THE MERSEA HARBOUR PROTECTION TRUST.

BUSINESS CASE - Draft 25 of 01/12/2016

PROPOSED CLIMATE CHANGE ADAPTION RECHARGE PROJECT.

Mersea Harbour and Tollesbury Wick.

Protection to Mersea Harbour and habitat for BAP species Little Tern and European Flat Oyster.

Joint venture with RSPB and Essex Wildlife Trust.

SUMMARY.

- Mersea Harbour is under threat from the erosion by storm wave action of Cobmarsh, Packing Marsh and Old Hall.
- If these natural saltmarsh wavebreaks disappear, the harbour will be exposed and eventually become unviable for moorings, the existing public jetty, oyster layings and many commercial and leisure marine activities.
- There will be severe loss of habitat for vulnerable birds including the rare Little Tern as well as many animal and plant species.
- The harbour could disappear within the next 20-30 years.

This process could be arrested by protecting these exposed sites from erosion by a recharge programme depositing up to 95k m3 of appropriate material on the seaward faces.

A previous programme by the Environment Agency (EA) in 1998 -2002 has proved successful in combating storm waves and erosion for almost twenty years.

An opportunity has arisen to repeat the exercise as Harwich Harbour Authority have announced a potential new capital dredging programme, subject to their commercial and funding restraints, which will generate a substantial quantity of material suitable for such a recharge.

However the EA would not have the resources to do it again, so it will be necessary to establish a consortium locally to manage the project. Their objectives would be:

- To communicate with the wider local community to get a consensus behind the project
- To raise funds for the covering of operating costs of the Trust through grants, donations and contributions.
- Obtain the necessary licences and consents, including arranging any environmental impact and hydrodynamic assessments required which might cost up to £180k, although the previous trial should suffice.
- Negotiate with HHA for the supply and delivery of the material to Mersea, hopefully for free, but with a potential £294k delivery cost.
- To direct and supervise the placing of the material as it is delivered.
- To monitor the long term effects of the recharge on the topography and wildlife.

The project is to be managed by establishing a consortium, to be called:

The Mersea Harbour Protection Trust

OBJECTIVE: To promote for the benefit of the public the conservation, protection and improvement of the physical and natural environment in the area of West Mersea Harbour, Essex, in particular but not exclusively by:

- protecting West Mersea harbour including the BAP (Biodiversity Action Plan) European Flat Oyster beds from excessive erosion by climate change induced storm waves but still allow natural coastal process to apply and impact;
- providing new and more robust nesting sites for the BAP Little Tern, and
- enhancing wherever possible within the project, the conservation designation and integrity of the protected species and habitats.

Residual Outcomes.

- preserving the long term viability of the harbour for maritime commercial and leisure activities.
- preserving the character of the Mersea waterside area.

ORGANISATION OF THE TRUST

- The Trust will be formed as a Charitable Incorporated Organisation, to be governed by a Constitution and will apply for Charitable Status.

- The Trust will be managed by a group of Trustees, nominated by the members.

- It is actively supported by the Royal Society for Protection of Birds, the Essex Wildlife Trust and the Environment Agency.

- The Trust would have a finite lifespan, commencing with registration of the Charity and closure after the recharge and associated monitoring are complete. The monitoring requirements will probably be a condition of the consenting process and likely to be three years after placing of the final cargo.

MEMBERSHIP

Organisations or individuals with a significant financial or commercial interest in the harbour are to be invited to become members as well as national or regional organisations representing relevant special interest groups. Each organisation, if unincorporated, to be represented by a named individual notified to the trustees. Each member organisation will have one vote.

There will be an entry fee of £200. Further subscriptions may be called for as and when required but no more than £200 in any one year. Member organisations may make additional contributions or loans as appropriate.

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BUSINESS CASE

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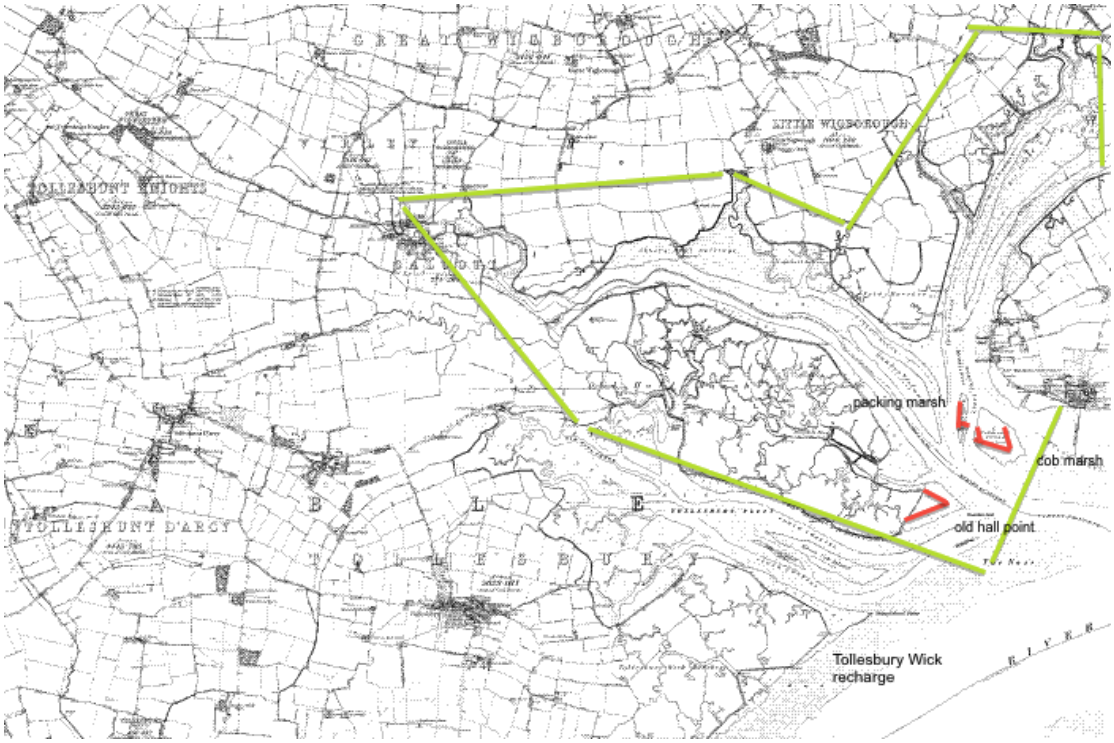
1. INTRODUCTION

1.1 Definition of Problem



1840 OS map. Green line affected area. Red line current shoreline showing extent of erosion.

- West Mersea harbour is an area of some 16 square km of sheltered tidal water creeks, saltmarsh and mudflat on the north bank of the Blackwater estuary in Essex. It exists because of the physical protection from storm waves provided by the islands of Cobmarsh and Packing Marsh and Old Hall Point peninsula. These natural saltmarsh wavebreaks have been eroding for centuries as the coast responds to isostatic adjustments (land sink and sea level rise) from the previous Ice Age. Tollesbury Wick frontage has lost all of its fronting saltmarsh and is now protected by a previous Environment Agency recharge wavebreak.

- But the erosion process is accelerating due in part to anthropogenic influences including the loss of the marine angiosperm *Zostera* (eel grass), potential ebb tide delta decline from historic enwalling of the saline flood plain and an increase in episodic storms from climate change scenarios (see also Appendix 1). This latter detrimental impact is predicted to escalate with high tide storm waves causing the vast majority of erosion. With the decrease in size and eventual loss of these protecting natural points the harbour will be exposed to higher and stronger wave forces than it has ever experienced. The habitat and assets that comprise the harbour will rapidly decline.

