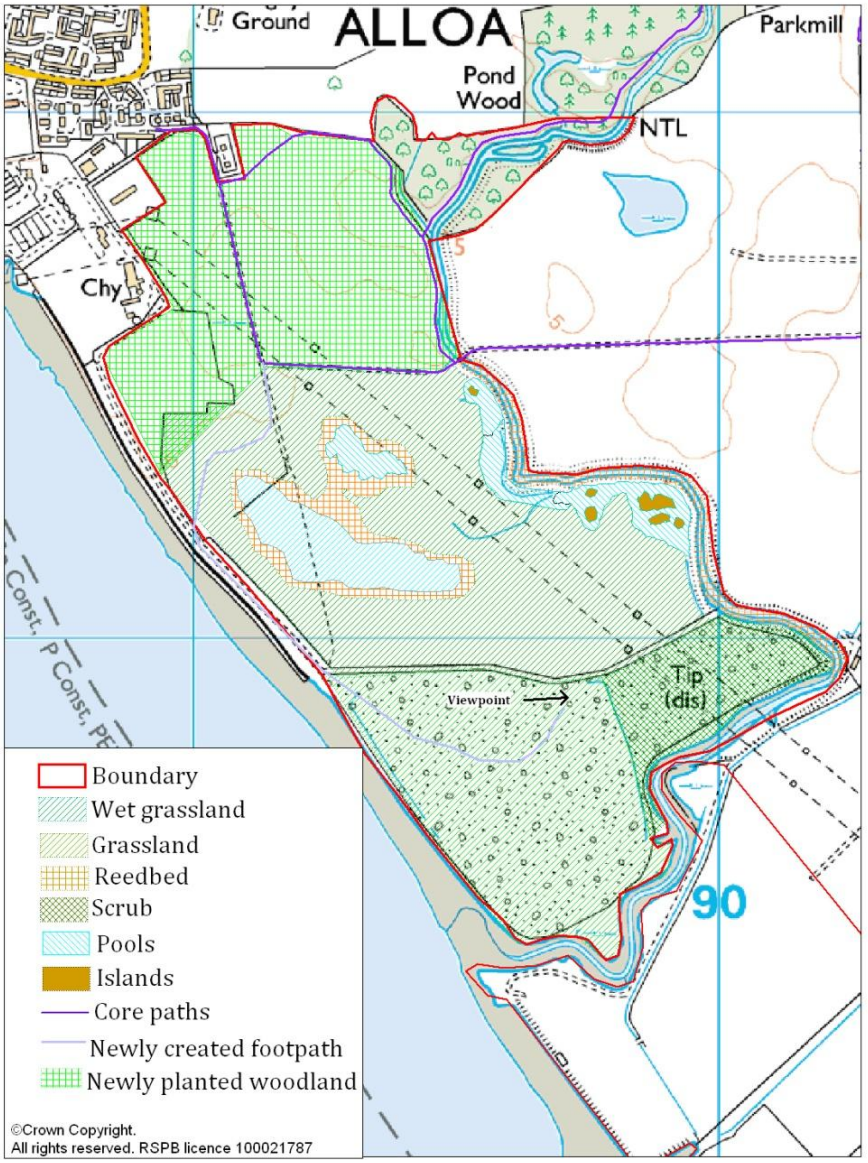


Figure 8: Outcome map for Black Devon Wetlands

Table 4: Options Appraisal

	Option A - Do Nothing	Option B - Habitat Enhancement and Creation
Description	**Maintain current situation**	**Creation of freshwater/ brackish habitats**
Works needed	n/a	Earthworks, fencing, vegetation control, installation of grazing infrastructure
Constraints	n/a	Two parallel power lines traverse the site connecting Longannet Power Station to a substation at Denny. Issues relating to the degree of protection required for the foundations and surrounding wayleaves in respect of the pylons require further investigation A Scottish Gas installation compound is located at the north of the site at the access point at Riverside View, Alloa. Maintenance of embankments would have be to ensured or undertaken to ensure no overtopping or breaches occur which would compromise freshwater habitats
Site assessment needed	n/a	Baseline ecological information including invertebrate populations, botanical interest, bird numbers. Flood risk assessment focusing on adjacent embankments. Drainage evaluation
Timescale	n/a	5-10 years
Demonstration site potential	n/a	Black Devon Wetlands is an ideal location to demonstrate habitat creation, develop understanding and build awareness of landscape scale conservation to local communities, statutory agencies, MP's and MSP's.
Threats to conservation interest/ potential	The continuing lack of management at the site could lead to a degradation of habitats, with	The continuing lack of management at the site could lead to a degradation of habitats at the site with encroachment of vegetation into open water, increased risk establishment of

	encroachment of vegetation into open water, increased risk of establishment of invasive species and development of scrub in wet areas. Current access is unregulated and unquantified but not thought be a significant negative issue, although it has the potential to expand and possibly result in a subsequent increase in anti-social activities such as fly-tipping, illegal wildfowling etc. A planning application for four wind turbines (three immediately adjacent to the site and one on the site) has been submitted to Clackmannanshire Council and if successful could lead to further development applications in the future.	invasive species, and development of scrub in wet areas. Current access is unregulated and unquantified but not thought be a significant negative issue, although has the potential to expand and possibly result in a subsequent increase in anti-social activities such as fly-tipping, illegal wildfowling etc. A planning application for four wind turbines (three immediately adjacent to the site and one on the site) has been submitted to Clackmannanshire Council and if successful could lead to further development applications in the future.
Consents required	n/a	Given the limited nature of the initial works required to realise the potential of the site, no consents would be necessary.
Capital costs	n/a	£60k
Set up costs	n/a	£52k over five years
Management costs	n/a	Ideally the project will be designed to minimise future management requirements other than routine maintenance A monitoring programme to evaluate the outcome of the project would be necessary over at least 5 years and at appropriate

		intervals beyond.
Immediate actions required	n/a	See liabilities (Table 1.)
Funding opportunities	n/a	The scope and multi-functional potential benefits of the project would make this proposal an attractive proposition. Funding could come from Scottish Government, local and national industrial concerns, trusts, statutory agencies and European sources with contributions from private capital and NGOs.

Current and potential access and interpretation

A surfaced access road via Forthbank local amenity site runs parallel to the Forth along a strengthened embankment to the limit of southern limit of the site. Access to vehicles is restricted.

Several footpaths access the area from both Alloa and Clackmannan. A footpath accessing the northern end of the site starts in Riverside View, Alloa and traverses the site from north to south joining the track around the landfill area. A track leads off Craigrie Road, Clackmannan and crosses the site from east to west crossing over the Black Devon before meeting the path from Riverside View. There are several other informal trails around the site

Given the relatively level ground at the site and easy access it would be possible to develop a wheelchair friendly trail. There is currently no interpretation at Black Devon Wetlands other than directional signposts. There is considerable potential to develop high quality interpretation at the site.

Table 5: Current and potential access

Facility	Current	Potential
Footpaths	Rights of way signposted Entrance at Riverside View, Alloa	Network of paths formalised and wheelchair accessible
Vehicle	Surfaced road via recycling centre to landfill site	No change
Interpretation	None	Interpretation of the wildlife and history

Recommendations

The consequences of a 'do nothing' option being followed at Black Devon Wetlands would lead to ongoing degradation of the habitats present and a missed opportunity to delivery a resource of considerable value to the local area and to wildlife. The development of wetland habitats as outlined in Option B is recommended as this presents an exciting opportunity to develop a high quality wetland reserve in an accessible location, at a relatively low cost.

Table 6: Options appraisal

Strengths		**Weaknesses**	
Option A	**Option B**	**Option A**	**Option B**
N/A	Cost effective Optimum location, with good access Site not designated Future flood management potential	N/A	Could attract anti-social behaviour Increase in disturbance to area Presence of pylons
Opportunities		**Threats**	
Option A	**Option B**	**Option A**	**Option B**
N/A	Restoration and creation of locally scarce habitats Excellent opportunities for community engagement Increased access	Habitat will gradually deteriorate and degrade.	Development encroaching or taking place on site

Appendix 11: Inch of Ferryton and Park Farm Site Assessment

Introduction

This site assessment has been produced following a desktop review of available information, site visits and initial discussions with stakeholders and land managers. The recommendations made are based on current knowledge. Further consultation with communities and landowners and detailed technical assessments will be required to develop and confirm proposals.

