ABSTRACT

The Port of London Authority (PLA) has a statutory responsibility for maintaining safe navigation within its port limits, which includes the dynamic sandbanks of the Thames Estuary. The potential long-term instability of one of the southern access routes into the port led PLA to consider the provision of improved access by the navigational dredging of Princes Channel. In accordance with government guidance and international requirements, the PLA is committed to using dredged material in a beneficial manner wherever possible.

By working in partnership with the dredging industry, the PLA sought sustainable options for using the dredged sediments, such as infrastructure development, habitat creation, coastal defences and recycling within the estuary system. To facilitate this approach, the PLA employed Dredging Research Ltd to develop a Contract incentivising dredging contractors to explore and acquire opportunities for the beneficial reuse of this material, but without commitment if no such needs existed.

The Rochester Riverside Development, part of the Government promoted and funded Thames Gateway Regeneration, is improving a brownfield site to a standard where commercial, residential and leisure development can be instigated. A key element of these enabling works was the improvement of the site’s flood defences, this being partly achieved through land-raising.

Van Oord UK Ltd was awarded the Contract for supplying 340,000 m$^3$ of sand fill, using material from Princes Channel in accordance with the PLA’s Pro-Forma Contract. The seemingly ideal use of this material was not straightforward; the designation of dredgings as waste resulted in protracted discussions between the PLA/Van Oord partnership and the regulatory authorities before the works could commence. The successful completion, in August 2006, demonstrates that estuary dredgings can legitimately be used within the construction sector providing cost savings and environmental benefits when compared to the use of virgin aggregates.

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INTRODUCTION

The Port of London Authority (PLA) is responsible for ensuring the safety of navigation on the River Thames whilst protecting the diverse environment of an estuary which includes many National, European and International conservation designations. After having successfully completed Phase 1 of their project to deepen the Princes Channel (the southerly access into the Port of London) in 2003, the PLA decided to investigate ways in which these works could be completed at low cost, with a minimal impact on the existing environment, and simultaneously in which maximum opportunities could be ensured for the dredged material to be reused beneficially rather than being deposited at sea.

This article describes how the PLA worked in partnership with the dredging industry to identify and develop a form of Contract that would incentivise Contractors to acquire opportunities for the beneficial
reuse of the material to be dredged from Princes Channel. The success of this approach was demonstrated in the autumn of 2005 when a Contract for the Preparatory Engineering Works of the Rochester Riverside Development was awarded by Medway Council to an Edmund Nuttall/Van Oord Joint Venture. Included within the scope of the project was a requirement to improve the site’s flood defences; this would be achieved by a combination of new or refurbished river walls and the raising of the land by approximately 1 metre. A key factor in the Council awarding the Project to this Joint Venture was Van Oord UK Ltd’s proposal to undertake the land-raising by beneficially reusing the Princes Channel material. Whilst keen to support the beneficial use of this material, the Council also benefited financially from this proposal as it provided a cheaper source of fill than alternative sources such as the Outer Thames Estuary’s Crown Estates Licensed Dredging Areas.

THE PLA REQUIREMENT FOR THE DREDGING OF PRINCES CHANNEL

The PLA is a self-financing public sector trust which manages a range of responsibilities along the tidal River Thames. Its operations cover 95 miles of the River Thames, which, in broad terms, can be broken down into the following three main sections:

- Teddington to Putney: principally recreational uses, including rowing and sailing and some occasional, special-project cargoes.
- Putney to the Thames Barrier: mainly tourist and commuter passenger vessels with some smaller boats/barges, predominantly carrying aggregates and wastes.
- Thames Barrier to the sea: the main centre for the commercial Port operations, handling the larger sea-going vessels.

The PLA’s primary responsibilities are the safety of navigation and protection of the environment of the River Thames, an area which is recognised for its environmental importance, but with differing characteristics along its length. The wide expanses of the mudflats in the lower Thames are noted for their bird interest, with National, European and International conservation designations including Sites of Special Scientific Interest (SSSI), Special Protection Areas (SPA), Special Areas of Conservation (SAC) and Ramsar sites.