- Comparison between 1840 and current OS maps show that Cobmarsh has eroded from 12ht to 5ht, Packing Marsh 3ht to less than 1ht Old Hall Point from 40ht to 18ht and Tollesbury Wick has lost all its protecting southward facing saltmarsh .

- The entire tidal harbour is a habitat designated as SPA (Special Protection Area) of international importance for breeding, feeding, wintering or migration of rare and vulnerable species of birds; SAC (Special Area of Conservation) for wild animals, plants and habitats and is further designated as a RAMSAR site (Ramsar Convention in 1971 for the protection of internationally important wetlands). SPA and SAC status gives both UK and EU legal protection and RAMSAR international legal protection. Salcott Creek and the adjacent Little Dytch also hold significant stocks of the BAP (Biodiversity Action Plan) European Flat Oyster, *Ostrea edulis* bi-valve mollusc. The oyster beds are amongst the most important in the UK with a stock of European flat Oyster that appears to have developed a resistance to the devastating oyster disease *Bonamia.*

- In addition to the harbour's international importance for conservation is the relevance to local infrastructure, employment and housing. Some forty residential and commercial properties are on the immediate waterfront including a public jetty, two boatyards, four restaurants, sail making company, yacht chandler, public house hotel, two sailing clubs, two engineering companies, a publisher and a local shop. There is also a thriving commercial oyster cultivation industry and commercial fishing fleet with some 14 boats registered. A further eighteen shore connected houseboats are lived in full time. It is estimated that approximately eighty full time jobs rely on the harbour throughout the year.

- The harbour is defined by some 22km of sea walls that protect an estimated flood plain area of 650ht including 296ht of the RSPB Old Hall bird reserve (SPA, SAC, RAMSAR), the Essex Wildlife Trust farm reserve at Abbotts Hall and the National Trust Copt Hall farm reserve. The creeks themselves, apart from the privately owned oyster layings, have an estimated 550 yacht and boat moorings for vessels up to 20m, which serve the leisure and commercial boating industry utilising the public jetty. Packing Marsh has an historically important building, the Packing Shed, which has been subject to refurbishment and maintenance grants and is of UK east coast cultural heritage importance.

- The harbour and waterfront of West Mersea, together with the on shore facilities of public jetty, restaurants and leisure boating and adjacent nature reserves are the focal point of a wider tourism industry that results in the population of Mersea increasing from the full time residents of 7.50k increasing to 20k in the summer holiday season. This tourism results in many local full time and part time employment opportunities.

- The seaward points of Cobmarsh, Packing Marsh, Old Hall Point and the previous recharge to Tollesbury Wick, have all had significant breeding populations of Little Tern, *Sterna albifrons,* a BAP species which is in need of international assistance if it is to survive in the UK. Little Terns nest on mobile shingle beaches, a scarce habitat that is very vulnerable to destruction by storm waves and will be subject to serious or fatal habitat reduction from climate change predictions.

1.2 Deficiencies

- In 1998 the Environment Agency (EA) in partnership with Harwich Haven Authority (HHA) commenced a programme of beneficial use of appropriate capital navigation dredgings from the approach channels to the ports of Felixstowe and Harwich to limit storm wave action to key coastal locations of conservation or economic importance.

- These key locations included Sizewell, Shotley, Horsey Island, Jaywick, Wallasea Ness and in the Blackwater estuary Pewet Island at Bradwell, Tollesbury Wick, Old Hall Point, Packing Marsh and Cobmarsh with one cargo to the south of the sub tidal Nass Spit as an area for spat of the European Flat Oyster.

- The quantities to protect West Mersea Harbour were 6k m3 to Packing Marsh, 30k m3 to Cobmarsh and 36k m3 to Old Hall Point, this latter to two locations, the east facing Point itself and the south facing adjacent area in Tollesbury North creek, and 50k to Tollesbury Wick, a nature reserve of some 250 hectares of rare unimproved pasture.

- Although the then licences and consents were for larger quantities than finally placed, the full programme was not completed until monitoring had demonstrated that the material was behaving as predicted (moving landward and not into navigation channels) and not having detrimental impacts to adjacent conservation habitats.

- Subsequent monitoring by HR Wallingford for the EA for a year post placement period, showed that the material did move landward and upward, driven by wave action, and not into navigation channels and that impacts to adjacent conservation habitats were largely beneficial not detrimental.

- However, the results of the monitoring were not completed until after the period of the completion of the HHA capital dredging programme and as such no more suitable material was available.

- It is unlikely that the EA would now have the finance or staff resource (following Government public funding cuts) to manage such a project and as such a local consortium (The Trust) of interest groups will be formed as the only way forward if further recharge is to be undertaken.

- Such a consortium (The Trust) will probably not have the available finances if the consenting authorities insist on a full Environmental Impact Assessment (EIA), estimated cost £50k, and hydrodynamic assessment, estimated cost £30k. Estimated costs are based on similar recent projects undertaken by ABPMer of Southampton.

1.3 Opportunity for Change

- It is understood that HHA are preparing for another capital dredge programme to improve the navigation channels to the ports of Felixstowe and Harwich within the next two years, subject to their commercial and funding restraints. It is possible that suitable material may be available for beneficial use recharge.

- HHA have undertaken a survey which estimates that 25 million m3 may need to be dredged of which 5 million may contain sands and gravels with perhaps up to 2.50 million suitable for the Mersea and Tollesbury proposals. It should be noted that HHA have no legal or other obligation to find beneficial use sites and that placing sands and gravels for landward commercial use is still classed as beneficial.

- The fact that no new locations would be required for recharge i.e. previously consented Old Hall Point (51.766037N 0.893591E to 51.764566N 0.889348E), Packing Marsh (51.772630N 0.895273E) Cobmarsh (51.770151N 0.902264E to 51.770578N 0.897996E) and Tollesbury Wick (51.754847N 0.879726E to 51.752255N 0.874800E) may be considered favourable by the consenting regulators.

- The fact that the previous 1998 to 2002 recharge project by the EA to these locations were subject to full environment and hydrodynamic assessments and subject to a comprehensive impact monitoring programme may be considered favourable by the consenting regulators.

- That since the 1998 to 2002 EA project the beneficial use of dredgings is encouraged by the consenting regulators and may form part of any compensation or mitigation requirements for the HHA proposed capital navigation improvement dredge.

- That there is a legal duty to maintain the conservation integrity and favourable status of SPA, SAC and RAMSAR habitat and to protect BAP species. However, it must be noted that Natural England (NE), the Government body responsible for overseeing conservation designated areas, prefers natural coastal process over man made interference to prevent or halt erosion, but possibly further recharge may be considered as necessary for the management of the site to maintain the conservation designation integrity.

- The argument in favour of the previous and proposed recharge projects is that the placed material is of a size, natural type (glacial outwash coastal and estuary sands and gravels) and grading curve to allow movement by natural tidal forcing, albeit at a slower rate of change than the fine sediments that comprise a mudflat or saltmarsh.

- The proposed recharge project could be considered as a trial, subject to appropriate management and monitoring, to test the efficacy of such methods for adaptive climate change induced sea level rise and increased storminess scenarios.

2. OBJECTIVES

2.1 Terms of Reference

- To form a project management team from local interest groups (The Mersea Harbour Protection Trust), to consider the possibility and potential of recharge to Old Hall Point, Cobmarsh, Packing Marsh and Tollesbury Wick.

- The team to meet with the wider local community to inform a consensus of the recharge proposals.

- To use the final approved draft of this report for the team to negotiate with HHA and apply for the required consents and licences from the regulators.