Site Description

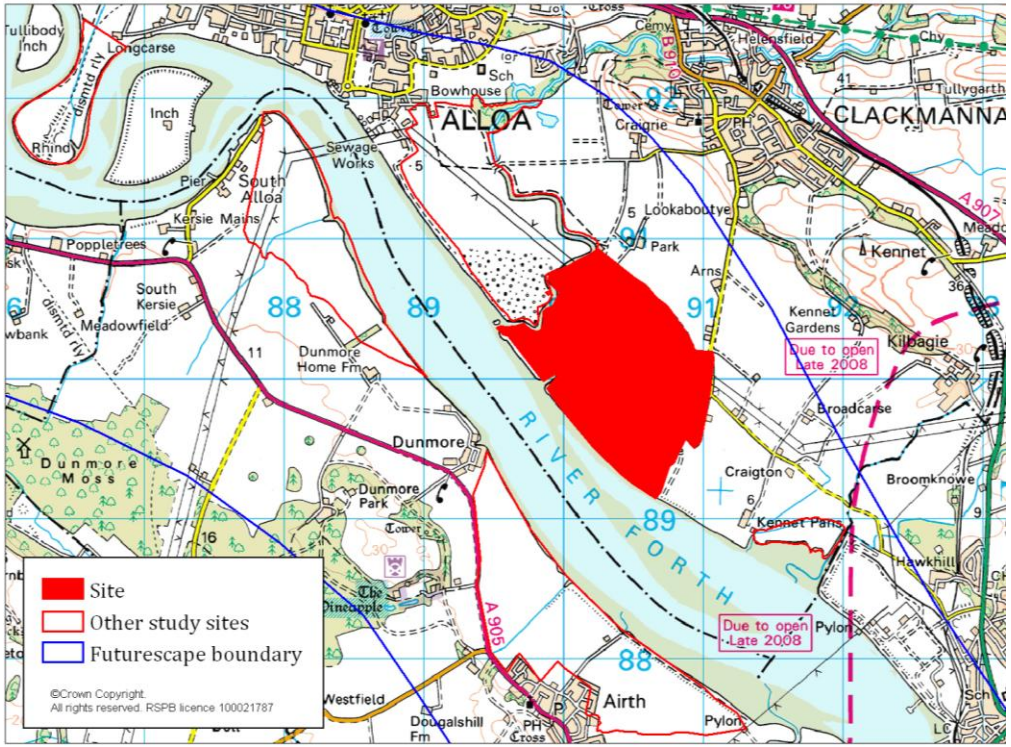


Figure 1 Location of Inch of Ferryton and Park Farm

The site at Inch of Ferryton is a key site, being one of the largest areas of reclaimed land on the Inner Forth and the largest site with habitat creation and restoration potential on the north shore of the Forth. Inch of Ferryton is located south east of Alloa and south of Clackmannan and covers approximately 160 ha. The area was one of the earliest in the Inner Forth to be reclaimed with records dating back to 1636 referring to sea walls at 'Ferryton'.

The site is bounded to the north west and west by the River Black Devon and River Forth and by a 1.8 km earth and rubble embankment, which runs from the north east corner of the site to the south east corner.

The embankment is between 5-6 m high and is reinforced on the seaward side along the majority of its length by considerable quantities of rubble, railway sleepers and concrete sandbags topped by slabs of concrete and masonry.

There was no evidence of recent maintenance works and the last known works took place in the mid 1980s, when the embankment was raised by at least 0.3 m. The south eastern end of the embankment is keyed into higher ground on the 5 m contour at Loanside, on which a track runs towards Loanside farm buildings.

Figure 2: Location of Inch of Ferryton and Park Farm

The 5m contour continues in a meandering northerly direction towards Alloa for approximately 5 km before returning to the meet the river bank 1 km north west of the mouth of the Black Devon. The embankment is narrow along most of its length and detours inland for 120m at NS899899 to allow ditches to drain into the Forth via a structure running under the embankment. A small area of saltmarsh is present within the creek here.

Figure 3:South eastern end of embankment meets 5m contour at Loanside

To the north west, 250m from the inlet, a compound containing gas pipeline infrastructure is associated with the submerged pipeline running below the Forth from Dunmore. The embankment then continues along the southern bank of the Black Devon inland to Pond Wood at the eastern edge of Alloa.

Landward of the embankment the land is low lying, rising gradually to the 5 m contour. The area is in agricultural production with a mix of cereals, hay and silage plus grazing livestock (beef cattle) and is drained by ditches which flow towards a pumphouse. Water is then pumped under and through the embankment exiting into the Forth via two outfalls at NS901896. There are several farms in the area; Inch of Ferryton, located at NS904899 lies at 3 m OD and 380 m north east from the embankment at its nearest point.

Figure 4: Saltmarsh at creek

Figure 5: Pumphouse landward of embankment

Figure 6: Outfall into the Forth

Park Farm lies 1.5 km north of Inch of Ferryton at NS905909, just east of the Black Devon and Arns which is located on the west side of the B910 at NS911906. There are farm buildings and yard located at Loanside at the southwest of the site at NS909895 and Loanside cottage nearby to the east of the access track to the farm buildings.

A derelict row of cottages is located at NS903901. A parallel row of pylons originating from Longannet Power station run across the site between Inch of Ferryton and Park Farms, carrying cables to Denny substation.

There is little in the way of woodland or hedgerow in the area with the only substantial area of hedgerows present alongside access tracks at Kennet Pans, Loanside, and isolated small patches of woodland at Kennet Pans, Loanside, Inch of Ferryton and on the south bank of the Black Devon.

The site is adjacent to the area designated as the Upper Forth Estuary as part of the River Basin Management Plan process, which covers 9.67 km^2 from Kincardine Bridge to Stirling on the south shore and from Stirling to Kincardine on the north shore. It has been classified as a Heavily Modified Water Body and has Poor Ecological Potential with a current ecological status of Poor and an overall chemical status as Pass.

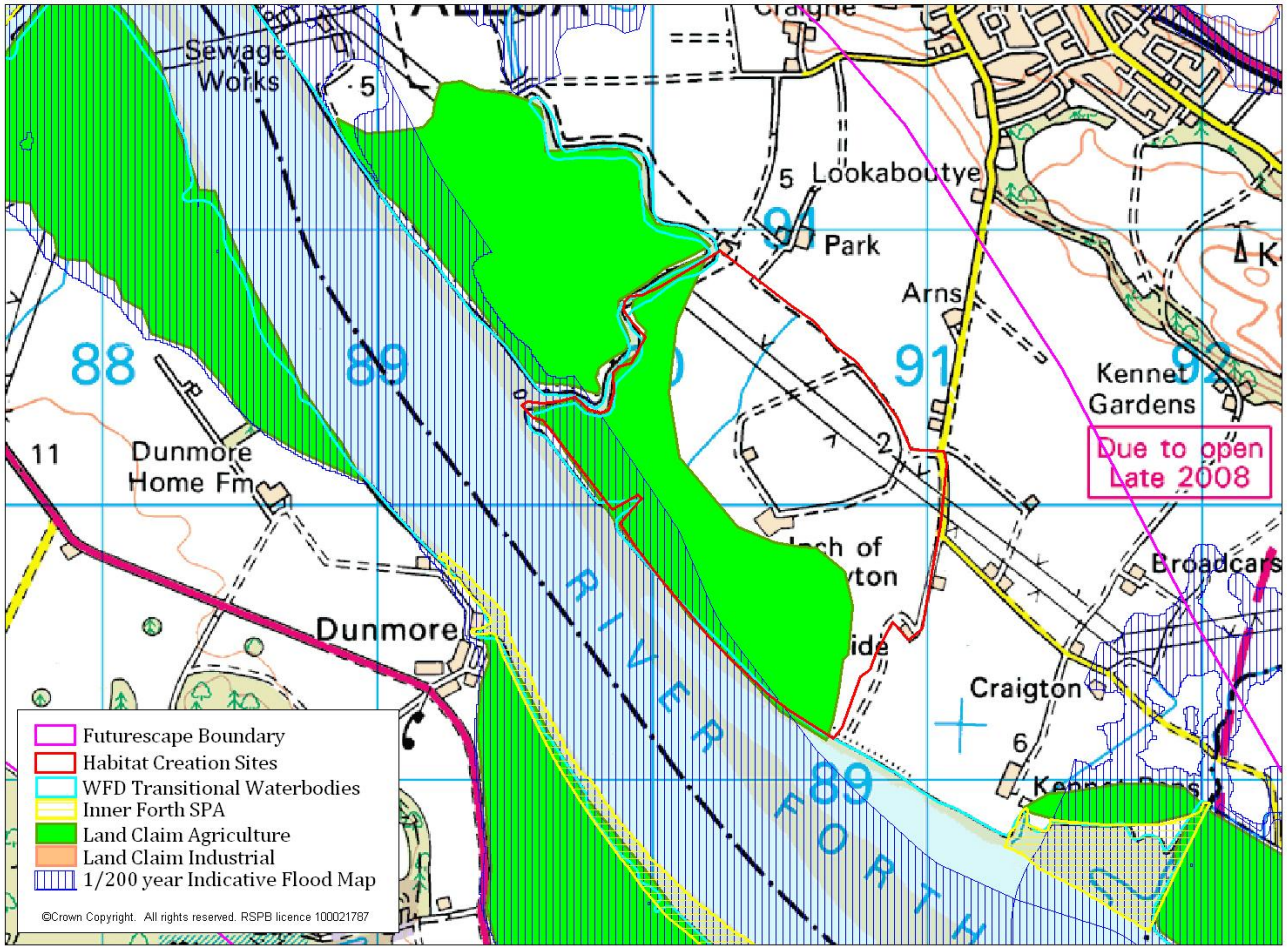


Figure 7: Land claim and flood risk at Inch of Ferryton and Park Farm

SEPA have established an ongoing programme of monitoring to identify pressures and measures which will protect or improve the status of water bodies in order that good status is achieved over successive RBMP cycles. Targets and environmental objectives have been set for the Upper Forth Estuary to maintain Poor ecological potential for the RBMP cycles in 2015 and 2021 with Good Ecological Status achieved by 2027. Pressures identified in the Upper Forth Estuary include morphological alterations in the form of historical land reclamation, point source pollution in the form of inputs and sewage treatment.

