

Case study 61. Pevensey Sea Defences

Author(s): Robert Harvey

Main driver: Improved defences and navigation maintenance

Project stage: Ongoing since 2000



Photo 1: Beach south of Sovereign Harbour from which material is taken to be bypassed (source: Robert Harvey)

Project summary:

The sea defences at Pevensey Bay in East Sussex (Map 1) are managed by Pevensey Coastal Defence Ltd (PCD) under a 25 year (2000 to 2025) public–private partnership (PPP) contract. The scheme is funded day to day by PCD. However, the contract is flexible enough to accommodate change. The sediment deficit of 30,000m³ on the Pevensey frontage is replenished in 2 ways:

- Recharge from offshore – as dredged material from Owers Bank (near Littlehampton) is rainbowed onto the beach at the western end of the frontage.
- Bypassing of material accumulated against the southern harbour arm around Sovereign Harbour (Photo 1) by road lorries – some 4,000–25,000m³ are moved per year with an annual average in recent years of 9,000m³. Under the PPP contract, PCD expects to receive 5,000m³ of material and pays for any over this amount.

In addition:

- Dredged material from the navigation channel adjacent to the harbour entrance is deposited below low water springs (this material is finer than material taken from the beach). This dredging is done by harbour owners, Premier Marinas, and not by PCD. PCD works with Premier Marinas to try and ensure suitable sediments are beneficially reused. About 40,000m³ have been reused in the last 2 years rather than being dumped at sea.
- Recycling from the eastern end of the frontage westwards – this is done piecemeal, moving material various distances but rarely the full length of the frontage. Recycling volumes average about 100,000m³ annually.

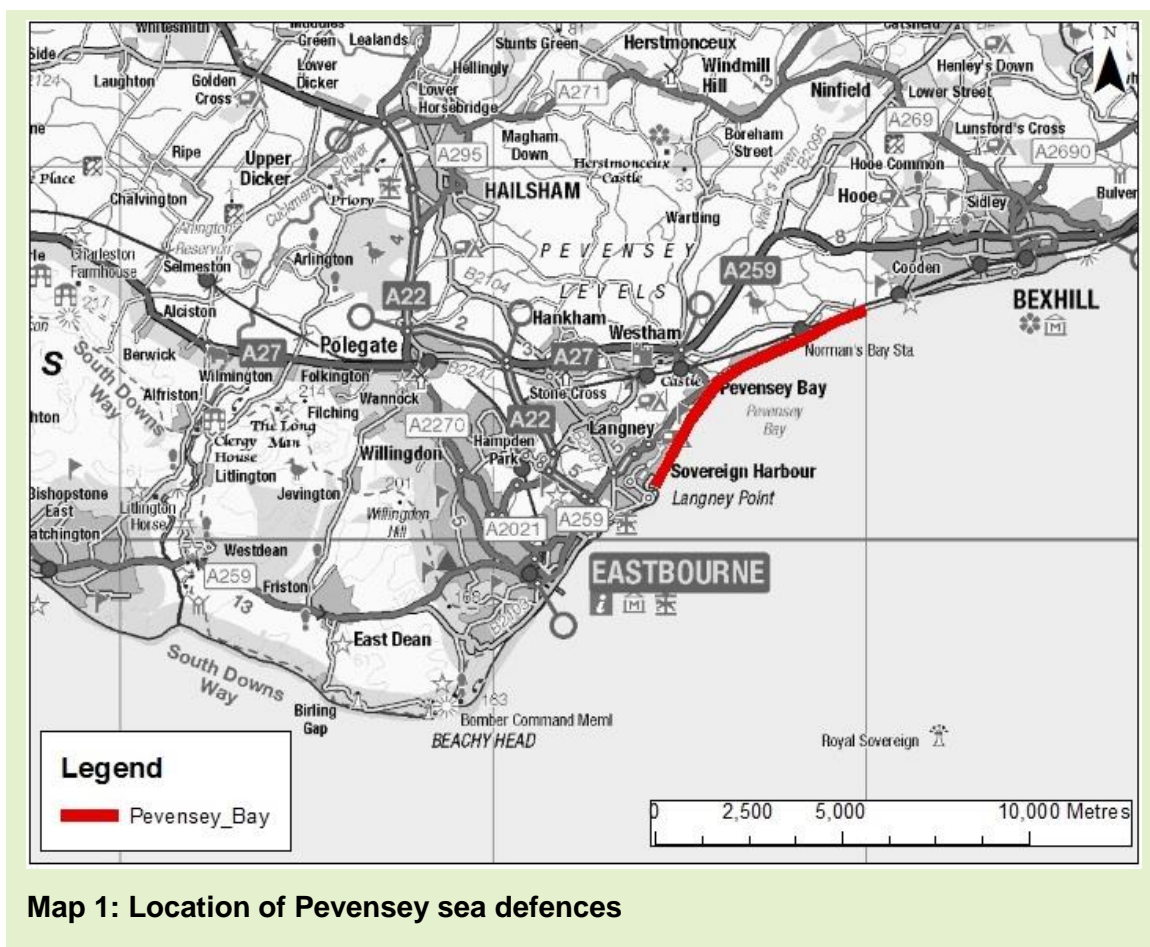
Project summary (continued):