Project overview

For many years the southerly access into the Port of London has been provided by the North Edinburgh Channel, Princes Channel and, more recently, the Fisherman’s Gat (see Figure 1). However the seabed in these areas has been in a state of constant flux, with water depths and channel centrelines continually changing. Historically, there has always been a southern access route into the main entrance channel of the Thames with a minimum depth in the region of 7 to 8 m. Whilst this is currently provided by the Fisherman’s Gat, the combination of the instability of this access together with the necessity for vessels to cross busy shipping lanes when entering from this point has required the PLA to consider alternative routes including the Princes Channel.

In order to comply with the recommendations derived from a Navigational Risk Assessment that studied the above factors, the PLA committed to deepen a section of the Princes Channel to –8.0 m CD.

The deepening project was planned to be undertaken in two discrete phases. The first was a trial that was completed in the summer of 2003. The purpose of this trial was to deepen a narrow part of the western section of the Channel to approximately –7.0 m CD (marginally below the existing regime depth) and then study its stability and rate of infill. The subsequent intensive regime of bathymetric survey demonstrated that a deepened channel was sustainable and confirmed the PLA’s intention to complete the project and provide an alternative stable access from the South.

Phase 2 of the deepening project would therefore complete the development of the Princes Channel to provide a 300 m channel with maintenance dredging zones of 75 m to either side to facilitate uninterrupted passage for shipping. This would require approximately 2,500,000 m³ of dredging.

In line with Government Regulations, and in accordance with the London Convention and OSPAR requirements, the 350,000 m³ of dredged material from the first phase of the Project was used beneficially in a
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NICK BRAY
is a director and founder of Dredging Research Ltd, which is now part of HR Wallingford. He has 40 years of experience in dredging and reclamation and maritime civil engineering. He has written numerous technical articles and is editor of the new IADC/CEDA book, "Environmental Aspects of Dredging". He has developed several computer-based dredging production and cost-estimating models and also has experience in the field of underwater rock removal by drilling, blasting and dredging. He has provided expert opinions on a variety of dredging disputes, acted as a mediator as well as an expert witness in various arbitration proceedings.

PAUL HESK
is Contracts and Business Development Manager at Van Oord UK Ltd. His primary responsibilities include identifying and securing projects in the UK and Ireland. He acted as tender coordinator for the Rochester Riverside Project and led the liaison with the PLA regarding opportunities for the beneficial reuse of material dredged from Princes Channel. He is also responsible for Quality, Health, Safety and Environmental Management in the UK and Ireland and coordinates all of Van Oord’s works under their second generation, four-year Framework with the Environment Agency.

construction scheme on the East Coast. The PLA decided that they should continue to seek beneficial uses for the material from Phase 2 of the Project, for example, land reclamation, maritime construction, coastal protection and environmental enhancements. However, in recognising the difficulties in coordinating the requirements and timescales of the various projects they were aware might require large quantities of sand fill, they realised this aim might not be fully achievable. Therefore a fall-back strategy of placing dredged material in a marine disposal site was developed. The designation of a new location within the dynamic regime of the estuary, the North Edinburgh Channel, was suggested.

Environmental assessment
The general position around the coast of England and Wales is that dredging undertaken for navigational purposes is regulated by the Department for Transport (DfT) (via the Marine Consents and Environmental Unit) under Section 34 of the Coast Protection Act (CPA). However, within the PLA’s Port limits the situation is different as they have the powers to both license and undertake dredging operations. These powers have been given to the PLA under successive Port of London Authority Acts (most recently PoLA 1968, sections 60 and 73). The CPA recognises these powers, Section 35 of the Act exempting dredging on the Thames from the requirements for consent.

Whilst, therefore, exempted from the requirements of the CPA, Section 48A of the Harbours Act requires the PLA to “have regard to” a number of environmental issues whilst fulfilling its functions such as the licensing of dredging operations. For example the PLA must pay regard to:

- the conservation of the natural beauty of the countryside and of flora, fauna and geological or physiographical features of special interest;
- the desirability of preserving for the public any freedom of access to places of natural beauty;
- the desirability of maintaining the availability to the public of any facility for visiting or inspecting any building, site or object of archaeological, architectural or historic interest.