Table 1: Site summary

Site name	Inch of Ferryton
Location and Local Authority Area	Clackmannan, Clackmannanshire
Grid Reference	NO9089
Area	160 ha
Ownership	Earl of Mar and Kellie
Access	Track accesses site from B910 at Loanside. Single track road from B910 then unclassified private road at Inch of Ferryton Access road to Park Farm from Craigrie Road, Clackmannan Footpath from Black Devon wetlands via Park Farm.
Buildings and services	Park Farm is adjacent to the area and Inch of Ferryton lies within the area. Arn Farm and Loanside cottage and farm buildings are in the immediate vicinity. Services include an electrical supply to the pumphouse and water supply for livestock
Designations	None
Liabilities and health and safely issues	The farm buildings at Inch of Ferryton lie at 3m OD and would require a substantial secondary defence to be constructed should a regulated tidal exchange/ managed realignment scheme proceed. A substantial 5-6m high earth, concrete and rubble embankment forms the southern boundary of the site and would require assessing, surveying, extensive repair and on-going maintenance. The site is drained by electric pumps operated from a pumphouse and discharging into the Forth via twin pipes exiting through the embankment. The affect of ceasing pumping operations will have to be factored in to any change in land management/ habitat creation proposal. Two parallel power lines traverse the site between Inch of Ferryton and Park Farm connecting Longannet Power Station to a substation at Denny. Issues relating to the degree of protection required for the foundations and likelihood of relocating pylons surrounding wayleaves in respect of the pylons require further investigation.

	The area is within a Coal Authority Development Referral Area and would require a non-residential mining report from the Coal Authority before any works or investigations commenced. At least one pipelines crosses the Forth under the site with an associated compound located at the north west of the site near the mouth of the River Black Devon immediately landward of the embankment. The location of this infrastructure constrains any proposal north of the inlet.

Future Vision

Inch of Ferryton is one of the largest habitat restoration and creation sites on the Inner Forth. The creation of over 100 ha of intertidal, wetland and associated habitats has made a significant contribution to an enhanced and sustainable level of flood protection for the area and to the objective of achieving Good Ecological Potential by 2027 by removing morphological pressures.

The proximity of wetland habitats at Black Devon to the north and Kennet Pans to the south east means Inch of Ferryton is the centre of an extensive wetland of over 200 ha, considerably enhancing the conservation value of the area and transforming it from one a landscape of rectilinear agricultural fields and artificial embankments to a more naturally functioning landscape with a mosaic of habitats including intertidal habitats, saline lagoons, brackish pools, ditches and open water.

Conservation Interest and Potential

The area is currently of limited conservation interest due to the relatively intensive arable and livestock farming being undertaken on the site with the aid of pumped drainage. The area is currently in agricultural production mainly arable production (wheat and barley) plus hay and silage. There are small numbers of grazing livestock (beef cattle) present on improved grassland. Areas of rough and rank grassland, hedgerows and scrub currently present will be important for invertebrates and farmland bird species. There is a population of tree sparrows in the area plus numbers of grey partridge.

There are no designations on the site but is adjacent and opposite to the Firth of Forth SSSI and SPA at Kennet Pans and on the opposite shore from the Airth to Dunmore foreshore. Due to the embankment there is no saltmarsh present between Kennet Pans and Alloa with the exception of a very small

Figure 8: Inch of Ferryton Farm looking west from access track at Loanside

area at the inlet creek.

There is considerable potential to create a range of wetland habitats on a fairly large scale at the site which would contribute to landscape scale conservation objectives, greatly enhance the conservation value of the area and provide a significant area which could potentially alleviate the effects of climate change and mitigate against pressures created by disturbance elsewhere in the Inner Forth.

To realise the conservation potential of the area would mean a fundamental change in the way that the land is managed with a move from intensive arable production to a change in the water management system or by carrying out a managed realignment scheme involving either a breach or removal of the embankment or installing a regulated tidal exchange system.

The area is suitable for a managed realignment scheme, meeting the relevant criteria and being in a middle estuary location with good salinity and a source of colonising invertebrates and saltmarsh plants immediately downstream and upstream. The composition of the muds on the north bank of the Forth at this point in the estuary would be suitable for colonisation of invertebrate species preferred by waders and ducks as seen at the Kennet Pans managed realignment site 1.3 km downstream from Inch of Ferryton.

The exact areas of habitat potential for inter-tidal, saltmarsh, brackish pools and reedbed, would be determined and informed by detailed feasibility studies with due consideration of the constraints present.

Current and potential bird numbers

There is no detailed information available at present regarding bird numbers at Inch of Ferryton for either farmland or wetland species. WeBS counts are undertaken at Kennet Pans and grey partridge, skylark, tree sparrow and yellowhammer are present in the area, with pink-footed and greylag geese frequenting the arable stubbles in the winter months.

The restoration and creation of wetland habitats, either freshwater or intertidal/ saltmarsh, would provide suitable conditions for breeding waders such as lapwing, oystercatcher and redshank, possibly curlew and snipe. Any habitat creation or restoration would have to ensure the populations of red or amber listed farmland bird species are not compromised and the design should incorporate suitable habitat for these species by retaining mature trees, rank grasslands and arable areas. The creation of intertidal habitat would benefit species such as teal, shelduck, dunlin, black-tailed godwit and bar-tailed godwit which have responded positively to the managed realignment scheme downstream at Kennet Pans.

Other biodiversity

There is little information about other biodiversity at Inch of Ferryton.

Management Activities and Options

The area is currently in agricultural production, primarily arable with silage/hay production plus grazing livestock and is pump drained using electric pumps.

The potential of the site involves changing the land management from one of agricultural production to restoration and development of wetland habitats. The site offers considerable potential to create or restore habitats either by altering the existing land management operations by removing the pump drainage system or undertaking a managed realignment project. This could be done either by means of a regulated tidal exchange system or by a breaching or removal of the embankment.

The site is ideally placed within the estuary for carrying out a managed realignment or regulated tidal exchange scheme but there are several major constraints in the area which will have a significant bearing on the potential outcome.

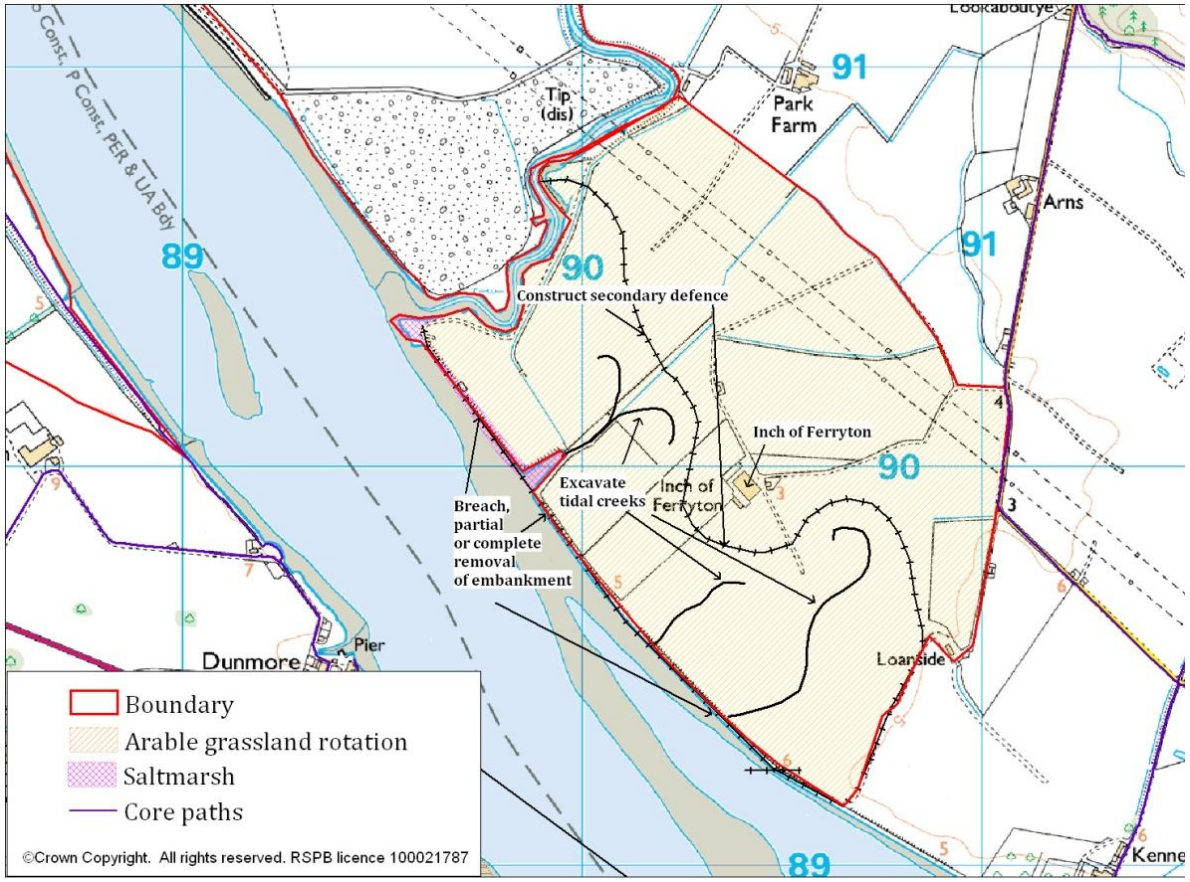


Figure 9: Current habitats and management proposals

The area of reclaimed land between Alloa and Kennet Pans forms a broad bay shape and as half this area is the former landfill tip at Black Devon any managed realignment or regulated tidal exchange scheme will have to carefully consider the effects any alteration to estuarine functionally may have on the area further upstream. Depending

on the method of managed realignment employed there is a risk the area may become adversely exposed and create an artificial obstruction to the flood tide.