Other flood risk management measures carried out by PCD on the frontage are beach profiling, constructing/maintaining retaining walls to hold beach material in place and maintaining around 7 groynes. The remaining 150 groynes on the frontage are not being maintained and had already deteriorated to a poor standard before the project started.

The hybrid scheme improves responsiveness, flexibility and sustainability. The South West Beach at Sovereign Harbour is a highly volatile section of coast and sediment can build up to a point where it should be removed in days. PCD is best placed to initiate bypassing works at short notice. Bypassed material is only available between October and March, when dredgers generally find conditions are too rough for them to operate. Recharge and bypassing both represent Working with Natural Processes (WWNP).

Key facts:

The standard of defence against breach to between 7,000 and 10,000 properties has been improved from a 1 in 20 year event to a 1 in 400 year event under the PPP contract. The deficit of about 30,000m³ of material lost from the Pevensey Bay frontage is replaced by dredged and bypassed material in a hybrid scheme. This provides greater flexibility and a more sustainable operation. Bypassing beach material around Sovereign Harbour to the Pevensey frontage is cheaper than recycling westwards and emulates what natural processes would do if Sovereign Harbour had not been constructed.



1. Contact details

Contact details	
Names:	Ian Thomas (PCD), Peter Amies (Environment Agency), Uwe Dornbusch (Environment Agency)
Lead organisation:	Pevensey Coastal Defence Ltd
Partners:	Environment Agency, Boskalis Westminster Ltd, Balfour Beatty, Mackley
e-mail address:	pcdl@pevensey-bay.co.uk

2. Location and coastal/estuarine water body description

Coastal/estuarine water body summary	
National Grid Reference:	TQ 065015 to TQ 070062 (approximately)
Town, County, Country:	Pevensey, East Sussex, UK
Regional Flood and Coastal Committee (RFCC) region:	South East
Transitional and coastal water body size (km²):	Not available
Transitional and coastal water body and location:	Not available
Water Framework Directive water body reference:	Not available
Land use, geology, substrate, tidal range:	Residential seafront, with railway line, agricultural land and freshwater wetland in hinterland Shingle beach Tidal range: 7.6m

3. Background summary of the coastal/estuarine water body

Socioeconomic/historic context

Pevensey Bay is a heavily developed seafront with an extensive low-lying hinterland. Between 7,000 and 10,000 properties are at flood risk in the event of the frontage being breached.

Sovereign Harbour was constructed in 1993 at the western end of Pevensey Bay. The harbour entrance is kept open by northern and southern harbour arms. These have severed the natural movement of beach material from the Eastbourne frontage further west by natural longshore drift to Pevensey Bay. This has exacerbated the shortage of beach material on the Pevensey frontage.

Prior to the scheme being implemented, the standard of defence against breach on the Pevensey Bay frontage was as low as 1 in 20 years. A PPP contract was set up in 2000 to manage the Pevensey Bay frontage to a standard that would withstand a 1 in 400 year event. The contract was let to PCD – a consortium owned by Boskalis Westminster Ltd, Balfour Beatty and Mackley – for a period of 25 years. The value of the contract is in the region of £30 million over 25 years with annual payments subject to inflation indexation.

Flood and coastal erosion risk management problem(s)

Eastbourne and Pevensey Bay are at the eastern (updrift) end of sediment cell 4b. The net loss of sediment above 0m Ordnance Datum (OD) from Eastbourne and Pevensey Bay is estimated at 10,000m³ and 30,000m³ respectively each year. Beaches formed by natural processes through time are no longer self-sustaining. The supply of sediment driven ashore by wave action acting on the seabed and from cliff erosion is now surpassed by losses due to littoral drift. There is insufficient beach material to manage Pevensey frontage to required 1 in 400 year standard. Unless this is remedied, between 7,000 and 10,000 properties would be at increased risk of flooding in the event of a breach.