In addition, as a public body, the PLA must comply with the following environmental legislative requirements when licensing or undertaking dredging operations:

- Conservation (Natural Habitats &c.) Regulations 1994;
- Countryside and Rights of Way Act 2000;
- Environmental Impact Assessment (EIA) Directive (97/11/EC);
- Shellfish Waters Directive (79/923/EEC);
- and
- Surface Waters (Dangerous Substances) (Classification) Regulations 1997 and 1998.

Therefore the PLA undertook an environmental assessment of the likely effects of the Phase 2 Dredging operations which considered the following:

- Coastal Processes
- Sediment Quality
- Water Quality
- Marine Biology
- Natural Fisheries
- Birds
- Designated Conservation Sites
- Marine Archaeology
- Commercial Fishing
- Navigation
- Recreational Activity
- Other Seabed Uses
- In-Combination Effects

The conclusions of this assessment were as follows:

- Whilst the dredging operation would cause localised changes to the hydrodynamic properties of the Princes Channel, areas outside of this would be unaffected.
- The seabed sediment was considered chemically clean and therefore suitable for either beneficially reuse or disposal at sea.
- Water quality was unlikely to be impacted owing to the low levels of contaminant, organic material and fines in the dredged sand.
- The marine biology within the dredging area was impoverished and no species of conservation importance were identified.
- Whilst the Thames estuary is important to fisheries as both spawning and nursery areas for a variety of fish, there was no evidence to suggest that the dredge site
was of any specific importance.
- The presence of dredging vessels in an already busy shipping channel was unlikely to affect bird activity that is geographically widespread and variable from year to year.
- The nearest designated conservation sites were over 20 km from the dredging area; no impacts on these were therefore predicted.
- An archaeological assessment found evidence of a historically important wreck within the Princes Channel. This was investigated further and subsequently lifted in accordance with a mitigation strategy agreed with English Heritage.
- The local fishing community indicated that the Princes Channel was of limited importance for fishing, therefore negligible impacts were expected.
- The dredging operation could be effectively managed by the Harbour Master to avoid any interference with the interests of commercial and recreational navigation.
- Whilst a number of other infrastructure projects were either ongoing or planned for the area, no interference was predicted.
- Geographical separation limited the potential for any in-combination effects.

In conclusion the PLA concluded that the Phase 2 dredging project was unlikely to have any significant effects on the natural environment in the vicinity of the Princes Channel.

The loss of the limited biological community was considered to be only a temporary effect as recovery would commence upon completion of the dredging operation. The next step was to work in partnership with the dredging industry to find viable solutions.

THE DREDGING CONTRACT

Having demonstrated that Phase 2 of the Princes Channel Deepening Project was unlikely to have significant environmental effects, the PLA consulted with the dredging industry to both seek their views on the options available for the sustainable utilisation of the dredged material and the type of Contract required to promote its use to the mutual benefit of the End User, the Contractor and themselves. To facilitate this approach, PLA employed Dredging Research Ltd to develop a Contract incentivising dredging contractors to explore and acquire opportunities for the beneficial reuse of this material, but without commitment if no such needs existed.

The Requirements

The essence of the contract was that it should provide a win-win outcome for both the PLA and the dredging contractors. The PLA needed the dredging to be carried out in a specific way in order to gain the benefits of the dredging in terms of navigational improvement. The dredging contractor needed the reassurance of being able to take the requisite volume of material for its project, at a time to suit its programme and for a known cost.

In more detailed terms the PLA required:
- A way of ensuring that the full width of the channel was dredged and that the shallowest zones were lowered gradually to give a continuously improving navigable depth;
- A method of directing the final dredging operations to ensure that no parts of the channel contained high spots;
- A contract form that encouraged use of the material rather than disposal;
- A contract form that would encourage the dredging contractors to use the Princes Channel material rather than other competing sources of fill; and
- A contract that would be reasonably easy to administer.