The farm buildings at Inch of Ferryton lie at 3m OD, almost in the centre of a potential managed realignment site. This would entail building a substantial secondary defence to defend the farm and designing a scheme around the farm which obviously restricts the amount of land available for habitat creation. The derelict cottages to the north of the farm could be left in situ or demolished.

The parallel rows of pylons that traverse the site present a major constraint as any scheme would have to take into account provision of protection for the foundations. The presence of cables in the area may cause problems with potential bird strike in the future once wetland habitats become established and pre-emptive work would have to be considered in advance of work commencing.

There is at least one pipeline crossing the Forth in the area, with associated infrastructure located landward of the embankment at NS897901 and this would obviously have a bearing on the design of a scheme, as the operators would need to support any change to the land management. Access to the compound would have to be maintained along the existing route.

There are several buildings in the vicinity which could potentially be directly or indirectly affected by any developments

Table 2: Options available for future management

	Option A - Do Nothing	**Option B – Maintain Embankment/ Drainage system**	**Option C – Freshwater Habitat Enhancement and Creation**	**Option D – Regulated Tidal Exchange**	**Option E - Managed Realignment**
Description	Maintain current situation	Maintain embankment & operation of pumps	Creation of freshwater/ brackish habitats	Installation of a regulated tidal exchange system	Managed realignment
Works needed	Continued operation of drainage system	Extensive remedial and repair work will be required to upgrade and raise 1.8km embankment to provide the recommended level of protection to the surrounding area eg 1:250 year flood event	Hydrological management works as determined by results of ecological, hydrological and geomorphological surveys – earthworks, ditch clearance, installation of water control structures.	Construction and installation of tidal exchange structure, earth moving, rubble and waste removal, , re-grading of material into fields, construction of secondary defence, re-instatement of creek	Embankment removal, waste removal, earth moving, re-grading of material, construction of secondary defence, re-instatement of creek system, relocation of control structures

		Maintain operation of pumps	Vegetation control – mechanical or by grazing – install or relocate necessary infrastructure eg fencing, crossing points, watering facilities for livestock. Removal of existing water control and drainage infrastructure	system, removal and relocation of existing drainage infrastructure.	
Constraints	n/a	n/a	Drainage of the site is via electrically operated pumps fed by a series of ditches into which land drains run. A parallel row of pylons traverses the site from east to west between Inch of Ferryton Farm and Park farm. Maintenance of embankment would have be to undertaken to ensure no overtopping or breaches occur which would compromise freshwater habitats.	Drainage of the site is via electrically operated pumps fed by a series of ditches into which land drains run. A parallel row of pylons traverses the site from east to west between Inch of Ferryton Farm and Park farm. Farm buildings and houses at Inch of Ferryton, Park Farm and Loanside are within the area and buildings at Kennet Pans and Arns are adjacent to the area.	Drainage of the site is via electrically operated pumps fed by a series of ditches into which land drains run. A parallel row of pylons traverses the site from east to west between Inch of Ferryton Farm and Park farm. Farm buildings and houses at Inch of Ferryton, Park Farm and Loanside are within the area and buildings at Kennet Pans and Arns are adjacent to the area.

			Farm buildings and houses at Inch of Ferryton, Park Farm and Loanside are within the area and buildings at Kennet Pans and Arns are adjacent to the area		
Site assessment needed	n/a	Assessment of condition of embankment	Detailed ecological, topographic, hydrological and geomorphological assessments will be needed to inform future habitat creation and management including assessment of current water control system. Baseline ecological information including invertebrate populations, botanical interest, Flood risk assessment focusing on embankment	Detailed ecological, topographic, hydrological and geomorphological assessments will be needed to inform future habitat creation and management including assessment of current water control system and impact of RTE on estuarine function particularly with regard to impacts on shoreline in surrounding area. Baseline ecological information including invertebrate populations, botanical interest, Flood risk assessment focusing on embankment	Detailed ecological, topographic, hydrological and geomorphological assessments will be needed to inform future habitat creation and management including assessment of current water control system and impact of managed realignment on estuarine function particularly with regard to impacts on shoreline in surrounding area. Baseline ecological information including invertebrate populations, botanical interest, Flood risk assessment focusing on embankment
Timescale	n/a	Immediately	Within 5 years	10-20 years	10 - 20 years

Demonstration site potential	n/a	n/a	A good location to demonstrate habitat creation, to develop understanding and build awareness of landscape scale conservation to local communities, statutory agencies, MSP's.	Inch of Ferryton would be an ideal location on the Inner Forth to develop understanding and build awareness of landscape scale conservation to local communities and decision makers.	Inch of Ferryton would be an ideal location on the Inner Forth to develop understanding and build awareness of landscape scale conservation to local communities and decision makers.
Threats to conservation interest/potential	The conservation and flood management potential of the site would not be realised if status quo maintained	The conservation and flood management potential of the site would not be realised if status quo maintained	n/a	n/a	n/a
Consents required	n/a	Initial consultation with local planners would determine planning consent requirements. As the site is adjacent to a SSSI and SPA, consent would be required from SNH for any works. SEPA regarding RBMP Marine Scotland re FEPA licence	Works would require EIA, Appropriate Assessment and full planning consents. CARS licenses As the site is adjacent to a SSSI and SPA, consent would be required from SNH for any works and would be involved in the planning, development and management of the project.	Works would require EIA, Appropriate Assessment and full planning consents. CARS/ FERA licenses As the site is adjacent to a SSSI and SPA, consent would be required from SNH for any works and would be involved in the planning, development and management of the project.	Works would require EIA, Appropriate Assessment and full planning consents. CARS/ FERA licenses As the site is adjacent to a SSSI and SPA, consent would be required from SNH for any works and would be involved in the planning, development and management of the project. Public consultation would be required and communications plan

			Public consultation would be required and communications plan produced	Public consultation would be required and communications plan produced	produced
Capital costs	n/a	The costs of raising and upgrading the embankment would be considerable and would be borne by the landowner if grant-aided funding not available Cost = high	The costs of implementing a freshwater habitat creation scheme would be considerable involving earthworks, regrading of material, construction of bunds, provision of new drainage structures, land purchase and associated legal costs. Cost = high	Capital costs will involve construction and installation of tidal exchange infrastructure, earthworks, regrading of material, construction of secondary defence, provision of new drainage structures, land purchase and associated legal costs Cost = high	Capital costs will involve removal or partial removal of embankment, , earthworks, regrading of material, construction of secondary defence, provision of new drainage structures, land purchase and associated legal costs Cost = high
Set up costs	n/a		Design of scheme, manufacture of water control structures, specialised machinery and staff recruitment and existing staff time.	Design of scheme, manufacture of water control structures, specialised machinery and staff recruitment and existing staff time.	Design of scheme, manufacture of water control structures, specialised machinery and staff recruitment and existing staff time.

Management costs	n/a	Inspection, maintenance and repair costs.	Ideally the project will be designed to minimise future management requirements other than routine maintenance of drainage control structures and any other earthworks undertaken. A monitoring programme to evaluate the outcome of the project would be necessary over at least 5 years and at appropriate intervals beyond.	Ideally the project will be designed to minimise future management requirements other than routine maintenance of drainage control structures and any other earthworks undertaken. A monitoring programme to evaluate the outcome of the project would be necessary over at least 5 years and at appropriate intervals beyond	Ideally the project will be designed to minimise future management requirements other than routine maintenance of drainage control structures and any other earthworks undertaken. A monitoring programme to evaluate the outcome of the project would be necessary over at least 5 years and at appropriate intervals beyond
Immediate actions required	n/a	Assessment of embankment	See constraints	See constraints	See constraints
Funding opportunities	n/a	Individual landowner. Scottish Government flood and coastal defence.	The scope and potential benefits of the project would make the proposals an attractive proposition. Funding streams from local and national industrial concerns, trusts, statutory agencies and European sources	The scope and potential benefits of the project would make the proposals an attractive proposition. Funding streams from local and national industrial concerns, trusts, statutory agencies and European sources	The scope and potential benefits of the project would make the proposals an attractive proposition. Funding streams from local and national industrial concerns, trusts, statutory agencies and European sources

Access and Interpretation and Opportunities

The area has several vehicular and pedestrian access points leading from the B910; at Loanside a track leads to farm buildings passing Loanside Cottage then continues along the crest of higher ground towards the embankment where it ends. There is no footpath along the top of the embankment or alongside although farm vehicles are able to drive parallel to the embankment. Inch of Ferryton Farm is accessed by a road leading off the B910 with a track leading off to the north then returning to the farm past the derelict cottages to the farm forming a loop. The track continues in a north easterly direction where the track veers west continuing at this point on to Park Farm. A short track leading from Inch of Ferryton farm accesses the fields to the south of the farm buildings. Park Farm is accessed from Craigrie Road, Clackmannan. A track leads from Park Farm to the fields south of the farm and further tracks access the farm from Black Devon wetlands. The nearest Core Paths run along the B910 (Core Path 101) and along Craigrie road and track towards Alloa (Core Path 6). National Cycle Route 76 passes runs along the B910.