The general longshore transport direction moves beach material eastwards along the Eastbourne frontage towards Sovereign Harbour. Before the marina was constructed in 1993, this material would have found its way into Pevensey Bay but some of it now accumulates west of the harbour entrance, in the area between Langney outfall and the southern harbour arm. As the process of longshore transport continues, the beach against the harbour arm would keep growing and eventually spill round the harbour arm and into the entrance channel.

The sediment deficit of 30,000m³ on the Pevensey frontage is replenished in 2 ways:

- Recharge from offshore – as dredged material from Owers Bank (near Littlehampton) is rainbowed onto the beach at the western end of the frontage. Typically around 21,000m³ are recharged annually.
- Bypassing of material accumulated against the southern harbour arm around Sovereign Harbour by road lorries – between 4,000m³ and 25,000m³ are moved each year with an annual average in recent years of 9,000m³.

In addition:

- Dredged material from the navigation channel adjacent to the harbour entrance is deposited on the beach. Although this material is finer than material taken from the beach and generally does not meet the specification for the beach above 0m OD, placing it on the lower shore increases the resilience of the beach. This activity is not part of the PPP contract but has been done in partnership with (and the support of) the Crown Estate, the Marine Management Organisation, Premier Marinas, Boskalis Westminster, Eastbourne Fishermen and Wealden District Council. No additional funding has been sought since PCD has been able to use savings generated from within the contract to cover costs that have arisen. There is no anticipation that the reuse of sand as is currently undertaken will be of direct benefit to the contract in the remaining 8 years, but is being done for the benefit of future coastal management.
- Recycling from the eastern end of the frontage westwards – this is done piecemeal, moving material various distances but rarely the full length of the frontage. Recycling volumes are about 100,000m³ annually.

Other flood risk management measures carried out by PCD on the frontage are:

- beach profiling
- constructing/maintaining timber or recycled plastic walls to hold beach material in place
- maintaining approximately 7 groynes

The remaining 150 groynes on the frontage are not being maintained and had already deteriorated to a poor standard before the project started.

Other environmental problems

- Build-up of material against western (southern) side of Sovereign Harbour entrance would eventually lead to blocking of the navigation channel.
- Freshwater wetland in the immediate hinterland of the frontage – Pevensey Levels Site of Special Scientific Interest (SSSI) and Ramsar site – would be vulnerable to saline incursion in the event of a breach.
- Vegetated shingle on the beach is vulnerable to disturbance.
- Dredged sand deposited on the lower beach of Pevensey frontage has interfered with the operation of Pevensey Bay Sailing Club at spring low tides. The Food and Environment Act license used for

this work is currently being revised to prevent a recurrence of this problem

- Beach recharge can interfere with fisheries. This is addressed through a fisheries liaison officer.

4. Defining the problem(s) and developing the solution

What evidence is there to define the flood and coastal erosion risk management problem(s) and solution(s)

In the absence of beach management, loss of beach material would lead to a breach of the defences within a few years and flood risk to between 7,000 and 10,000 properties.

Beach profiles are monitored by PCD monthly and by the Channel Coastal Observatory for the Environment Agency 2–3 times per year. The shape and volume of the beach determines the need for replenishment with additional material.

Dredged material is imported as and when the Sospan Dau dredger is available in the area. This flexibility is a feature of the PPP contract and is relatively cost-effective. Sometimes it is too rough for dredgers to operate in the winter months.

Bypassed material is transported by lorry along an agreed 6km haul route between 1 October and 31 March each year. Typically equipment is mobilised for a 2 week bypassing campaign within this period. Bypassed material is placed either in a stockpile behind the north harbour's rock revetment or added directly to the scour hole at the eastern end of the revetment. The stockpile acts as an emergency source of material; it was last used in winter 2013 to 2014 and has been replenished since then.

The contract specifies the grading curve of material to be used on the beach (Table 1).

Table 1: Specified grading curve (all figures in mm)

Sand grade	Minimum	Ideal	Maximum
D20	0.4	1.0	7.0
D50	7.0	12.0	30.0
D90	30.0	40.0	80.0

What was the design rationale?