- To operate within an agreed defined financial budget.

2.2 Objective

To promote for the benefit of the public the conservation, protection and improvement of the physical and natural environment in the area of West Mersea Harbour, Essex, in particular but not exclusively by:

- protecting West Mersea harbour including the BAP European Flat Oyster beds from excessive erosion by climate change induced storm waves but still allow natural coastal process to apply and impact;
- providing new and more and robust nesting sites for the BAP Little Tern; and
- enhancing wherever possible within the project, the conservation designation and integrity of the protected species and habitats.

Residual outcomes.

- To preserve the long term viability of the harbour for maritime commercial and leisure activities.

- To preserve the character of the Mersea waterside area.

2.3 Deliverables

- Agreed contract with HHA on material supply and delivery.
- Consents and licences approved on time.
- The local wider community approval of the project.
- The local wider community kept informed of progress.
- 40km3 of appropriate material placed to Old Hall Point, 48km3 to Cobmarsh, 5km3 to Packing Marsh, 5km3 to Tollesbury Wick. Total 98km3.

2.4 Success Factors

- The completed project to time and budget.
- The material quality placed as the licenced and consented grading curve (generally an as dredged mix of sand, shell, gravel with a maximum y% fine sediments – HHA/MMO to advise).
- A three year monitoring programme to demonstrate that the recharge material responds to natural tidal forces.
- An increase in nesting and roosting bird numbers subject to natural variations in those species, with particular reference to Little Tern.
- Continuation of European Flat Oyster cultivation in Little Dytch and Salcott Creek.

3. OPTIONS

3.1 Selection Process

- Four options were considered to combat the future erosion problem, do nothing, fixed off shore wavebreak, mobile foreshore recharge.

- The do nothing option will result at some time in the next 50 to 100 years, of irreversible loss of the quality and quantity of the designated conservation habitats and oyster layings, the demise of West Mersea harbour as a yachting and sailing centre, increased flood risk to a significant number of residential and commercial properties and decline in local employment opportunities, with increased flood risk and habitat loss to the Tollesbury Wick nature reserve.

- A fixed wavebreak, similar to the old Thames lighters used by the EA at St Peter's Point on the Blackwater and Marsh House outfall on Dengie, although effective, would be unlikely to meet the new stricter regulations for environmental protection making consents and licences approval improbable. Fixed wavebreaks constructed from imported rock are very expensive and would cost in the order of £10 million to provide and place to Old Hall Point, Packing Marsh and Cobmarsh.

- A system using geotubes filled through a floating pipeline by specialist floating plant. Filling would have to be from a nearby with any perceived navigation problems from accretion. Despite a presentation

from representatives Dutch specialists the method was dismissed on grounds of cost, potential environmental damage or risk, sustainability and landscape issues

- As the EA recharge project has proved itself successful in combating storm waves and erosion, has been sustainable for almost twenty years, responds to natural tidal forces and has improved the habitats, for, in particular nesting and roosting birds including Little Tern, this is the preferred option. (See Appendix 4)

3.2 Hydrodynamics and Coastal Process

- The wind and consequent wave fetch to the entrance to the harbour and Tollesbury Wick, is some 4km from the south, 10km from the south west and in excess of 50km from the east. Despite the fact that the Blackwater is a relatively shallow estuary, significant wave heights are attained during high tide periods to have a continuous eroding impact to the saltmarsh during those cycles (see section 1.1 paragraph 2 above). The erosion is to the saltmarsh cliff edge and adjacent mudflat.

- Recharge material placed under the previous EA project was limited to exact location by the depth of the vessel used and discharge method, a 4m draught and “rainbow” discharge, so some cargoes were placed slightly offshore of their ideal final location. But consequent wave action moved the material landward to form a mobile protecting “bandage” to the eroding frontage at Cobmarsh, Packing Marsh and Old Hall Point east facing, with Old Hall Point south facing and the material to Tollesbury Wick, accumulating significant quantities of fine sediments in their landward lee i.e. a change from an eroding to accreting process. (See Appendix 4). This latter may provide opportunities to Cob and Old Hall to regenerate softer invert rich mudflat and saltings.

EA recharge at Tollesbury Wick showing new mudflat to landward (right) and Little Tern nesting site to seaward (left).

- It is relevant that recharge material recipient locations are proposed at eroding sites only, with the mudflats that receive the material being of a consequent harder and coarser grain size, the finer material having been washed away. Such eroding foreshore habitats have poor invertebrate bio-mass and bio- diversity.

- The proposed recharge sites are in a relatively open estuary location, and the volume of placed material insignificant in relation to natural swept tidal volumes, so detrimental hydrodynamic impacts, including increases in tidal currents as a consequence of channel restrictions are inconsequential, with any regime change quickly adjusting.

3.3 Ecological Function

- Small “beaches” and chenier ridges are a natural habitat that form within estuary mudflats and saltmarsh as a response to tidal forcing and wave action, particularly in systems with relatively low suspended sediments such as the Blackwater, and are used in particularly as roost and nesting sites by birds.

- By the introduction of appropriate material by recharge it has been demonstrated that birds quickly utilise these sites, with Cobmarsh, Packing Marsh, Old Hall point and Tollesbury Wick following the EA project, all used by a range of waders and wildfowl for roosting, loafing

and nesting. Of particular relevance is the nesting by Little Terns, Oystercatchers and Ringed Plover.

- The new accreting mudflats at Old Hall Point (south facing location) and Tollesbury Wick landward of the recharge areas hold higher numbers of feeding waders and wildfowl than pre recharge, with monitoring by the EA demonstrating an increase in invertebrate and bi-valve bio mass and bio diversity post recharge.

- The higher recharge areas between Mean Water Spring Tides (MHWST) and Highest Astronomical Tides (HAT) have been colonized by a range of halophytic plants including Sea Holly *Eryngium maritimum*, Yellow Horned Poppy *Glaucium flavum* and Shrubby Sea Blite *Suaeda vera*.

3.4 Compliance with Existing Coastal Strategies

- Coastal flood defence and coastal erosion strategies are subject to UK and EU legal compliance on protection to both the natural and built environments with further legislation to protect fisheries and shell fisheries.

- As compliance is complicated, and in the UK divided between a number of different Government organisations, often responsible to different Ministers, only the process of consent and licence application can determine whether approval will or will not be granted.

3.5 Consents

- The following is not an exhaustive list, but will include:

- Marine Management Organisation (MMO) to include application for a FEPA (Food and Environment Protection Act 1985) licence.

- Planning application under the Town and Country Planning Act 1990, to the local planning authority and committee at Colchester Borough Council for planning approval.

- Natural England for a licence and consent to undertake work within a protected designated site and protection of wildlife under the Crow Act of 2012 (Countryside and Rights of Way Act).

- Environment Agency for, in particular, flood defence and water quality potential detrimental impacts under the Land Drainage Act 1991 and subsequent legislation.

- Consent from Crown Estates Marine for areas outside the jurisdiction of Mersea Haven Ltd.

- Consent from Admiralty for impacts to navigation – Notice to Mariners.

- Landowners permission which will include the RSPB for Old Hall Point, Mr D. Stoker for Cobmarsh, Essex Wildlife Trust for Tollesbury Wick, the Packing Marsh Trust, Mersea Haven for inter tidal waters where appropriate and possibly Crown Estates Marine (this latter depending on potential areas outside Mersea Haven's claimed boundary).

4. ECONOMIC APPRAISAL

- This report will not extend to an economic cost:benefit analysis as public funding is not being sought. Public funding for such works are limited to those demonstrating an economic cost benefit to the taxpayer but still subject to conservation and environmental compliance.