Table 3: Current and potential access and interpretation

Facility	Current	Potential
Footpaths	Network of tracks and footpaths (not including B910) approximately 4 km	Dependant on design of habitat creation scheme
Vehicular	1.1km	No increase
Directional signage	None	High quality branded signage 'Inner Forth trail'
Interpretation	None	Interpretation of project, site history and wildlife

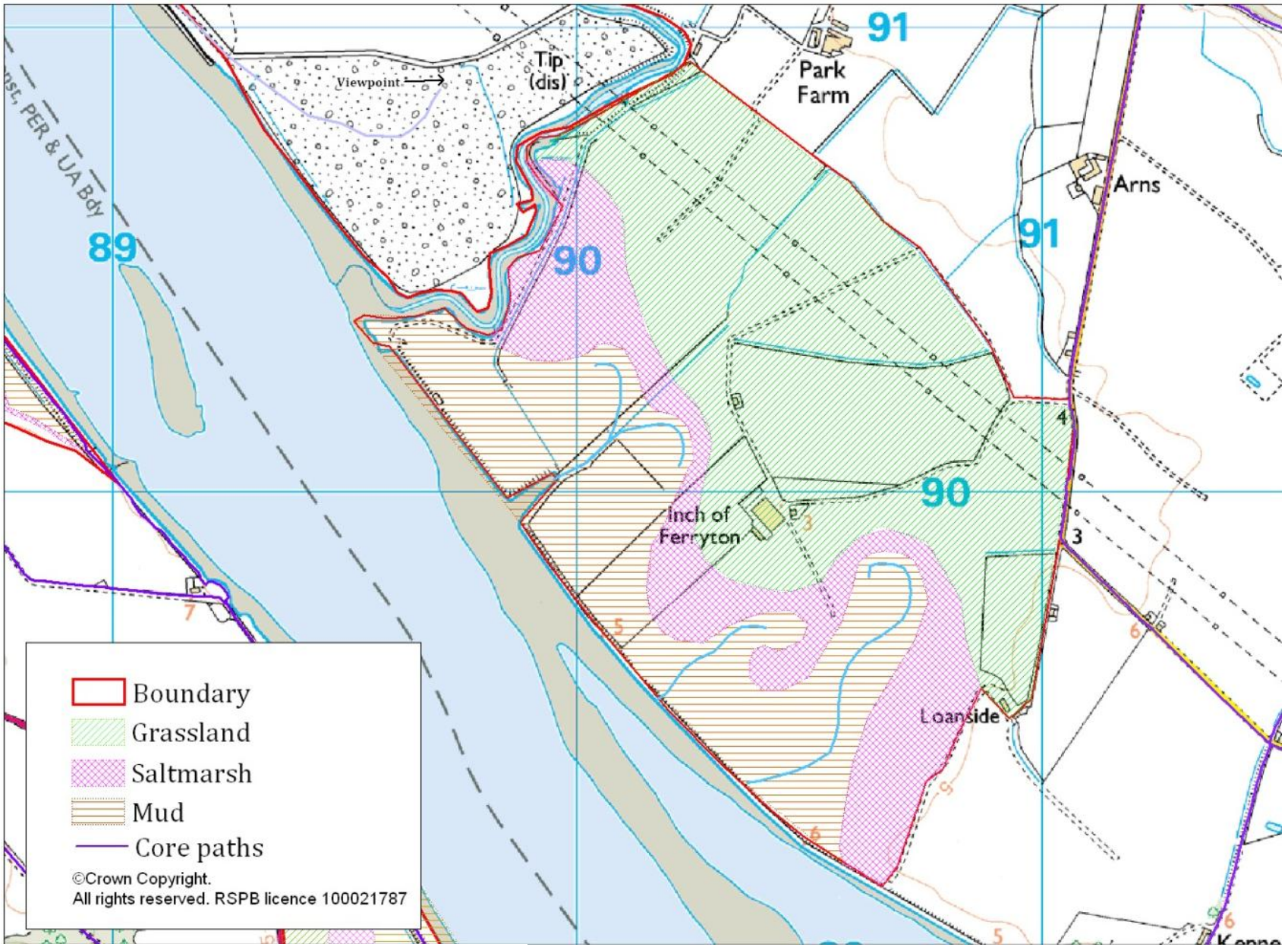


Figure 10: Outcome map for Inch of Ferryton and Park Farm

Recommendations

Inch of Ferryton is a complex site with several major constraints which may ultimately determine or influence the outcome of any design plans. With predicted sea level rise and increased rainfall leading to increased chance of flood events, Option A is unsustainable in the long-term. Any flood events would have potentially serious consequences for land, property and infrastructure in the area should existing the embankment fail through breaching or overtopping. Preventing this using Option B assumes a significant investment on behalf of the landowner if no grant-aid is available and this option is therefore entirely dependant on landowner goodwill and financial ability. Flood management in the Inner Forth requires a strategic and equitable approach which this option does not provide.

As the surrounding land drains through the area into the Forth it would be possible to manage and control the water to create a freshwater habitat (Option C) which would undoubtedly prove attractive to biodiversity and would be worthwhile from this perspective. However, the multi-functional value of such a scheme is limited and as with Options A and B, such a scheme would have a limited lifespan with costs of maintaining the embankment potentially proving onerous. Options D and E are both realistic and both have merits in terms of habitat creation, flood management and landscape scale conservation. Detailed feasibility studies involving hydrodynamic modelling would inform a final design but in terms of long-term sustainability and benefits Option E would be the cost-effective option to pursue if feasibility studies show that a managed realignment scheme is technically possible.

Table 4: Options Appraisal

Strengths					Weaknesses				
Option A	**Option B**	**Option C**	**Option D**	**Option E**	**Option A**	**Option B**	**Option C**	**Option D**	**Option E**
n/a	Increase in local flood protection in short term Maintain production value of	Creation of wetland habitat Links to Black Devon Wetlands	Fits MR criteria Reduced costs to maintain in long term Reduces	Fits MR criteria Maximum contribution to estuarine functionality Reduced long-term	Not sustainable in long term	High cost Expensive to maintain and repair Maintains conditions leading to	Not sustainable in long term	High initial cost Potentially technically complex	High initial cost Potentially complex project Potential negative effect on

	farmland		flood risk Contribute to WFD objectives	maintenance costs Reduces flood risk Contributes to WFD Maximises habitat creation		coastal squeeze Sea level rise will accentuate problems with local drainage system			estuarine function
Opportunities					**Threats**				
Option A	**Option B**	**Option C**	**Option D**	**Option E**	**Option A**	**Option B**	**Option C**	**Option D**	**Option E**
n/a	n/a	Community involvement Improved access	Community involvement Improved access Develop saltmarsh grazing	Community involvement Improved access Develop saltmarsh grazing	n/a	Lack of funding	Lack of funding	Lack of funding Existing infra-structure Concerns from local residents	Lack of funding Concerns from local residents

Appendix 12: Kennet Pans Site Assessment

Introduction

This site assessment has been produced following a desktop review of available information, site visits and initial discussions with stakeholders and land managers. The recommendations made are based on current knowledge. Further consultation with communities and landowners and detailed technical assessments will be required to develop and confirm proposals.

Site Description

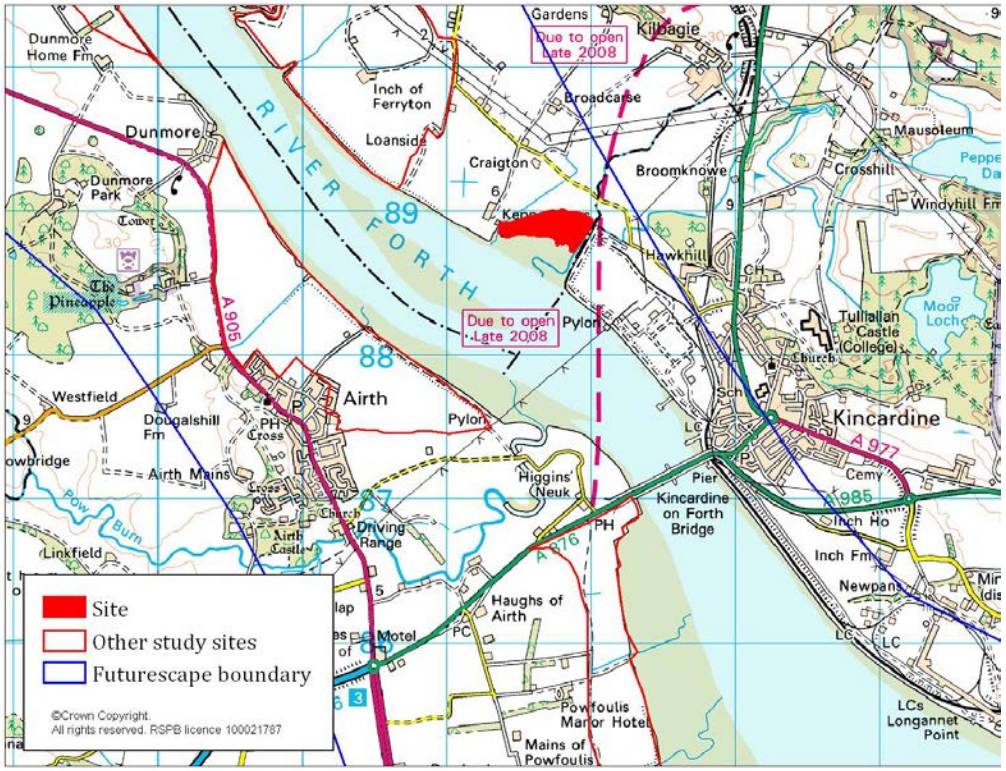


Figure 1: Location of Kennet Pans

This small area of reclaimed land is located on the north shore of the Forth immediately to the east of the Clackmannanshire Bridge within a small embayment. It lies between two creeks (Kennet Pans 'harbour' and Canal Burn) and adjacent to a managed realignment scheme carried out in 2008 as part of the bridge construction works. To the west of the site stand the ruins of the Kennet Pans distillery, a scheduled monument, plus associated outbuildings and infrastructure.

