EARLY CONTRACTOR INVOLVEMENT;
IMPROVING COMPLEX MARITIME INFRASTRUCTURE PROJECTS

by Rene Kolman

ABSTRACT
With the advent of the jumbo dredging fleet and advanced technologies, the ability to execute ever larger and more complex maritime infrastructure projects has increased exponentially. However, the means to manage and cost estimate these projects has not kept pace. The preparation for these large infrastructure projects often consumes an extraordinary amount of time, money and human resources and is not particularly cost effective. The importance of input from the contractors who are executing the work is too often underestimated. In addition, the legal structure governing tenders and procurement is mired in the past of seeking the lowest price, preventing collusion and protecting competition, but not allowing for the competitive edge which may result in added value.

Whilst these are commendable goals, they are only part of the picture. International and national legislation often create legal barriers which prevent contractors from supporting the ultimate goal: doing the best job for a fair price, that is, finding the most efficient solutions – not the least expensive – to these complex challenges. The concept of Early Contractor Involvement presented here encourages the adaptation of the legal framework to the realities of today’s complex infrastructure projects. It outlines a pathway to a changing system of procurement which enforces competition as well as takes advantage of the knowledge, expertise and advanced research of the contractors. Two case studies are presented.

INTRODUCTION
The preparation for large infrastructure projects often consumes an extraordinary amount of time, money and human resources and is not particularly cost-effective. This is obviously also inefficient.

Some of this inefficiency is caused by traditional procurement methods which bring contractors into the process after many key decisions have been made. Another reason is the usual project management style, which focuses on control instead of expertise and experience. When clients and consultants adopt the Early Contractor Involvement (ECI) concept – allowing a contractor to be involved from the earliest beginning of the project - all stakeholders benefit. And not only for efficiency reasons. ECI offers contractors the opportunity to profile themselves with their expertise and knowledge and to step out of the downward spiral to the lowest price.

This paper will elaborate on some aspects of the procurement and building processes of infrastructure based on literature with an ECI perspective. Although the literature on the subject is limited the paper will be expanded with case studies of two large maritime infrastructure projects: The C-power wind farm park located in front of the Belgium coast and the Ichthys LNG project in Darwin, Australia.

The traditional way
The majority of construction contracts provide for the appointment of a contractor when construction is about to commence. The appointment is preceded by a single stage procurement exercise to select a suitable contractor based on the requirements and constraints formulated in the tender document and the lowest price. The translation of the client’s needs into a tender document is generally supported by a consultant.

Nowadays, however, the “economically most favourable tender” (instead of lowest price) is gaining some acceptance. In addition to price, other elements such as the safety programme and sustainability of the construction process are being taken into consideration to determine the best offer. Despite this ‘progress’ in procurement, very little possibility exists for one contractor to distinguish itself from other contractors using the power of creative and innovative proposals.
Kashiwagi, D. (2011) characterises the project management of the traditional process as less effective. “The traditional method of delivery of service is by use of a contract and specifications developed by the client/buyer’s professional representative. The buyer is in the position of being the expert and directing expert vendors. Most of the time the client’s representative sets minimum acceptable standards in the specifications to identify the required system/services.”

According to Kashiwagi, D. (2011) this traditional process has several negative results:

1. Control; who is responsible?
2. Enforcement; who is responsible?
3. Low price; becomes the most important factor.
4. Reactive; forces vendors/contractors to react rather than invent.
5. The project manager; is the non-expert.

Control and enforcement have never been validated as a method to improve performance and value, and have always led to higher costs, more negative impacts and higher risks (Kashiwagi, D. 2011).

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Figure 1: Industry structure model; Kashiwagi, D.( 2011).

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Figure 2: Minimum standards, Kashiwagi, D. (2011).
The downward spiral

When the client sets minimum standards, a contractor will assume that the job will be awarded based on the lowest price. As a result the contractors will drive down value and performance. According to Kashiwagi this way of tendering will result in reactive behaviour, low performance and a lack of accountability.