4.1 Do Nothing

- If no remedial action is taken and if the natural wavebreaks that protect the harbour do erode during the next 50 to 100 years under climate change increased storminess scenarios, then losses of the built assets as outlined in section 1 could amount to some £32 million (see 4.3 below for calculation).

- If the internationally protected wildlife reserves at Old Hall and Tollesbury Wick are not more robustly protected from erosion to their vulnerable coastlines then sea defence breaching and loss of a total of over 500 hectares will result.
- Numbers of Little Tern will continue to decline and local Native Flat Oyster beds deteriorate or cease to exist.

4.2 Recharge Option Costs (October 2013 price base)

It is estimated that similar quantities would be required as were placed as under the EA project, i.e. 5k m3 to Packing Marsh, 48k m3 to Cobmarsh, 40k m3 to Old Hall and 5k m3 to Tollesbury Wick. If HHA provide and deliver the material at no charge, as a compensation licence requirement or a desire to enhance the local natural environment, and if it is accepted that the work is necessary to maintain the integrity of the conservation designated habitat and assist with the preservation of BAP creatures by recharge, and if it is accepted that the previous EIA and hydrodynamic assessment by the EA are still relevant following the EA's monitoring, then estimated budget costs could be £122k (£50k for the licences and consent approval fees, £25k for consent condition works and monitoring and possible £12k for contingencies). All other management works would be by community funding local **unpaid** volunteers, RSPB and EWT with an estimated value of some £187k in **unpaid** volunteer manpower, equipment and materials (see appendix 2). **If HHA charge for supply**

and delivery of the recharge material then this will cost an additional £294k.

4.3 Appraisal Methods (October 2013 price base)

- The Do Nothing loss of built assets costs are budget estimates of £1 million for oyster layings (total 3 hectares); £500k for boat moorings (550 mooring @ £900.00 each); £4.5 million for devaluation of 40 properties (£112k per property devaluation); £1 million for devaluation or loss of commercial companies (15 companies at £66k per company), £19 million for the loss of 900 hectares of land at £21k per hectare and £6 million for loss of tourism (12,500 temporary resident tourists, spending an estimate £100.00 each, times (say) a 50% reduction for harbour degradation and times a 10 year period). The tourism and boating income to Mersea would be particularly affected by the loss of the public jetty. This asset could be the first casualty within 10 years, as increased storm wave heights put the structure beyond its original design criteria. (Section 1.1 paragraph 6 and 7). Total £32 million. NB this is not a professional calculated figure, but a budget estimate only.

- It should be noted that no financial value has been placed on the value of SPA/SAC/RAMSAR conservation grade inter tidal areas, BAP designated species habitat requirements that will be degraded or lost if no recharge work is undertaken.

- The preferred option recharge costs are based on 98k m3 of supply and place appropriate dredgings at no cost but as a licence requirement for the capital navigation dredge by the regulators or a desire by HHA to enhance the local natural environment. **If HHA charge for supply and delivery of the recharge material then this will cost and additional £294k**. If the regulators do not accept the previous EA's EIA then add £30k, hydrodynamic assessment add a further £15k to total some £172k including contingencies and licence and consent management fees and costs.

5. RISK ASSESSMENT

5.1 Options

- The Do Nothing Option presents the lowest short term (1 to 20 year) risk but the highest medium (20 to 50 year) and long term (50 to 100 year) risk. The highest national risk is to the degradation and probable devastation to the high quality, internationally important conservation SAC, SPA and RAMSAR habitat and BAP Little Tern and European Flat Oyster survival. Loss and degradation to the built assets is not a legal issue, but mainly personal financial loss and distress. This would be unlikely to meet any Governmental financial aid under current Treasury guidance. In the UK there is no compensation for loss of property by erosion or flooding.

- The possibility of a fixed wavebreak of redundant Thames steel lighters carries significant risk of not being approved by any of the regulators. They do not allow coastlines to respond to natural tidal forcing, add nothing to the natural environment or conservation habitat, need maintenance and navigation lighting, have a limited lifespan, are a navigation hazard when they deteriorate, have no aesthetic, landscape or cultural significance.

- Recharge carries the lowest risk as a consequence of the previous EA project. There is now, following the EA monitoring, known tidal forcing responses, habitat and wildlife benefit, quantified erosion reduction, no maintenance, no natural landscape issues, limited navigation impediment, generally a very positive public response. However, it must be noted that recharge will never be a final solution. The power of the sea during storm surges and the huge unknowns from climate change detrimental impacts cannot guarantee any designed solution.

5.2 Risk Register and Risk Minimisation – Recharge

H - high M – medium L - low

Risk	Factor	Risk management	Residual factor
Hydrodynamics acceptable	H	Only use EA recharge sites	L
Complies with coastal strategies	H	Communicate with EA	M
H & S impacts	M	Keep public away during works	L
Water quality	H	Only accept clean material	L
Fisheries legislation	M	Communicate with sea fisheries officer	L
Sustainable	M	Only use EA recharge sites	L
Environmental damage landward	H	Disturbance to nesting birds. Either recharge outside bird nesting season (April to end July) or manage sites with RSPB to prevent nesting for that 1 season)	M
Environmental damage seaward	H	Will be destruction of inverts and bi-valves under recharge. Limit placement to required areas by marker withies.	L
Socio economic impacts	L	Remote sites so little impact.	L
Procure dredgings	H	Communicate very early with HHA.	H
Communicate to community	M	Open session public	L

		meetings and local newspaper updates.	
Available finance	H	Very limited available funds. If HHA require payment or EIA needed then project unlikely.	H
Impacts to flood defence	M	Limited quantity required.	L
Planning permission	H	Talk to local councilors at early stage.	H
Obtain consents	H	Communicate with regulators at early stage. Demonstrate commitment to any restrictions or conditions. Have agreed monitoring programme.	H
Navigation impacts	M	Issue notice to mariners.	L
Material acceptable	H	Agreed grading curve as available from HHA.	M
Smothering of existing oyster layings by disturbed sediment during recharge placing	H	Applies only to Tollesbury north channel. Only discharge at start of ebb for Old Hall Point.	L
On Cobmarsh placed material migrates to west into Mersea Fleet	M	Place initial cargoes to western end of recharge at HWST to join shore and form “limit wall”. Construct 1m high brushwood fence to 10m to west of recharge “limit wall” as fail safe during extreme easterly storms.	L

6. PREFERRED OPTION

6.1 Recharge Materials

- Materials to be as acceptable to the regulators and within the “as dredged” grading profiles from the HHA survey, depending on what will be available. This may mean that some fine material may be part of each cargo but generally majority from fine sand to 100mm stone with occasional 200mm+ large stone. Pollution profile as HHA FEPA licence to acceptability. It should be noted that as capital dredgings are mainly into glacial outwash deposits (or earlier geological period), pollution levels are normally very low or insignificant.

- Quantities of 40k m3 to Old Hall Point, 48k m3 to Cobmarsh, 5k m3 to Packing Marsh and 5k m3 to Tollesbury Wick. There is potential for Cobmarsh and Old Hall point material to be placed to the south of those locations to protect the most eroding adjacent coast, but this would mean up to 100m distance (because of required water depth for working draught of dredger) between the placed material and the

current shoreline. This would then naturally accrete to produce an invert rich mudflat and lower level salting as has happened at Tollesbury Wick.