The site consists of a single 7 ha oval shaped field, which lies below the 5 m contour. There is an earth bank running along the north and south boundaries and a 4m wide bank at the eastern end separating the field from the creek.

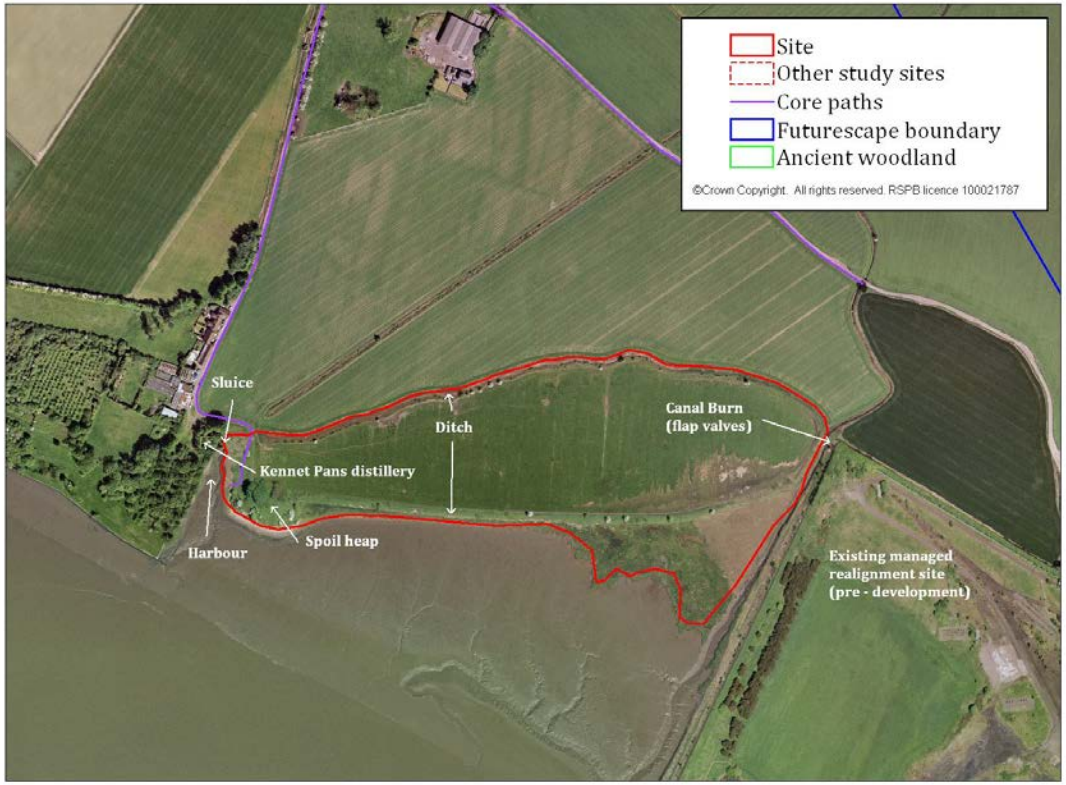


Figure 2: Overview Map of Kennet Pans

An over grown 'blind' ditch, originating from the creek at the derelict Kennet Pans distillery, runs west to east via a sluice and through a culvert and north of the northern embankment appearing to end just short of the Canal burn.

A ditch on the landward southern side of the field originates at the harbour creek and flows towards the Canal Burn creek. The Canal Burn feeds into the Forth via a sluice with pipes fitted with flap valves.

The field is fenced and accessed via a gate at the north west corner. A disused plant nursery and a row of residential cottages stand 300 m from the north west corner of the site. A small, well vegetated bing lies on the south west corner of the site, which is comprised of mining spoil or ballast from ships using the now almost disappeared 18th and 19th century harbour. It is approximately 10 m high and occupies about 0.25ha.

The embankment on the southern edge of the field measures 620 m long and shows signs of considerable erosion and undermining particularly around the mid-point. The northern embankment is higher and more substantial at the eastern end, although there is a noticeable low point adjacent to a sluice which controls the tidal influence inland from the Forth into the Canal Burn.

Figure 3: Disused sluice at Kennet Pans

The field is currently improved pasture with several poached areas and wet 'flashes' , particularly at the southern and northern edges. These will have a saline influence via the surrounding ditches.

Immediately to the south of the site is approximately 14 ha of intertidal mud, 2ha of saltmarsh and 1ha reedbed, designated as part of the Firth of Forth SPA. The saltmarsh found at Kennet Pans is similar to that found on the south shore of the Forth at Pow Burn (almost immediately opposite) and at Skinflats. While the saltmarsh present is characteristic of an accreting saltmarsh there is

Figure 4: Kennet Pans site from top of bing, looking north east, May 2011

Figure 4: Kennet Pans looking north west, May 2011

Figure 5: Southern embankment showing evidence of erosion May 2011

evidence that in places it is eroding with scattered fragments of marsh present in the mudflats and presence of a low cliff. These features indicate deposit and accretion of sediment at high tides but wave erosion is resulting in the formation of a saltmarsh cliff. (Kennet Pans Feasibility study, 2003) A small 'island', accessible at low tide lies immediately to the south just off the newly created mudflats.

The site is adjacent to the area designated as the Upper Forth Estuary as part of the River Basin Management Plan process, which covers 9.67 km^2 from Kincardine Bridge to Stirling on the south shore and from Stirling to Kincardine on the north shore. It has been classified as a Heavily Modified Water Body and has Poor Ecological Potential with a current ecological status of Poor and an overall chemical status as Pass.

SEPA have established an ongoing programme of monitoring to identify pressures and measures which will protect or improve the status of water bodies in order that good status is achieved over successive RBMP cycles. Targets and environmental objectives have been set for the Upper Forth Estuary and aim to maintain Poor ecological potential for the RBMP cycles in 2015 and 2021 with Good Ecological Status achieved by 2027. Pressures identified in the Upper Forth Estuary include morphological alterations in the form of historical land reclamation, point source pollution in the form of inputs and sewage treatment.

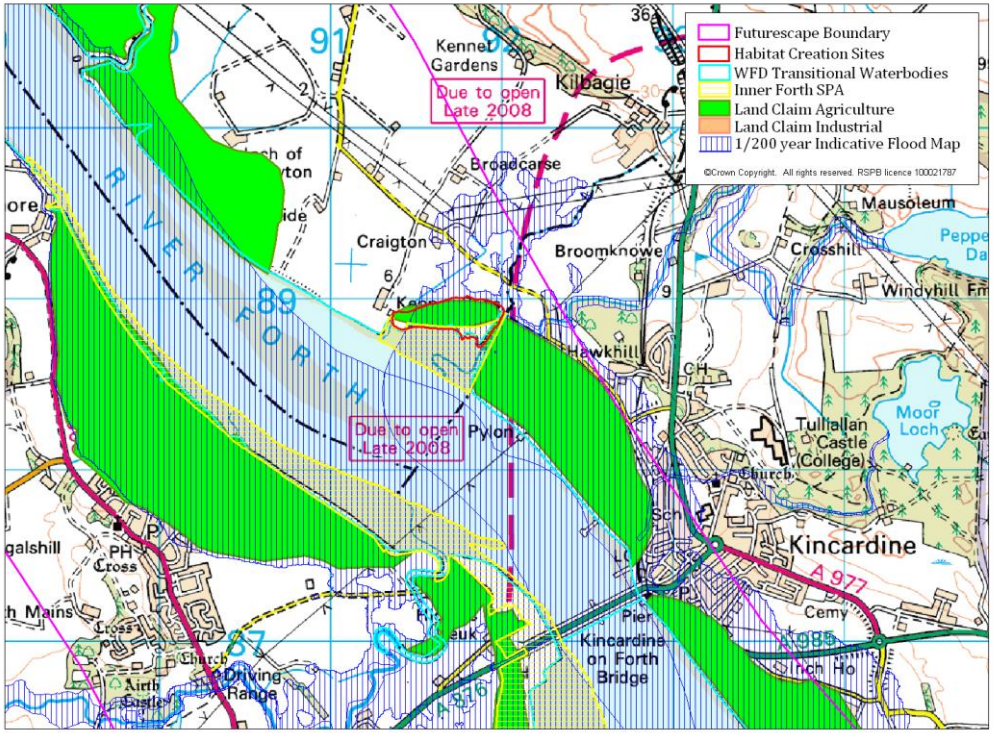


Figure 6: Land claim and flood risk at Kennet Pans

Future Vision

Kennet Pans is a small but significant site on the Inner Forth and links to other existing and potential habitat creation sites immediately adjacent and nearby. Kennet Pans is now an extension to the adjacent successful habitat creation scheme at Clackmannanshire Bridge, forming one contiguous 25 ha wetland that provides habitat for waders, wildfowl and other biodiversity. Visitors have the opportunity to view the site, utilising existing footpaths and infrastructure in the immediate area and enjoy both the wildlife and industrial heritage of Kennet Pans. The project has reduced flood risk to residents at Kennet Pans, with an improved embankment and contributed to the objective of achieving Good Ecological Potential by 2027 by removing morphological pressures.