When it is assumed that the job will be awarded to the lowest bidder, the high performer vendor/contractor is then forced to:

1. Assume that the specifications are perfect and all inclusive. The only way to minimise price is to assume that the project has no risk, as risk increases price.
2. Assume that the minimum requirements are enforceable. Most minimum standards are not enforceable allowing vendors to "meet the minimum standards" with services that do not meet the intent.
3. Become reactive, minimizing any proactive thinking to minimise risk.
4. Accept that the client is the expert.
5. Minimise the need for experts on their team.

Directing the vendor /contractor with specifications makes vendor/contractor 1 less competitive and allows vendor/contractor 4 to be competitive even if vendor/contractor 4 does not meet the minimum standards because no one can legally prove that vendor/contractor 4 is substandard.

Kashiwagi (2011) enumerates several problems resulting from the traditional way of procurement:

1. The client's management, direction and control of the contractor do not create an optimal delivery system and lead to increased project risk and a degradation of value.
2. Contractors become more reactive and less visionary over time in a price-based, client-directed and -controlled environment. This increases project risk.
3. An increased decision making environment: The client representative must make more decisions on "what can be done?" and "how to make the contractor do what is required?" The contractors must make decisions on how to make a profit when reacting to a non-expert's directions and cost expectations. Both these increase project risk as well as the chances of parties thinking in their own best interest (win/lose).
4. Clients and contractors respond to the increased risk by forming relationships, passing on more information and working together. This minimises accountability and increases legal issues.
5. Problems are looked at as technical issues, which require more technical expertise, more details, and decreasing transparency.
6. The time is not taken on projects to pre-plan or plan ahead of time. Rather, project managers representing buyers and clients concentrate on meeting technical requirements which are not easily translatable into performance requirements. This leads to a major effort in dispute resolution, mediation, and methods of solving problems once they occur.
The only conclusion that can be drawn is that the traditional way is not an optimal procedure for tendering complex infrastructure.

**An alternative way: Early Contractor Involvement**

Emmerson, H. (1962) already recognised that the design responsibility was far removed from the construction responsibility in most construction tenders. Apparently it has taken almost 50 years for this insight to lead to some adjustment of procurement procedures. For regular maintenance work the old fashioned way may still be suitable, but when it comes to capital works a closer relationship between design and construction is beneficial to all parties involved.

Though five decades have passed since Emmerson’s observations, this concept of “early contractor involvement” is still not commonly accepted in the governmental purchase process as a result of legal (fair competition) obstacles. Notwithstanding legal restraints, some progress has been made.

As Walker (2012) makes clear: the contractor can be taken on board at several stages of the procurement process DG 0 to 3.

![Figure 4: Project Life CyclePhases: (Adapted from Klakegg et al. 2010, p38-39)](image)

Decision Gates: DG0 = formally recognised idea, DG1 = acceptable initiative to investigate, DG2 = choice of concept, DG3 = go/no go, D4 = accept outputs for the operation phase.

The earlier contractors are taken on board the more their knowledge and expertise can contribute to the final result. Mosey (2009) recognises the following benefits;

1. **Design:** contribute to buildability and affordability. The knowledge of the contractor brings in innovative ideas and the capability to translate ideas into practice with recognition of potential problems. This will reduce costs and potential risks.
2. **Costs:** cost plan can be tested by contractor. Client and consultants can have their budgets reviewed by an expert with practical experience. Potential budget problems will be recognised upfront and alternatives can be discussed. This will result in less risk and less discussion in the execution stage.
3. **Risks:** risk assessment of client/consultant can be compared with those of the contractor; risk management actions can be undertaken without delaying the process. Risk has its price. A contractor will price all risks, so risk reduction will result in more certainty about the total costs, but also potentially to a lower price.
4. Main contractor tender: Improvement of project information creates transparency and transparency leads to a reduction of risks and costs. The review of the project information by the contractor will reveal blind spots, which will result in discussions during the construction stage. At the construction stage the contractor has still the opportunity to present alternative ideas.