The dredging contractors were understood to require:
- A sand source of a quality that could be used for future reclamation projects;
- A known cost (i.e. material cost plus royalty) of obtaining this material from Princes Channel;
- An arrangement that permitted use of the Princes Channel sand but that did not tie them exclusively to using this sand; and
- An assurance that sufficient material would be available, but that this material did not have to be taken if, for instance the quality became too poor or the reclamation contract was curtailed.

The Solution

The solution adopted was to develop a Pro-Forma Contract that all interested dredging contractors could sign up to in principle. This ensured a level playing field and gave all parties the confidence that all potential users were being treated equally. The Pro-Forma Contract was based on the FIDIC Conditions of Contract for Dredging and Reclamation Works and contained the following provisions for any contractor who had signed up to the pro-forma:

a) Within reason, sand could be dredged from the channel by a contractor at a production rate to suit any intended reclamation project and its programme.
b) The contractor was not obliged to use the exact amount of sand specified in the contract, but could excavate any volume that was convenient for the given purposes. In effect the contractor had no obligation to dredge at all. Dredging was entirely at the contractor’s discretion.
c) If the contractor carried out dredging, there was an obligation to dredge the channel in relatively thin layers, to maintain a steady increase in navigable depth (see Figure 2). In practice, the specification stated that the deepest part of the dredged footprint should be no greater than 500 mm deeper than the shallowest part of this footprint.

d) Contractors would have to take account of the fact that more than one company might be dredging at any one time. In such cases, the channel would be split longitudinally into strips of equal width and each contractor would be allocated a strip in which to dredge.

e) Whilst the PLA would neither make nor receive payment for any sand dredged, the contractor would have to pay the Crown Estate a royalty for the removal of the seabed.

The Incentive

As a means of encouraging the contractors to favour the Princes Channel as a suitable source, rather than obtaining the required sand from a licensed area offshore, an incentive was built into the contract. This incentive was that:

“For every 100 m³ of sand removed, in hopper, from the site and reused in a reclamation project, the contractor would have to pay the PLA by 20%.

In addition to these advantages, the movement of sand from Princes to the North Edinburgh Channel, where it was carefully placed in the deeper water according to a prescribed grid system, had the effect of keeping the sand in the same sedimentary system.

Other aspects of the Contract

Apart from the provisions of the Contract described above, there were a number of others relating to environmental effects, both around the dredging site and at the placement site in the North Edinburgh channel. These included:

- Bathymetric surveying at the dredging and placement sites on a prescribed frequency;
- Arrangements for dealing with obstructions and patches of sub-soil that were clearly not classified as sands and gravels, such as stiff clay.

The operation of the Contract

The forerunner of the contract operated successfully in 2003, when some 350,000 m³ of sand were dredged from the channel and taken to Felixstowe for reclamation. Subsequently, the incentive arrangements were added and the full Pro-Forma was issued in December 2004. Since then, the Rochester project has been carried out using the contract and approximately 340,000 m³ of sand was taken to reclamation and another 85,000 m³ to the North Edinburgh channel (see below).

A review of the workings of the contract has demonstrated that it has worked well. Improvements for the future might include:

- nominating the sub-contractor that executes the environmental monitoring to ensure that the data collected is of a high standard and presented in a consistent manner, and
- allowing a little more flexibility in the timing of the incentive dredging.

THE ROCHESTER RIVERSIDE DEVELOPMENT

The aim of the Rochester Riverside Development, a 30 hectare site on the River Medway (see Figure 3) and part of the UK Government promoted and funded Thames Gateway Regeneration, is to create a sustainable development of a mixed-use community of around 1800 homes with a hotel, primary school and other community facilities and employment opportunities. As part of this development an Edmund Nuttall/Van Oord Joint Venture was awarded a Preparatory Engineering Works Contract by Medway Council in autumn 2005 which included the following scope:

- Land-raising (to provide improved flood defences);
- Contamination Remediation; and
- Inter-Tidal Habitat Creation.

A key element of the Contract was the improvement of the site’s flood defences, to be achieved by a combination of approximately 2.5 km of new sheet-piled or refurbished river walls and the average raising of the land by approximately 1 m. The improvement of the flood defences to the standards required in the UK Govern-

Table I. Responsibilities for contracting parties.