Table 1: Site summary

Site name	Kennet Pans
Location and Local Authority Area	Kennet Pans, Clackmannanshire
Grid Reference	NT917889
Area	7 ha
Ownership	Private
Access	Access to site is via an unclassified/ private road which leads to a row of cottages at Kennet Pans from the Kincardine to Clackmannan road at NT914894.

Buildings and services	No buildings on the site itself
Designations	Adjacent to SSSI & SPA
Liabilities and health and safely issues	The area is within a Coal Authority Development Referral Area and would require a non-residential mining report from the Coal Authority before any works or investigations commenced. There is a concrete sluice at the eastern end of the site draining Canal Burn and a ditch flowing from Kincardine in to the creek. There is a stone culvert under the bank connecting the north and south bank which would require assessing prior to any machinery movements taking place.

Conservation Interest and Potential

The 7 ha improved field at Kennet Pans is currently grazed by cattle during the summer months. The field is wet and floods during the winter months, attracting reasonable numbers of feeding curlew and other waders. It is subject to occasional saline influence via ditches and seepage through the embankment. It is not known if the field has been under cultivation but a crop of hay or silage appears to have been taken off. The adjacent managed realignment site is used by waders and waterfowl to feed and roost and a significant pink-footed geese roost has developed in the winter months in recent years. A NVC survey summarised the site as an interesting and diverse collection of saltmarsh communities and this appears to be intact and in a healthy condition.

There is considerable potential to develop the conservation interest at Kennet Pans and the area is ideally located to extend the successful managed realignment site, which would obviously increase the intertidal habitats available to feeding waders and wildfowl. The development of intertidal mud and saltmarsh on the site would reduce the area available for grazing but limited grazing may be possible on developed saltmarsh. The exact ratio of habitats would be determined by results of hydrological, geomorphological surveys but perhaps about 4 ha inter tidal and 3 ha of saltmarsh could develop.

Current and potential bird numbers

Despite its small size, Kennet Pans is an important site on the Inner Forth for a number of species which feed in the managed realignment area and species such as redshank use the 'island' as a secure ,nocturnal roost site.

Other biodiversity at Kennet Pans

There is little information about other biodiversity at Kennet Pans, although otters are present in the area (author's observation).

Table 2: Current and potential bird numbers at Kennet Pans

Species	Current	Potential
Breeding (prs)		
Redshank	1	3-4 prs
Reed bunting	2	4-6 prs
Wintering (peak count winter 2010/11)		
Pink-footed goose		
Teal	183 (Sept 10)	300
Redshank	35 (Nov 10)	100
Shelduck	137 (Feb 11)	200
Oystercatcher	40 (Feb 11)	100
Dunlin	77 (Feb 11)	150
Black-tailed godwit	26 (Feb 11)	100
Bar-tailed godwit	23 (Feb 11)	100
Curlew	255 (Feb 11)	300
Potential colonists		
Curlew	Possible breeding if correct habitat provided	
Twite	Possible wintering if saltmarsh extended	

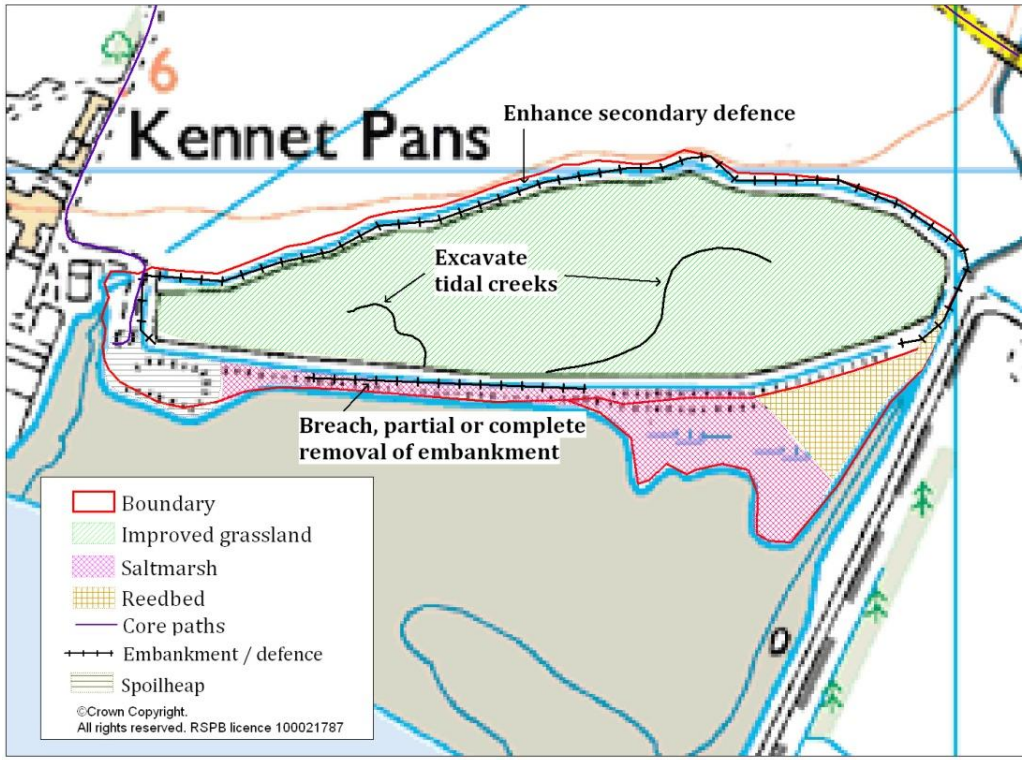


Figure 7: Existing habitat and management proposals

Management Activities and Options

The site is grazed by a small herd of beef cattle in the summer months. There is no evidence of recent maintenance carried out to the earth and turf embankments surrounding the site and ditches have no evidence of recent clearing although the southern ditch is clear of vegetation.

At present the site is of limited conservation value although has some interest in terms of a feeding area for waders particularly curlew. A 'do nothing' option would almost certainly result in the embankment being overtopped or failing in a flood event, resulting in a unplanned incursion of water into the area. This would have a detrimental effect on the grazing value of the field and possibly the arable areas to the north although the adjacent fields lie at a higher elevation.

There is considerable potential at the site for habitat creation or restoration involving either enhancing the existing habitat by adapting the current hydrological regime or by carrying out a managed realignment project. The area has previously been identified as suitable for managed realignment (Geowise, 1999) and a similar size managed realignment project was carried out as part of the Clackmannanshire Bridge construction work in 2008 immediately to the south east. The site would appear to be ideal and meets all criteria for a managed realignment project although the limited area may preclude a project due to relative cost. A managed realignment scheme could involve either complete removal of the existing embankment and regrading of the material into the field or breaching the embankment in one or two locations. The existing embankment to the north of the ditch could be enhanced to provide a secondary defence. The immediate area around the bing would have to be assessed and the defence possibly keyed into the bing via the existing track. The size of the site may preclude the complete removal of the embankment on cost grounds and a breach may be the preferable option. Earthworks may be necessary to provide drainage and speed up restoration of saltmarsh.

Table 3: Options Available for Future Management

	Option A – Do Nothing	Option B Maintain Embankment	Option C - Habitat Enhancement and Creation	Option D - Managed Realignment
Description	Maintain current situation	Maintain embankment	Creation of habitats	Managed realignment
Works needed	n/a	Raise and widen existing 0.6km earth embankment to provide protection to 1:250 year flood event standard.	Limited earthworks eg creation of shallow pool, ditch clearance.	Partial (breach) or complete embankment removal, earth moving, re-grading of material into field, upgrading of northern embankment/secondary defence, possible re-instatement of creek system. Removal and relocation of fencing.
Constraints	n/a	n/a	None	See liabilities (Table 1.)
Site assessment needed	n/a	Assessment of condition of embankment	Detailed ecological, hydrological, topographical, geological, land-use and historical surveys would inform precise course of any habitat management.	A design and impact study to determine the nature or size of breach, level of flooding, future works necessary and impact of estuarine functionality would be necessary. A geotechnical investigation regarding material for secondary defence/ embankment fill and a local drainage study would be necessary.