5. Subcontractor tender: as result of improved information subcontractors are able to offer fixed prices and show their capability and design and risk contribution. As said before, the reduction of risk will lead to a lower price, but also to less litigation during or afterwards.

6. Time and processes can be created for joint client/consultant/contractor activities as value engineering and risk management. Additional time provides the opportunity to discuss how the value of the project can be increased without an increase of costs and again with a reduction of risk.

7. Production phase programme can be agreed upon. The contractor is responsible for the execution. As the client and consultant lack the knowledge and experience to transfer the initial programme into a real construction schedule the contractor will probably change the initial thoughts, changes which can lead to uncertainty and tuning problems. Early involvement means a realistic production phase programme.

8. Subcontractor appointments can be finalised prior to the start of the work reducing risk and increasing cost certainty.

The CIRIA report “Selecting Contractors by Value” (1998) recognises also the substantial contributions contractors can make by offering design alternatives. Some of the contributions highlighted are:

1. Use of more cheaply sourced material;
2. Use of Manufacturers standards;
3. Engineering from the perspective of ease of construction;
4. Increase of the degree of repetition.

The UK Highway Agency has its programme reviewed in March 2007 on potential benefits of early contractor involvement. The following benefits were recognised:

1. Potentially reduces preparation time by 30-40% by carrying out certain development processes simultaneously;
2. Gives the client access to detailed cost data to improve future estimates and output;
3. Increases innovation and facilitates value management and engineering;
4. Provides benefits from clients and suppliers working as a team, which also leads to an open and honest process so that real costs are highlighted early.

Kashiwagi (2011) described some shortcomings of the traditional way of tendering as mentioned earlier in the paper. He also recognises advantages of a new project management style which is closely related to early contractor involvement. He is of the opinion that “if a client hires a vendor who knows what they are doing, the project has a great probability of being a success”. Success is closely related to risk; minimisation of risk will improve the probability of a successful project.

He identifies potential requirements for a renewed and effective project management style to minimise risks, two of which are mentioned:

1. Minimise decision making. Provide a situation where it is clear what the next step in the process will be and what its outcome will be. Multiple possible outcomes make decision making necessary without having all information. This increases risk.
2. Treat contractors as experts. Their expertise will ease the translation of functional requirements into real construction work and reduce risk. An expert can identify risks that are out of his control and take mitigating measures.

Although for less complex maintenance works, with less risk involved, the classical way of tendering may work. Clearly, for more complex infrastructure projects, early contractor involvement has some substantial advantages. Still, a tender procedure which facilitates ECI can be quite challenging and the next section deals with some legal issues that may arise.

Legal challenges presented by Early Contractor Involvement

The elaboration on legal issues below is based on the situation of the European Union but will most probably also be valid outside that region. The European Public Procurement Directive (EU, 2004) identifies different tender procedures:
1. Open procedure (no selection);
2. Restricted procedure (with pre-selection, pre-qualification);
3. Negotiated procedure without prior publication, very strict application thresholds;
4. Negotiated procedure with prior publication (hereafter: negotiated procedure) e.g., applicable if the nature of the project is such that specifications cannot be drawn up with sufficient precision to permit the award of the contract by means of the open- or restricted procedure (“no specifications ground”);
5. Competitive dialogue (new), specifically introduced for complex situations/projects and applicable if tendering a particularly complex contract and the contracting authority finds it objectively impossible to define the means of satisfying its needs or assessing what the market can offer in the way of technical, financial and/or legal solutions.

The competitive dialogue

The European Commission recognises that standard procurement procedures do not always provide the best results, especially pertaining to the building and design of complex infrastructure projects. The competitive dialogue procedure is an attempt to diversify procurement procedures and stimulate professional input early in the tendering process.

At the same time the procedure is clearly quite complex and not free from pitfalls.

The fundamental demand is that the dialogue with different bidders must take place in parallel. Since the Contracting Authority may not share solutions proposed by different candidates, entirely different technical approaches could be developed in parallel, a situation which can complicate the life of the Contracting Authority. The temptation to provide hints to competitors on the strength of a solution proposed by another contractor is very real.