The contract incorporates assumptions on the volume of material available from the east by bypassing, sea level rise over the 25-year period and the magnitude of storm events leading to shingle loss. The contract requires that at least 16,000m³ of sediment must be allowed to drift past the eastern terminal groyne and onto the adjacent Rother District Council frontage (at Cooden/Bexhill-on-Sea). In practice, PCD states that twice this volume is lost eastwards.

PCD considers that ideally the sub-cell should be managed by feeding the updrift end and managing the sediment as it drifts east by means of recycling, reprofiling and bypassing. However, inappropriate development in the past means there are sections of frontage where, in order to maintain the 1 in 400 breach standard, the defences are well forward of a more 'natural' alignment. In storms, these erode more quickly than surrounding areas and require regular, short-distance recycling so that protection is restored.

The southern harbour arm of Sovereign Harbour is intended to hold up to 60,000m³ of beach material on its westward side, but in practice, it holds much less and long before that volume is reached, material spills around the harbour arm into the harbour entrance. The contract allows PCD to take 5,000m³ of material from west of Sovereign Harbour for bypassing at no charge (though PCD pays transport costs). For material over this amount, PCD pays the difference between the cost of importing material from offshore and the cost of bypassing Sovereign Harbour (Photos 2 and 3). This value has been index linked since 2003 (RPIX) and currently stands at £16.05 per m³ (until June 2017). So although there is only a marginal financial incentive for PCD to use bypassed material, it is of higher

quality (lower fine content) and available at short notice when dredgers are not available or able to operate. PCD is contractually required to use bypassed material when instructed to do so. If material were not bypassed eastwards, it could be recycled westwards along the Eastbourne frontage. However, this would cost more owing to the need for double handling to get it to where it is required and amenity issues.

There is provision in the contract for risk sharing, for example, when storm events over a certain standard occur. PCD claimed an extra £800,000 in 2013 to 2014 and an extra £500,000 in 2014 in 2015 owing to exceedance of contractual design events.



Photo 2: Sovereign Harbour – material is dredged from the entrance channel (source: Robert Harvey)



Photo 3: Beach east of Sovereign Harbour on which bypassed and dredged material is placed, showing stockpile on right (source: Robert Harvey)

Project summary	
Area of transitional and coastal water body or length benefiting from project:	9 km frontage
Types of measures/interventions used (Working with Natural Processes and traditional):	Beach bypassing Beach recharge Beach recycling Beach profiling Groyne maintenance
Numbers of measures/interventions used (Working with Natural Processes and traditional):	Two WWNP measures: beach bypassing and beach recharge Three 'traditional' measures: beach recycling, beach profiling, groyne maintenance
Standard of protection for project as a whole:	1 in 400 year standard against breach This standard is achieved by adding material from dredging, bypassing and recycling in variable proportions. In 2015, 15,000m ³ of material was added from dredging Sovereign Harbour entrance, 20,000m ³ from bypassing material accumulated against the southern harbour arm and 20,000m ³ from dredging. However, only 10,000m ³ was needed from dredging in 2016. On average, ~9,000m ³ of material is derived from bypassing and 21,000m ³ from dredging (Dornbusch, 2016, personal communication).
Estimated number of properties protected:	7,000–10,000

How effective has the project been?

The PPP contractual arrangement has enabled PCD to develop and optimise best practice in beach management as the contract specifies the result to be achieved but not the method of getting there. It is also flexible in balancing expenditure between different years (public sector rules do not allow savings in one year to be carried forward). PCD inherited a beach with a standard as low as 1 in 20 years and imported 200,000m³ of shingle in the first year to achieve the design standard, the cost of which to the public purse was spread throughout the contract. However, the contract requires payments to be made over the whole 25 year period, even if it were decided not to maintain defences to Pevensy Bay and to that extent it is inflexible.

The PPP and adopted methods of beach recharge, bypassing, recycling and profiling have enabled the design standard to be achieved and the flood risk management objectives to be fulfilled. The use of bypassed, dredged and recycled beach material to recharge the beach (hybrid project) has provided additional flexibility, allowing the environmental sustainability and economic cost-effectiveness of the project to be improved.

5. Project construction

How were individual measures constructed?

Construction has been limited to localised retaining walls and 7 groynes to hold the beach in place. PCD has experimented with recycled plastic as an alternative to timber and initial results in relation to

durability are positive. Bypassing, recharge and recycling are purely reactive with the dates and quantities involved dependent on the weather.

How long were measures designed to last?