- It should also be noted that the dredger has a minimum 3m working draught when fully loaded with between 1k to 1.50k m3. As such for continuity of placement during the Neap/spring tide cycle has to allow for 2 cargoes per 24 hours, which will mean that Old Hall Point can only be achieved on Spring tides (with discharge only commencing on the ebb to protect existing oyster layings) with Tollesbury Wick and Packing Marsh kept as a reserve for Neap tides, having deep navigable water immiediately adjacent to seaward.

6.2 Methods and Timing

- Shallow draught “rainbow discharge” trailer suction dredger, or similar, as used under the previous EA project.

- Work to be undertaken to suit HHA capital dredge programme, but NB if this is in the bird breeding season then advice needs to be taken from NE and RSPB on impacts and potential of a nesting bird management programme that may require prevention of breeding by continuous disturbance for that season only to prevent nesting. This may require additional licence application and funding of a qualified specialist, estimated at £15k (see 4.2 above).

- As the consenting process can take up to 24 months from original approach to regulators, then an early approach is vital, together with immediate commencement with public open meetings and local press article to notify intentions.

6.3 Risks and Benefits

- Residual high risks include agreement of material availability and cost from HHA, finance for funding the project, planning permission, consents and licences from regulators, material quality and grading curves for the proposed recharge sites.

- Benefits are sustainable protection from current and climate change induced eroding wave forces to 16 square km of nationally and internationally important SAC, SPA and RAMSAR conservation wetlands, to allow management of their environmental integrity, protection for the existing cultivation grounds of the BAP European Flat Oyster, new and more robust nesting sites for the BAP Little Tern, and related socio-economic benefits and heritage within the area of West Mersea harbour.

- There is a high chance, based on the previous EA recharge project to protect West Mersea harbour, with significant environmental benefits for Eastern Atlantic Flyway birds with, in particular, enhanced and larger areas for breeding, roosting and feeding species.

6.4 Environmental Compliance

- Each consent, licence or permit applied for will have conditions for environmental compliance which will require both management during the project, management post recharge to prevent nesting bird disturbance and pre and post recharge monitoring requirements.

- These will include evidence that the placed material is subject to natural coastal process forces, i.e. is mobile under storm wave attack and moves both landward and upward. This can be achieved by on site survey and photographic evidence, which will probably require at least three years of post placement monitoring.

- As the material migrates to the salt marsh cliff it may need (as per the EA project) control to prevent salt marsh plant smothering. This was achieved by the EA by the construction of brushwood fences, 600mm high above the existing salt marsh level (to the height of HAT tides), to encourage recharge material stability at that level and so limit plant smothering. Provision of brushwood fence materials are likely to cost £10k (*pers.comm.* from EA contractor J. Pullen) with volunteers constructing the fencing.

- Material placed to the south of Cobmarsh will need management to reduce the risk of the material migrating toward the adjacent Mersea

Fleet. Initial cargoes will be placed at HWST to form a “limit wall” with a 1m high brushwood fence constructed 10m to the west of the “limit wall” as a fail safe during extreme easterly storms. (See also 5.2 Risks).

- As detailed in 6.2 above, if the material has to be placed (to comply with the HHA dredging contract programme) during the bird breeding season of 1 April to 31 July (or up to 15 August for some birds such as the Little Tern) then, if a licence is granted, it will be required that birds are prevented from breeding for that season, with disturbance having to commence in March.

- Consent conditions may also require at least one year pre placing and three years post placing monitoring for use by breeding and roosting birds of the recharge sites. The RSPB and EWT have already indicated that they are willing to assist with this work at their cost. This is a substantial contribution to assist in achieving the projects objectives. Effective local support to prevent nesting bird disturbance will be needed.

- If there is an insistence from the regulators that monitoring post placement includes either or both hydrodynamic or invertebrate impact monitoring then the cost would be too high for local funding with costs likely to exceed £120k for this work for a three year period.

6.5 Management

- Management would be under a small unpaid volunteer guiding committee comprising West Mersea harbour interest groups (The Mersea Harbour Protection Trust – “The Trust”) with a member from the Essex Wildlife Trust and the RSPB that would meet at regular predetermined intervals. It will require strict and agreed control over financial spending.

- The Trust committee will oversee public consultation, application for consents and licences, compliance with consent conditions, environmental, fisheries, flood management legislation, negotiations with HHA and manage the dredger during discharge operations.

- The Trust committee will be responsible for all aspects of health and safety during material placement including public safety, pre and post monitoring to agreed quality and programme including dissemination of the monitoring results to the appropriate authorities.

- Responsibility for the placed material will rest with the Trust committee in whose name all legal consents and licences will be held.

- Local support will be needed for effective control of nesting bird disturbance.

7. RECOMMENDATIONS AND CONCLUSIONS

- That a small unpaid volunteer working committee be formed from The Trust within the next month to oversee the potential of recharge material being obtained from HHA to assist with the management of the integrity and sustainability of the SPA, SAC and RAMSAR designated areas of West Mersea harbour and Tollesbury Wick to prevent excessive climate change induced wave action degrading the wetlands and provide new opportunities for BAP Little Tern nesting colonies and sustainability for BAP European Flat Oyster.

- That the Trust committee seek approval for all required licences, consents and permits, and if obtained to oversee the placement and subsequent management of the recharge areas.

- That 40k m3 of material is placed to Old Hall Point, 48k m3 to Cobmarsh, 5k m3 to Packing Marsh and 5k m3 to Tollesbury Wick to agreed locations at a cost range between £122K and £172K excluding material supply and delivery.

- If the current erosion is not managed then the SPA, SAC, RAMSAR designated wetlands that comprise West Mersea harbour will decline and degrade within the next 20 years with irreversible loss within the next 50 to 100 years. The sustainable future for BAP Little Tern and European Flat Oyster will be seriously compromised.

- Such loss will not only affect the legal requirements on conservation designated wetlands and BAP requirements, but also have serious socio-economic consequences for the local area, economy and heritage.

8. CRITICAL PATH PROGRAMME

Year	2014	2015	2016	2017	2018
ITEM					
Form guiding charity	--	-			
Committee meetings	-	-	-	-	-
Public consultation	------	--------	-----	---	---
Negotiate with HHA	-	-	--	--------	
Consult regulators	-	-	------	-----	-
Consent application			---	---	
Pre surveys and monitoring	---	--------	------		
Prepare ES/EIA		--------	------		
*Undertake recharge				--	---------
**Post recharge monitoring					---------

*Will depend on HHA capital dredge programme – 2017/18 earliest date.
**May require 3 years post recharge placement monitoring.

9. Appendix 1.

Causes of erosion and the methods and benefits of coarse material recharge.

1. Causes of erosion.

- The causes of erosion are isostatic adjustment, loss of *Zostera*, ebb tide delta decline, pollution, increased storm waves.
- **Isostatic adjustment** is the land mass sinking as a result of the previous Ice Age that only ended 12k years ago. The weight of the ice sheet on the northern UK pushed down the northern land mass causing the southern land mass to rise, similar to a see-saw. As the ice sheet retreated so this action was reversed and the southern land mass is now sinking. This action has been calculated to average 150mm per century for southern England (south of the Humber). Coupled to this is the warming and consequent expansion of the seas since that last Ice Age, calculated at a further 150mm per century, to give a combined *relative* sea level rise estimated for southern England of 300mm per century.
- Wave heights are a function of wind speed, length of available fetch of that wind and water depth. The deeper the water the bigger the wave that is able to propagate. In very deep water waves rotate on themselves, but as they enter shallower water the friction on the base of the wave as it impacts on the sea bed or foreshore, rather than just water, causes the wave shape to become elliptical until such time as the top of the wave overtakes the bottom of the wave, hence causing a wave to “break” onto the shore, causing erosion.
- The impact of deeper water from isostacy creates the opportunity for larger and more erosive wave forces that cause both muddy foreshore and higher level saltmarsh loss. Mudflats and saltmarsh accreted in estuaries in sheltered high sediment load sheltered waters. The high sediment loads and sheltered conditions that created the original conditions for accretion were a result of the gradual rising of sea levels after the last Ice Age progressively flooding freshwater valleys, with very high sediment concentrations from glacial melt waters. The background sediment levels in the southern North Sea have been measured at about 50 parts per million (ppm), but can rise to 600 ppm in the Essex creeks and estuaries during episodic easterly gales.
- As the estuaries have deepened and widened as a result of relative sea level rise, the consequent increase in wave height and tidal forcing has led to a switch from conditions that allowed accretion to those that favour erosion, with insufficient sediment in suspension to permit more accretion than erosion in the outer estuaries, but with accretion still being the prevalent factor in upper estuaries and in more sheltered locations.
- **Loss of *Zostera*** (Eel Grass) has exacerbated the erosion. Eel Grass, a marine angiosperm, used to colonise the mudflats in the east coast estuaries in vast beds throughout the entire Greater Thames (and