The concern of the Contracting Authority is to keep the bid evaluation process manageable and to maintain effective competition. The interest of the parties invited to such a dialogue is the opposite: Attempt to be as creative as possible and provide cost-effective solutions, preferably protected by patents that provide an unbeatable “competitive edge” or advantage.

This is likely to make the contracting authority feel vulnerable, because it realises early in the dialogue that one of the invited bidders may develop a strong advantage over the rest.

The review of the European legislation on public procurement and public-private partnerships (PPPs) has made it clear that the principles of the Treaty give preference to broad competition and leave little room in the proposal stage for relationships with contractors that are closer than at arm’s length. The dominating concern in the various directives is that access to tenders should be transparent and that competition should be maintained throughout the bidding stage.

The current public procurement directive 2004/18 does open the possibility for “competitive dialogues”, but only for “particularly complex contracts”. Under this procedure the competition should be maintained through to the final bidding between at least two contractors. In the revised procurement directive the competitive dialogue is opened up to all “complex contracts” where early input on possible technical solutions is necessary or desirable. Nonetheless, the idea is maintained that at least two contractors should be consulted in parallel during the competitive dialogue.

Competitive edge vs competitive dialogue

Over the last two decades, the marine offshore and dredging industry has evolved rapidly and technical options to solve complex problems (soil issues, environment, production capacity, special tools, holistic approaches...) in a cost effective manner often exist. The contracting authority is most likely not familiar with the latest technology and consultants may not be familiar with the possible solutions either. For that reason it is in the interest of all parties that optimal solutions can and should be discussed between the contracting authority and the contractors prior to the phase of priced tenders.

Under European competition and procurement law, the competitive dialogue is the instrument that offers the best compromise between the requirement of sustained competition and the need to discuss technical approaches. As stated above, the case of an institutional PPP is even more complex, because selection of the referred partner must take place on the basis of objective criteria, as the
authority and the contractor plan to enter into a joint venture that will be responsible for the design, construction and operation of the works.

Even though cost and design information are not available yet, the criteria of transparency and equal treatment must be respected. Table I summarises the present review and lists the three types of contracts and procedures that may accommodate early contractor involvement under European procurement rules.

<table>
<thead>
<tr>
<th>Type of Contract</th>
<th>Complex Contracts with concessions (Contractual PPP)</th>
<th>Complex contracts without Concessions</th>
<th>Institutionalised PPP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Which procedures</td>
<td>&quot;Negotiated procedure&quot;</td>
<td>&quot;Negotiated procedure&quot;</td>
<td>&quot;Competitive dialogue&quot;</td>
</tr>
<tr>
<td>Is ECI possible?</td>
<td>Limited to negotiation stage</td>
<td>Limited to negotiation stage</td>
<td>Yes; Private partner responsible for design</td>
</tr>
</tbody>
</table>

Table 1. When is Early Contractor Involvement an option?

*: Recital 2 of the current Directive on Public Procurement states this as follows: *The award of contracts concluded in the Member States on behalf of the State, regional or local authorities and other bodies governed by public law entities is subject to the respect of the principles of the Treaty and in particular to the principle of freedom of movement of goods, the principle of freedom of establishment and the principle of freedom to provide services and to the principles deriving therefrom, such as the principle of equal treatment, the principle of non-discrimination, the principle of mutual recognition, the principle of proportionality.
Early Contractor Involvement in practice: Two Case Studies

Finding and exploiting new energy sources has become one of the major challenges of the 21st century. Such infrastructure projects are complex and often high risk endeavours. The case studies presented here represent just two of many such projects executed in the very recent past in which dredging played a significant role and for which the expertise and experience of the major international dredging companies provided cost-savings and innovative solutions because they were invited early on to participate in the ‘think’ work that precedes operational works.