The recharge and bypassing rationale can be applied indefinitely. The PPP contract is for 25 years from 2000 and requires that structures have a residual life of 10 years beyond this.

Were there any landowner or legal requirements which needed consideration?

The PPP contract has a great many clauses defining the rights and obligations of each party and arrangements for cost sharing in the event that design events are exceeded.

The cost of bypassing material around Sovereign Harbour is recoverable from the owners through a service charge on properties within the development.

No land is owned by the Environment Agency, which has permissive powers under the Land Drainage Act 1991 to undertake flood defence works. The Environment Agency required a legal agreement with Carillion/Harbour Company for permanent rights of access to Southwest Beach (Langney). A designated sea defence access route for bypassing shingle was included in the construction of Sovereign Harbour North.

6. Funding

Funding summary for Working with Natural Processes (WWNP)/Natural Flood Management (NFM) measures				
Year project was undertaken/completed	2000 to 2025			
How was the project funded:	Public–private partnership			
Total cash cost of project (£):	~£30 million over 25 years (at 1999 prices)			
Overall cost and cost breakdown for WWNP/NFM measures (£):	From 2010 to 2016, annual expenditure on 4 beach management activities ranged widely mostly due to weather experienced each winter and in part because of changing fuel costs (Table 2).			
	Table 2: Annual expenditure, 2010 to 2016			
	Activity	Maximum cost	Minimum cost	Average cost
	Reprofiling	£100,000	£20,000	£60,000
	Recycling	£650,000	£190,000	£300,000
	Bypassing	£300,000	£28,000	£80,000
	Recharge	£600,000	£500,000	£550,000
WWNP/NFM costs as a % of overall project costs:	Based on the average expenditures over the last 6 years (Table 2), £630,000 out of an annual expenditure around £1 million (63%) relates to WWNP measures (recharge and bypassing).			
Unit breakdown of costs for WWNP/NFM measures:	See above			
Cost–benefit ratio (and timescale in years over which it has been estimated):				

7. Wider benefits

What wider benefits has the project achieved?

In relation to bypassing, benefits relate to navigation and flood defence only.

How much habitat has been created, improved or restored?

- No habitat has been created, improved or restored.
- The project provides flood defence to freshwater habitat in Pevensey Levels.
- The impact of beach management on vegetated shingle is limited as it is mainly undertaken in the autumn and winter months.

8. Maintenance, monitoring and adaptive management

Are maintenance activities planned?

Maintenance activities include:

- groyne and retaining wall repair
- beach profiling

These are all carried out by PCD under the PPP contract. The maintenance philosophy is 'little and often' to avoid problems arising.

Is the project being monitored?

Beach profiles are monitored by PCD monthly and by the Channel Coastal Observatory for the Environment Agency 2–3 times per year.

Has adaptive management been needed?

PCD has adapted management in the light of experience over the 16.5 years that the contract has been running:

- Beach recharge material was originally pumped on to the beach and then distributed by bulldozers. It is now pumped to the western end of the frontage and natural processes are allowed to distribute it along the frontage.
- A convoy system has been introduced for lorries carrying bypassing beach material to reduce the duration of their impact on local residents.
- Sand and silt accumulated in Sovereign Harbour has been used on the lower shore of the Pevensey frontage (below 0m OD) to increase stability of the beach: 32,000m³ was used in 2015 and 17,000m³ in 2014. This is not part of the contract (which only counts beach material above 0mOD), but it offsets losses that are occurring and increases the stability of the frontage at minimal cost to PCD.
- Sea level rise since 2000 has been only half the rate predicted in the contract. However, storm events have been more severe (especially in winter 2013 to 2014), leading to loss of shingle and the need for additional replenishment.

9. Lessons learnt

What did you learn and how could it be applied elsewhere?

The PPP contract is a way of managing unpredictability of coastal environments. A wealth of experience has been built up by the operator and best practice on this frontage has been refined, using a hybrid system of sourcing beach material. However, the PPP has not been replicated elsewhere on the coast.

Beach recharge is widely used in the UK and elsewhere to manage beaches. Beach bypassing is less widely used, but is applicable to a number of specific situations where longshore drift is interrupted by structures such as harbour arms, breakwaters or inlets.

10. Bibliography

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Project background

This case study relates to project SC150005 'Working with Natural Flood Management: Evidence Directory'. It was commissioned by Defra and the Environment Agency's [Joint Flood and Coastal Erosion Risk Management Research and Development Programme](#).