globally). These beds were composed of 4 types of the plant, the largest *Zostera marina* had fronds of over 1 m long. The roots of the plant form a dense web that bind fine sediments together. This vast mattress protected the fragile muds of the foreshore, acting as a natural wavebreak creating relatively sheltered conditions to the inshore zone, allowing a dynamic stability to vulnerable soft coastlines.

- However, by the 1930's the Eel Grass started to decline and wholesale die back was recorded throughout the developed world. Apart from the loss of the main nursery conditions for fish fry and as a food source for many species of wildfowl, this loss caused an acceleration of the foreshore's erosion particularly during episodic winter storms.
- This loss was attributed to a disease in the plant similar to "rust" in wheat.
- Research in the 1980's in the UK by Professor John Lester from Imperial College, London, has indicated that the most likely cause of loss was a combination of the first use of agricultural herbicides and pesticides (developed as a commercial spin off from nerve gases used in WW1) combined with the first large scale use of nitrogen as an agricultural fertilizer and the ploughing up of coastal pasture in favour of wheat and other crops. This latter released high amounts of nitrogen stored in the soils.
- The chemicals from the herbicides and pesticides quickly found their way into the estuary system, impacting on the health of the Eel Grass.
- The Eel Grass also was taking up the nitrogen that had also been flushed into the estuaries with the result that the cell structure in the plant grew larger but weaker.
- The combined impacts caused the plant to be washed out or die back during storm waves and the result was a rapid increase in erosion and further lowering of foreshore levels with resulting opportunity for even larger waves to propogate.
- **Ebb tide delta decline**. The formation of deltas from freshwater rivers in generally understood, sediment loads in suspension or as bed loads are deposited when a river reaches the sea with consequent current speed decline allowing those sediments and loads to be deposited to form a delta. The same process takes place within many estuary systems. For a delta to form relatively shallow water is required.
- The quantity of sediment is partly a function of the volume of tidal water that is entering and leaving that estuary system i.e. given the ppm, 1 million cm of water will hold a greater quantity of sediment than 500k cm.
- As the high water floodplains of estuaries were enwalled for largely historic agricultural gain from the C16 onward, with Essex for example having some 40k hectares of saltmarsh enwalled, so the amount of sediment that formed the deltas, largely in the form of spits and headlands e.g. for Mersea the Nass Spit, Cobmarsh Spit, declined. The result has been a gradual decrease in the extent of those deltas and spits with the impact that these features are no longer available to act as natural wave breaks, hence an increase in the erosion process.

- **Pollution** has had two major impacts. The first is explained above in the impacts on Eel Grass. The second is the impacts from the 1970's from TBT (tributyltin) which was used as the main ingredient in marine anti-fouling paints until it was banned.
- Again this is from the same research by Professor John Lester, and other linked international research, which demonstrated that TBT could cause the death of over 90% of marine plankton and had impacts of population numbers, growth deformity and reproduction on bivalves, invertebrates and marine snails.
- Although this research was never undertaken (too expensive) it was postulated that the decline in the creatures affected by TBT had a knock on effect on erosion.
- Sediment in suspension in a tidal water column has generally poor adhesive qualities, the particles only form weak bonds. Those same particles, processed by the ingestion and digestion by molluscs and invertebrates, result in a change to produce a particle similar to a clay platelet i.e. the particles bond to form a much stronger material.
- The result during the era when TBT was very widely used as a marine antifouling appeared to be much more fragile sediments on foreshores that were more easily eroded.
- **Increased storm waves** from climate change scenarios will be the biggest impact on increased erosion yet seen, with predictions of an acceleration of soft marine habitat loss that could prove to be devastating over the next 100 years or less. Coupled with the recent predictions for linked sea level rise the consequences will probably prove fatal for many niche creatures and potentially beyond the economic resource for even developed nations to cope with.
- It is worth noting that all the mud and soft sediments caused by the various forces of natural erosion have to go somewhere and large quantities are transported by the flood tide into the more sheltered creek locations or the upper ends of estuaries where they settle out at slack water. As they settle out they are colonized by invertebrates on the lower levels, or saltmarsh vegetation on the upper levels, which increases their stability. For example, the erosion to the tidal flats of the southern Mersea shore and the Nass spit has reduced levels by about 1m over the previous 50 years. This area is some 5 square km, so estimated eroded sediment is 5 million m3, which has been available for accretion within the more sheltered creek network. Such material as settles in tidal navigation creeks has been colonized by Tube Worm in some East Coast locations. The Tube Worm accelerates the accretion process and if not cleared by such activities as oyster dredging, can cause severely impeded navigation, particularly at low water, as available depths decrease. Examples of this can be found in the Walton Backwaters and Tollesbury south channel. There is often confusion between cause and effect, with the previous Environment Agencies recharge sometimes seen as the cause at Tollesbury and activities at the Exchem explosives factory as the cause in the Walton Backwaters. The Tollesbury channel navigation suffered when oyster dredging and clearance of sediment and Tube Worm gradually declined after the severe winter of 1963.

2. Benefits and methods of coarse material recharge.

- In recognition that the fine sediments that form the foreshores and saltings, originally accreted in calmer more benign conditions, cannot withstand the increased wave action from the more aggressive environment, coarser and more resilient materials are required to form a robust solution to protect the softer material habitats. Replacing eroded areas with imported similar soft sediments will only result in those materials quickly finding their way into navigation channels or commercial oyster beds.
- However, to ensure that natural coastal processes can continue, and the coastline naturally adapt to changing conditions, materials to be used for recharge must still prove themselves mobile to storm events.
- These materials must also reflect and emulate the long term results of increases in wave height and strength in estuary systems i.e. be allowed to form into estuary chenier ridges that are a natural consequence of erosion, forming in the Blackwater of largely terrace gravel (glacial outwash) aggregate material mixed with shell from adjacent sources. It is this sort of material that is available from the Harwich Harbour navigation material.
- As the material is mobile it can, and has previously been, placed adjacent but just off shore of the required location i.e. within 10m to 100m of the eroding saltmarsh edge. It should be noted that as the foreshore area that the recharge material is to be placed on is subject to erosion, the invertebrate populations tend to be of low value on both bio mass and bio diversity unlike soft accreting mudflat foreshores.
- The addition of coarser fine sand to 100mm + grading curve material creates niche microhabitats for a wider range of invertebrates to colonise, with subsequent feeding opportunities for waders such as Turnstone.
- The placement of material has been by shallow draft cutter suction dredger, with a hold capacity of between 1000cm to 1500cm, which is then “rainbowed” out of the hold by means of a high velocity water canon that can reach up to 60m from the bow of the boat. It takes about 40 minutes to discharge a full cargo, with 2 cargoes per 24 hour day being achieved.
- Once the material is placed it responds immediately to tidal forcing, with high tide waves transporting the material landward toward the salting edge. This process is dependent on distance originally placed from the saltmarsh edge and high tide wave events.
- When the material reaches the saltmarsh edge, high water spring tide waves will carry it up, over and onto the top of the salting. To both prevent saltmarsh plant smothering and raise to a dynamic stability the crest of the recharge material, low 600mm brushwood fences have been constructed adjacent on the saltmarsh. The 600mm reflects HAT tides in the Blackwater.