				The site lies within the Coal Authority referral area and a coal mining report would be required as part of a detailed feasibility study. A flood risk assessment may be necessary.
Timescale	n/a	Immediate	2-5 years	5 – 10years
Demonstration site potential	n/a	n/a	Kennet Pans would be an ideal location on the north shore of the Inner Forth to develop understanding and build awareness of landscape scale conservation to local communities and decision makers.	Kennet Pans would be an ideal location on the north shore of the Inner Forth to develop understanding and build awareness of landscape scale conservation and managed realignment to local communities and decision makers.
Threats to conservation interest/potential	If the site were to become available on the open market there is the possibility of a change in land use and may prove attractive to wildfowling	n/a	If the site were to become available on the open market there is the possibility of a change in land use compromising the conservation interest Continued erosion of the earth embankment coupled with rising sea levels will ultimately	If the site were to become available on the open market there is the possibility of a change in land use compromising the conservation interest. Continued erosion of the earth embankment through wave action will lead to inundation of site.

	interests. Continued erosion of earth embankment through wave action will lead to eventual inundation of site.		lead to inundation of the site.	
Consents required	n/a	Initial consultation with local planners would determine planning consent requirements. As the site is adjacent to a SSSI and SPA, consent would be required from SNH for any works. SEPA regarding RBMP Marine Scotland re FEPA licence	Initial consultation with local planners would determine planning consent requirements. As the site is adjacent to a SSSI and SPA, consent would be required from SNH for any works and would be involved in the planning, development and management of the project. Consultation with neighbours and adjacent landowners would be necessary.	Initial consultation with local planners would determine planning consent requirements but could require EIA, Appropriate Assessment and full planning consents – a design and impact study would assist planners and other agencies. As the site is adjacent to a SSSI and SPA, consent would be required from SNH for any works and would be involved in the planning, development and management of the project. Consultation with neighbours, adjacent landowners and local

				community at an early stage would be vital.
Capital costs	n/a	The costs of upgrading and repairing the embankment could be considerable and would be borne by the landowner unless carried out as a grant-aided flood defence scheme. Cost = low	Capital cost would involve pool creation, ditch clearance. Cost = low	Capital costs will involve removal of existing embankment and regarding of material, construction of secondary defence, provision of new drainage structures, land purchase and associated legal costs. Cost = low
Set up costs	n/a	n/a	<£5k	>£50k
Management costs	n/a	Inspection, maintenance and repair costs.	Ideally the project will be designed to minimise future management requirements other than routine maintenance of any drainage control structures, secondary defences and any other earthworks A monitoring programme to evaluate the outcome of the project would be necessary over at least 5 years and at appropriate intervals beyond.	Ideally the project will be designed to minimise future management requirements other than routine maintenance of drainage control structures, secondary defences and any other earthworks A monitoring programme to evaluate the outcome of the project would be necessary over at least 5 years and at appropriate intervals beyond.
Immediate actions required	n/a	Assessment of embankment	None	None apparent
Funding opportunities	n/a	Individual landowner. Scottish Government	The scope and multi-functional potential benefits of the project	The scope and multi-functional potential benefits of the project

		flood and coastal defence.	would make this proposal an attractive proposition. Funding could come from Scottish Government, local and national industrial concerns, trusts, statutory agencies and European sources with contributions from private capital and NGOs.	would make this proposal an attractive proposition. Funding could come from Scottish Government, local and national industrial concerns, trusts, statutory agencies and European sources with contributions from private capital and NGOs.

Access and Interpretation Opportunities

There is currently no formal access or interpretation of any kind at Kennet Pans. Access is via a 0.5km unclassified/ private road leading to cottages near the derelict distillery complex.

Table 4: Current and Potential Access and Interpretation

Facility	Current	Potential
Tarmac road	0.5 km	No change
Footpath	Core path 102 ends at Kennet Pans, originates at Kennet near Clackmannan Core path 102 meets path 101 at junction of road to Clackmannan	Links to Fife Coastal Path at Kincardine.
Cycle Route	Passes to north of site	Develop link to Kennet Pans
Interpretation	None	Ideal location for shared information & interpretation regarding site and industrial heritage
Signage	None	Some low key signage would be required

Recommendations

With predicted sea level rise and increased rainfall leading to increased chance of flood events, Option A is unsustainable in the long-term. Any flood events would have potentially serious consequences for land, property and infrastructure in the area should the existing embankment fail either through erosion, overtopping or natural breaching. Option B requires a significant investment on behalf of the landowner if alternative funding is not available and is entirely dependant on goodwill and financial ability. Flood management in the Inner Forth requires a strategic and equitable approach which this option does not provide.

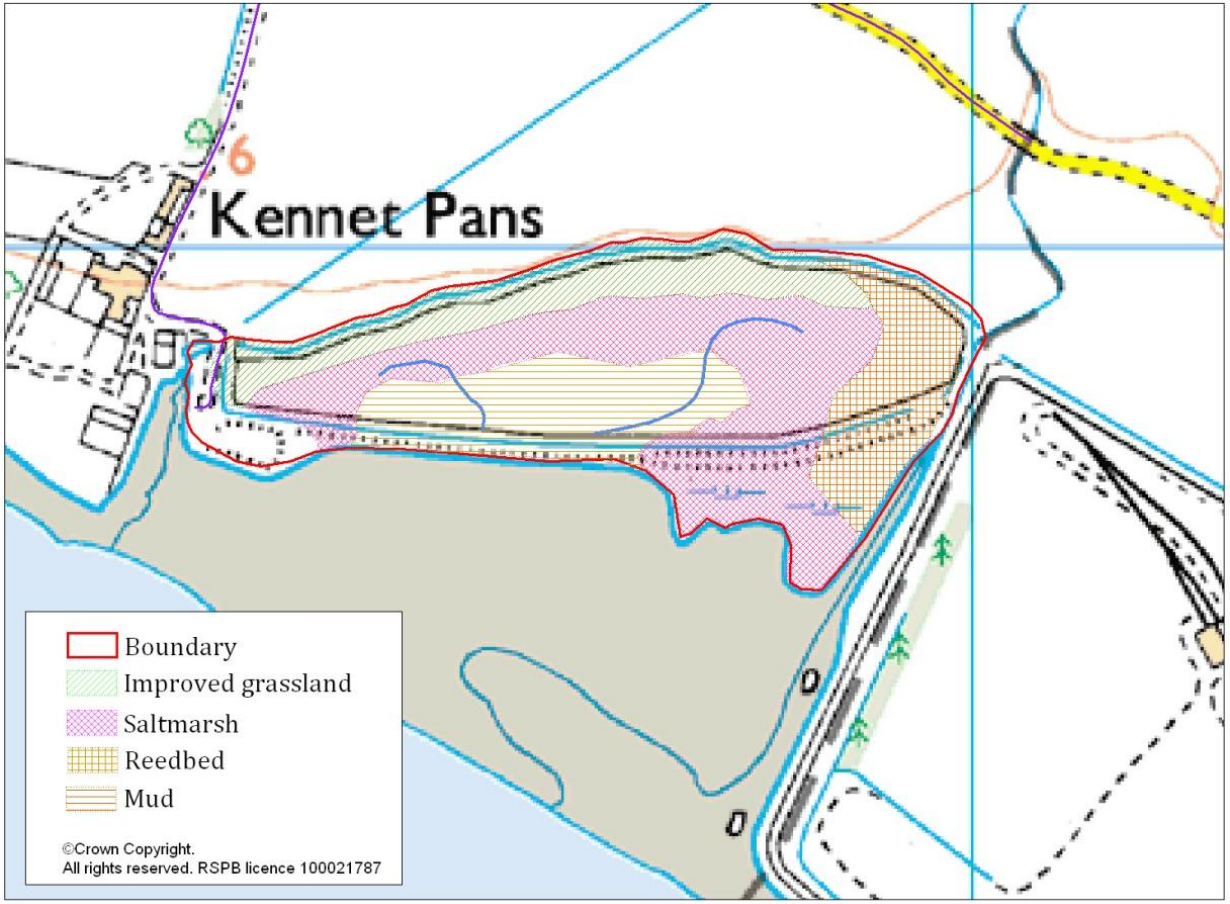


Figure 8: Outcome map for Kennet Pans

Option C provides an opportunity to create wetland habitat but will not be cost effective in the long-term as the embankment will ultimately fail in the future leading to inundation. The site at Kennet Pans fits the criteria for carrying out a small managed realignment scheme either by complete removal of the existing embankment or breach in one or two locations. Option D is therefore recommended and provides an opportunity to extend the adjacent successful realignment scheme , creating valuable habitat and offering a greater degree of protection from flood risk to local residents.

Table 5: Options Appraisal

Strengths				Weaknesses			
Option A	**Option B**	**Option C**	**Option D**	**Option A**	**Option B**	**Option C**	**Option D**
n/a	Increased short-term flood protection in local area. Maintain grazing	Low cost Location and suitability of site Local concerns unlikely	Enhanced flood protection to nearby properties and agricultural land Location and suitability of site Contribution to estuarine functionality and WFD objectives	Leaves area vulnerable to flooding events through overtopping, beaching or erosion of bank Unsustainable in long-term	High cost to On-going maintenance and repair costs Maintain conditions leading to Unsustainable in long-term	Unsustainable in long-term	Small size of site High cost relative to benefits Loss of grazing Increased opportunity for disturbance through wildfowling
Opportunities				**Threats**			
Option A	**Option B**	**Option C**	**Option D**	**Option A**	**Option B**	**Option C**	**Option D**
n/a	n/a	Links to Kennet Pans industrial heritage	Links to Kennet Pans industrial heritage Ideal study and demonstration Increased public access and potential for visitor facilities	n/a	n/a	n/a	Landowner and community concerns Archaeological interest may potentially limit work