<table>
<thead>
<tr>
<th>Van Oord UK Ltd</th>
<th>Edmund Nuttall Ltd</th>
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</thead>
<tbody>
<tr>
<td>Importation of sand fill for Land Raising Material into Reception Lagoons</td>
<td>Onward movement of sand fill from Reception Lagoons and subsequent placement into the Works</td>
</tr>
<tr>
<td>Installation of Vertical Drains to accelerate consolidation of the underlying strata</td>
<td>Construction of new and refurbishment of existing River Walls</td>
</tr>
<tr>
<td></td>
<td>Remediation of Contaminated Materials</td>
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</tbody>
</table>
ment’s Department for Environment, Food and Rural Affairs (Defra) Planning Policy Statement 25: Development and Flood Risk (PPS25) was critical in securing Environment Agency approval for the scheme.

A key part of the Edmund Nuttall/Van Oord Joint Venture’s success in being awarded this Contract had been their positive promotion to the Client and their Consultants of the benefits, both economically and environmentally, of using land-raising material obtained from the navigational dredging of the Princes Channel.

In bidding for and subsequently being awarded this Contract the parties within the Joint Venture had agreed to the split of responsibilities for the Works shown in Table I.

Included in Van Oord’s responsibilities were the negotiations with the appropriate Regulatory Authorities in order to gain consent for the dredging and importation of the Princes Channel material.

**Regulatory approval**

Immediately following Contract Award, Van Oord commenced negotiations with both the PLA and the Environment Agency regarding the dredging and subsequent reuse of the Princes Channel material for the Project.

The negotiations with the PLA were straightforward, the principles of the agreement to dredge having been agreed in advance through their Pro-Forma Contract. However, gaining the necessary approvals from the Environment Agency was a more protracted process.

In developing their proposed methodology for the sand importation at tender stage, the Joint Venture had recognised that the direct placement of the material into its required location would involve a significant risk owing to the presence of contaminants throughout the site. The risk of the transportation water being contaminated by contact with these materials was considered too great and therefore a methodology was developed of importing the sand into sealed reception lagoons before its subsequent onward movement and placement using conventional earthmoving equipment. The use of these lagoons meant that the large volumes of transportation water, used by a trailing suction hopper dredger (TSHD) to facilitate pumping the dredged material onto the site, could be effectively managed prior to its eventual discharge back into the River Medway.

The early discussions with the Environment Agency identified that by using this proposed methodology they would require the licences in Table I to be in place prior to works commencing.

The requirement for the Waste Management and Site Recovery Licences emanated from the Environment Agency’s designation of the material dredged at Princes Channel as a Waste. This designation resulted in protracted discussions with the Environment Agency by both the Client and the PLA /Van Oord partnership. Despite

![Figure 3. The Rochester Riverside Development, River Medway.](image-url)
continuing to disagree with their interpretation, it was recognised that, save for seeking a court ruling, the only practical way forward was to apply for these licences in line with this classification. However, Van Oord did continue to contend that an Abstraction Licence was inappropriate for this application and the operation was completed without one.

Despite the Environment Agency being supportive in principle to this beneficial reuse of dredged material being transported by sea, each licence application took approximately four months to process. Extensive negotiations were required to agree the levels of suspended solids permitted to be discharged back into the River Medway, with variations appropriate for times of spring and neap tides respectively.

**Importation of the land-raising material**

Prior to the final agreement and receipt of the Waste, Site Recovery and Discharge Consent Licences, Van Oord commenced construction of the Reception Lagoons. The layout shown in Figure 4 had been conceived at tender stage, but owing to a number of constraints identified following the award of the Contract an amended arrangement (see Figure 5) was used.

The overall lagoon layout accommodated two sand reception lagoons and a single sediment settlement and discharge pond. The size of each reception lagoon was sufficient to receive and store up to 3 days sand supply from the dredger. Two reception lagoons were used on an alternating basis; whilst one was being filled by the dredger the other was emptied using conventional earth-moving equipment. The size of the settlement pond was dictated by both the quantity of discharge water and the length of time it was anticipated this would have to be retained until its quality (i.e. suspended solids content) was of a level that complied with the requirements of the Discharge Consent Licence.