- The placed material has the immediate impact of stopping any erosion, but as the material continues to move in response to tidal forcing it transports by a combination of wave action, tidal currents and long shore drift to form a mobile but protecting “bandage” around the eroding saltmarsh.
- To the muddy foreshore it provides new coarser material which increases the robustness of the area from eroding forces.
- The direct benefits are a slowing down of aggressive erosion to protect both direct and indirect soft mud habitats, new habitats for feeding, roosting, loafing and nesting waders and wildfowl, new micro habitats for halophytic plants including the scarce Yellow Horned Poppy and Sea Holly, new micro habitats for specialist invertebrates.
- The indirect longer term benefits are that coarse material recharge still allows natural coastal process to continue, albeit at a slower rate, thereby “buying time” to manage the much larger and wider important conservation habitats that are protected by the areas benefitting from the recharge.

NB FOLLOWING PAGE SHOWS MONITORED RECHARGE MOVEMENT FROM EA WORK IN 1998-2002

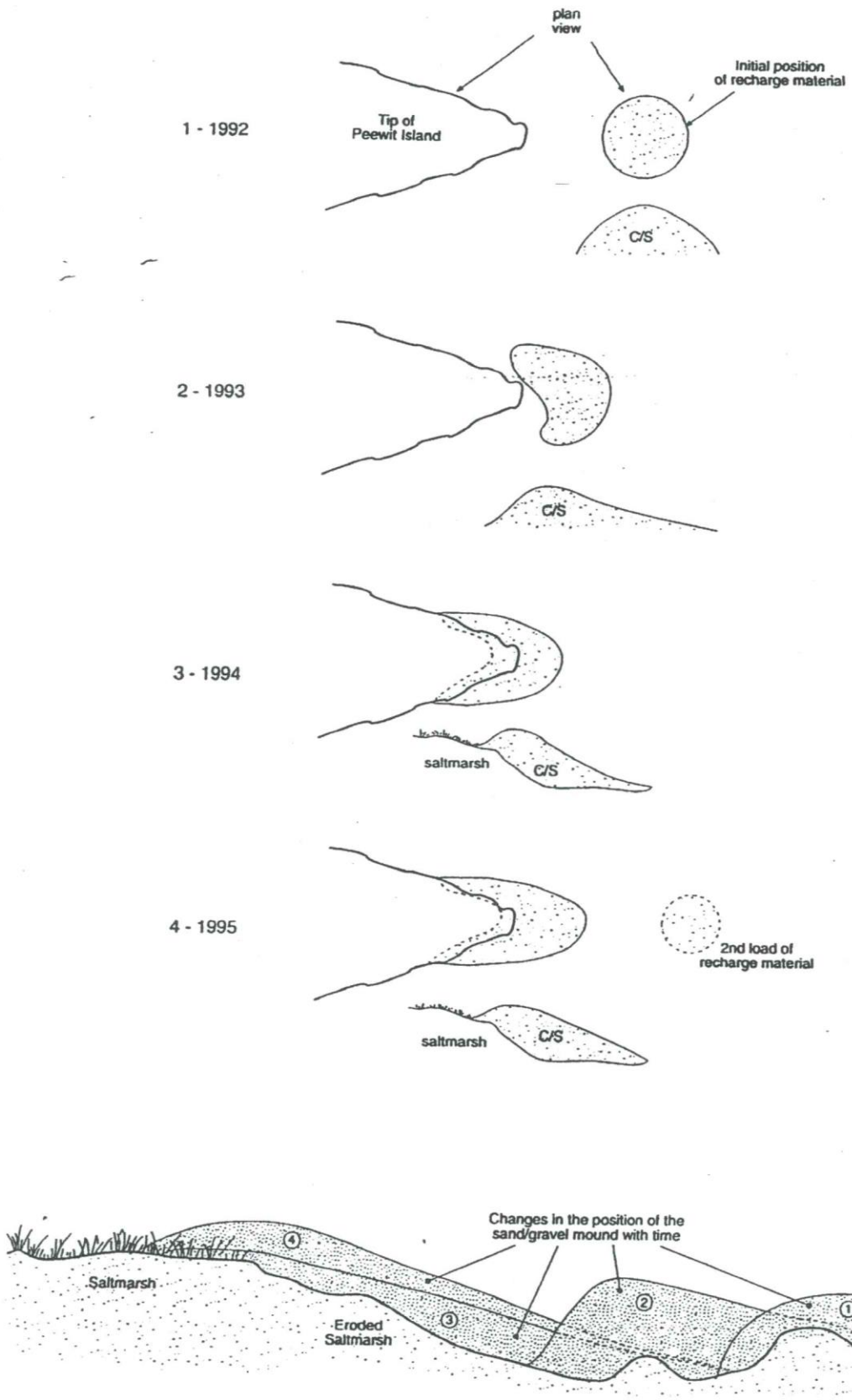


Figure 5.12 **Schematic representation of changes in the distribution of the recha material (after a sketch by Mark Dixon)**

10 Appendix 2 Budget Estimate Range and Community Funding

MINIMUM COSTS:
Specialist consultant to assist with the consenting process £42k
Consent fees and charges £12k
Potential additional monitoring of invertebrates £20k
Boat, fuel and navigation marker provision for monitoring and oversee recharge delivery £5k
Supply and place brushwood fencing to manage recharge stabilization £15k
Specialist drone photos/surveys £12k
Water depth and level surveys £4k
Contingencies (20%) £10k

TOTAL £120k

MAXIMUM COSTS:
Total from above £120k
Provision of hydrodynamic assessment £15k
Contingencies £10k

TOTAL £145k

COMMUNITY FUNDING (non paid volunteers):
RSPB/EWT/Essex University costs- bird/invert/hydro survey and monitoring costs = £64k (£24k birds, £25k inverts £15k hydro)
Trust management team £94K (2 man days per week for 3 years = 312 FTE man days @ £300.00 per day = £94k)
Trust committee members £7K (attendance at 15 meetings with 6 people – total equivalent = 22 FTE man days @ £300.00 per day = £7K)
Contingencies (20%) £22k

TOTAL £187K

If Harwich Haven Authority (HHA) charge for material supply and delivery (differential cost of dredge and dispose at sea with large vessel as opposed to dredge, transport and place with rainbow discharge shallow draft vessel) then HHA have indicated a potential fee of £3.00 per m3. For 98K m3 this equates to additional costs of £294k. The Trust and its partners the RSPB, EWT and Environment Agency will argue that beneficial use of dredgings should be at zero costs.

SUMMARY:
Minimum costs £120K
Maximum costs £145K
Non fee volunteer Community Funding £187K
Potential additional cost of supply and deliver material £294K

11 Appendix 3 Meeting with Harwich Haven (January 2014)

Informal meeting with Harwich Harbour Authority (HHA) on Friday 17th January 2014.

Attending: John Brien (HHA Harbour Engineer), Jim Warner (HHA Assistant Harbour Engineer), Mark Johnson (Environment Agency, Head of Flood Management Eastern Area), Mark Dixon (representing Mersea Oystermen).

Purpose of meeting: to discuss the potential recharge from HHA capital dredging proposal to West Mersea Quarters (see report of November 2013 – draft 3).

ACTIONS for the West Mersea Group (from MD)

- It is MD's opinion that the MMO/ NE ***may well*** require a formal EIA and hydrodynamic assessment. As pointed out in the report this is beyond the financial means of the West Mersea recharge group. **BUT** in our favour is the fact that rather than having a consultant model the proposal for the impact assessment as required by the EIA/hydrodynamic assessment, we already have the previous work which demonstrates the **actual** impacts, not modeled and therefore theoretical impacts. This will require on site meetings with the regulators. The only other option, if the MMO/NE still insist, may be to seek the assistance or funding from HHA or EA.

- AB (Alan Bird) - to provide missing information in the November 2013 draft 3 report (see attached) ie cost of restoration of Packing Marsh building (section 1.1 para. 5) and number of registered fishing boats (section 1.1 para. 4) and any aerial or ground shot photographs available.
- AB - to use the November 2013 report to initiate the group that will form the committee to take the project forward (suggest include John Jowers, Mersea Haven, RSPB, EWT, WMYC, Mersea Oystermen etc, but leave it to you Alan. JUST KEEP IT SMALL WITH ONLY ONE FROM EACH?).
- AB – to arrange first meeting of the group and then start to arrange on site meetings with the regulators.

12. Appendix 4

Summary of results of previous Environment Agency recharge works.
HR Wallingford Contract 0031.

The pre recharge monitoring studies were undertaken during 1998. The post placement monitoring were undertaken between October, November and December 1999 one year after recharge works completed. NB Packing Marsh was not included in the original monitoring contract.

The monitoring covered:

- Bathymetric survey of the frontage of each site.
- Grading curve profiles of surface sediments.
- Tidal current speed and direction measurements.
- Plant, invertebrate and bird surveys (surveys undertaken pre October 1998, post October 1999).
- Fixed point photography, over time, to record changes at each site.

RESULTS

1. Bathymetric survey

Methodology: A TRIMBLE DGPS was used for Lat and Long, accurate to with 2m. The DGPS was interfaced to a NAVBOX computer. Soundings by Raytheon 719C. Tide boards, with stlling tubes, leveled to ODN recorded continuous tide levels during the survey. Continuous soundings were taken along 50m transects.

Cobmarsh: stability to the +1.00, 0.00, -0.50 and -1.00 ODNm contour line. Continued but small erosion to the -1.50 and -2 m contour lines.

Old Hall Point: increase in height to the foreshore levels from 0.00 to +1.00m ODN contour line, reflecting recharge works to +2m. No change to contours below 0.00 to -4.00m ODN (in Tollesbury North Channel), with slight alteration to the -5.00 mODN contour. These latter in the creek bed below MLW.

Tollesbury Wick: increase in height to all contours +1.00 and +3.00m with increase estimated at +300.00mm between recharge and landward sea wall. All seaward contours to -4.00m, no change.

2. Grading curve profiles

Methodology: Samples of the top 300mm of sediment were collected with a corer on each 1m transect. Core samples were analysed at HR Sedimentology laboratory for particle size determination by sieve fractionation and laser granulometry.

Cobmarsh: All material is of a much coarser nature from the +1m to + 3m ODN contour line. Below +1m ODN no change.

Old Hall Point: All material is of a much coarser nature from the +1m to +3m ODN contour line. Below +1m to -1m ODN slightly coarser (sand) and below -1m ODN no change.

Tollesbury Wick: All material of a much coarser nature from the +1m to +3m ODN contour line. Below +1m ODN no change.

3. Tidal current speed and direction

Methodology: Measurements were taken over a spring tidal cycle. Valeport impeller driven current meters were used through water columns to record current speed and direction at different depth levels.

Results: All sites: no change in speed or direction pre to post recharge.

4. Plant Survey

Only Cobmarsh possessed sufficiently varied and abundant plant populations within the defined survey area to merit detailed assessment. At Old Hall Point and Tollesbury Wick the frontage was severely eroded and denuded of all salt marsh vegetation.

Methodology: walk over survey to defined affected area with species mapped.

Cobmarsh: results presented in a vegetation map. To the north species rich upper saltmarsh vegetation. *Atriplex portulacoides* is locally dominant with *Sarcocornia perennis* and *Salicornia* locally abundant. Also present is *Aster tripolium, Puccinellia maritime, Suaeda fruticosa, Spergularia marina, Limonium vulgare* and *Inula crithmoides*. No change post recharge but some suppression by sand and gravel was evident. To the east sparse *Suaeda fructicosa, Sarcocornia perennis* and *Atriplex portulacoides*. Scattered *Spartina anglica, Salicornia* and *Puccinellia maritima*. No change post recharge but some suppression by sand and gravel was evident. To the south *Suaeda maritime* dominant with *Beta vulgaris*, *Suaeda fruticosa* and *Atriplex portulacoides, Spartina anglica.* No change post recharge.

5. Invertebrate survey

Methodology: undertaken by EA staff in the form of an extensive species list. The procedure comprised the collection of 5 replicate 10cm core samples at high, middle and lower shore levels and at a control location at each site. NB full data sets are available including species list and biomass, below is a summary of main points only.

Cobmarsh: pre and post in italics

sample	Total species	range	range	Total individuals
		lower	upper	
U	10 *3*	0 *0*	5 *3*	57 *37*
M	12 *4*	0 *0*	9 *2*	369 *15*
L	30 *17*	0 *0*	15 *14*	541 *562*
C	25 *17*	0 *0*	17 *13*	971 *152*

Old Hall Point: pre and post in italics

sample	Total species	range	range	Total individuals
		lower	upper	
U	18 *17*	0	11 *11*	600 *85*
M	19 *7*	0	14 *2*	193 *7*
L	22 *8*	0	13 *7*	327 *53*
C	21 *15*	0	13 *9*	153 *99*

Tollesbury Wick: pre and post in italics

sample	Total species	range	range	Total individuals
		lower	upper	
U	23 *26*	0 *0*	18 *22*	1282 *2598*
M	25 *3*	0 *0*	17 *3*	488 *12*
L	27 *13*	0 *0*	15 *6*	215 *7*
C	20 *16*	0 *0*	18 *11*	919 *633*

6. Bird survey – pre December 1998, post December 1999 NB does not cover bird breeding. Pre and post in italics

species	Cobmarsh	Old hall point	Tollesbury
Cormorant	1 *2*	*3*	*17*
Brent goose	92	109	62 *4*
Shelduck		*2*	6 *2*
Eider	1 *2*		

Long tailed duck					1	
Goldeneye	3			*12*	3	
Red breasted merganser		*1*	2			
Oystercatcher	210	*352*	5		4	*14*
Ringed plover					2	*13*
Grey plover	10	*1*		*1*	5	*9*
Lapwing					6	
Knot					20	
Dunlin	95				63	*118*
Bar tailed godwit	4				2	
Curlew			1		3	*5*
Redshank	12			*1*	11	*3*
Turnstone					7	*9*
Common gull			1			
Herring gull		*12*	20	*21*	6	*14*
Great black backed gull	10	*8*		*32*		*23*
Widgeon						*4*
Lesser black backed gull						
Mallard		*4*				*3*
Grey heron						*1*

7. Fixed point photography

Photocopies from the original HR Wallingford monitoring reports are available on request.