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**Table II. Licences necessary to proceed with the project.**

<table>
<thead>
<tr>
<th>Licence</th>
<th>Details</th>
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<tbody>
<tr>
<td>Waste Management Licence</td>
<td>Control of the importation of the sand material into the Reception Pits</td>
</tr>
<tr>
<td>Site Recovery Licences</td>
<td>Control of the subsequent onward movement and placement of the sand material from the Reception Pits to its required location on site, including the effects of this on the underlying soils and ground water (which included contaminants)</td>
</tr>
<tr>
<td>Discharge Consent Licence</td>
<td>Control of the quality and quantity of transportation water being discharged back into the River Medway</td>
</tr>
<tr>
<td>Abstraction Licence</td>
<td>Control of abstraction of water from the River Medway by the TSHD for the pumping of the sand material into the Reception Pits</td>
</tr>
</tbody>
</table>

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**Figure 4. Tender stage layout of the reception lagoons.**

**Figure 5. Actual layout of the reception lagoons as amended.**
The movement and incorporation of the sand from the lagoons into the permanent works was undertaken by Van Oord’s Joint Venture partner since they were considered to be more experienced in conventional earth-moving operations. The sand material was also used as a surcharge to accelerate consolidation of the underlying strata; this process being aided by the installation of over 1,000,000 m of prefabricated vertical drain. Various monitoring methods were used during the placement of the sand fill. These included real-time measurements of the underlying pore water pressure and settlement monitoring using both settlement plates and electronic methods. The sand supply to the Rochester Riverside site was completed in September 2006 when approximately 340,000 m³ had been delivered.

**CONCLUSION**

By working in partnership with the dredging industry, the Port of London Authority and Dredging Research Ltd have produced a form of Contract that incentivises Contractors to acquire opportunities for the beneficial reuse of dredged material.

The use of this Contract has allowed the PLA to undertake a significant part of Phase 2 of their Project to deepen Princes Channel in compliance with Governmental, London Convention and OSPAR requirements. In addition, both they and Medway Council have benefited commercially from the beneficial reuse of this material.

The successful completion of the import of approximately 340,000 m³ of sand fill from the Princes Channel for land-raising at the Rochester Riverside Project has demonstrated that estuary dredgings can legitimately be used within the construction sector; providing cost savings and environmental benefits when compared to the use of virgin aggregates.

The reception lagoons were constructed from sand dredged from a Crown Estates Licensed source in the Outer Thames Estuary and was delivered to site by an Aggregate Dredger, from which it was dry-discharged using conveyor belts and an elevator. The use of this material and methodology for the construction of the lagoons was planned to allow the works to proceed in parallel with the licence applications, thereby saving time on the overall construction programme. Whilst the lagoon sides were lined with an impermeable membrane, the bases were formed on existing concrete ground-slabs. These slabs were deemed sufficiently impermeable for the purpose, and the risk of damage to a base membrane during the filling and recovery operations was considered too great for one to be of any long-term practical use.

All three lagoons were connected by pipelines and weir boxes (see Figure 6) in order that the discharge water from the reception lagoons could be transferred, by gravity, into the final settlement lagoon. The rate at which the water moved from the reception lagoons into the settlement lagoon and from there subsequently discharged back into the River Medway was controlled by the heights of the weirs between the lagoons and preceding the final discharge pipe work. This methodology and the real-time monitoring undertaken of the water discharged back into the Medway ensured that its quality (i.e. the suspended solids content) complied with the requirements of the Discharge Consent Licence.

The importation of the sand material dredged from Princes Channel commenced in late April 2006 using the TSHD Ostsee which carried an average load of 2,000 m³ per trip. Owing to navigation constraints, the dredger’s access to the Rochester site was only possible around times of high water. The sand discharge generally commenced 1 hour before the high tide and lasted for approximately 1.5 hours.

These constraints led to the dredging operation at Princes Channel being undertaken around times of low tide. There was however sufficient available time in the tidal cycle to allow, towards the end of the operation, some of the “incentive” dredging work to be undertaken in parallel with the sand supply operation.