CASE STUDY 1 - C-POWER PROJECT DEME

C-Power NV was founded in 1999 with the stated purpose to develop, construct and operate electricity installations and systems for generating energy at sea. C-Power NV is the project developer for the wind farm on the Thornton Bank, some 30 kilometres off shore in the Belgian North Sea with an installed capacity of 325 MW. DEME was from the very beginning shareholder in C-Power.

Exploratory conversations between the stakeholders delivered some specific results; the parties were complementary and had all the necessary capabilities to construct and operate a wind farm at sea.

A pilot project of 6 wind mills, 5 MW each would first be established on the Thornton Bank. Eight years of preparation were necessary before a final ‘go’ was given. The agreements for the financing, insurance and implementation of the works were signed on 23 May 2007, which was just at the top of the economic wave.

The focus here is on some typical Early Contractor Involvement elements of the project. With the participation early on of various contractors a joint “venture” feeling was created. Parties were their own client and when they recognised a problem, they brought their experts in to discuss and solve it, deviating from the original plans when necessary. This feeling of shared responsibility was highly effective and efficient.

ECI: A cost-effective solution

The initial design of the wind mill had a steel structured foundation. By the time the project was ready to start, the demand for this specific kind of steel was excessive and prices had sky-rocketed. The Eurostat-index for hollow pipes and the index for steel structures jumped from 100 in 2005 to
respectively 123.5 and 117.8 in 2008. Taking these prices into account, the feasibility of the project in its original design was highly questionable.

The expertise of the contractor DEME came to the fore and provided the knowledge needed to solve the problem. The engineering department redesigned the original steel jacket base foundation changing it to a gravity-based concrete foundation. Although a great quantity of steel was still needed, this was a more common type of steel and considerably less expensive than the original steel needed. The concrete structure has the form of a 7.5m wide ring with an outer diameter of 23.5m. The conical part has an outer diameter at the base plate of 17m which tapers to an outer diameter of 6.5 m. On top of this, a cylindrical section begins, ending up in a bed of 180 gigantic bolts for the mast to be fastened.

Figure 6: gravity based structure

Figure 7: dimension wind mill

ECI: The appropriate equipment

Because of DEME’s early involvement at the design stage of the concrete foundation, the designers were advised and took into consideration that the Rambiz, the heavy lift vessel of DEME, had a maximum lifting capacity of 3,000 tonnes. Often designs are made without any thought of the equipment needed. Nor of the fact that a search for suitable equipment that can cope with the requirements and limitations of the designed structure is time consuming and often expensive. Nor is thought given to the availability of the specific piece of equipment.

The ultimate weight of the concrete foundation turned out to be slightly more than estimated, although it stayed under 3,000 tonnes at all times.

Figure 8: Rambiz lifting structure
ECI: Special work methods

For the assembly of the wind turbine, a Liebherr LR 1750 crane with a lifting capacity of 750 tonnes and a large counterweight to maintain balance during lifting work was used. The weight of such a large crane usually exceeds the capabilities of the Buzzard (jack-up), certainly when lifting the heaviest component, the nacelle, which weighs 316 tonnes.

Together GeoSea (the DEME group) and Sarens, the supplier of the crane, worked out a creative and very bold solution – use a smaller load for the Buzzard. As a result of its high positioning, the crane could work with a shorter, 63 m boom, while the counterweight remained limited to 150 tonnes. Special work methods prevented the crane from tipping over.

Figure 9: Buzzard lifting nacelle

ECI: More innovations

During this pilot phase, C-Power and its contractors were ultimately able to test all sorts of new techniques and acquire much useful experience which could be applied to the next phases of construction. As a result, C-power ultimately decided to thoroughly re-evaluate the foundation concept and even the choice of the wind turbine and to adapt these where necessary.

With the economic turndown, the price of steel also went down and interest in building wind turbines on steel jacket foundations increased. In addition, by optimising the design, the weight of the steel jackets decreased and a new technique was found for installing a jacket foundation. The traditional sequence of operation was reversed: in the new technique first the tubular piles are driven into the seabed and only at a later stage are the legs of the jacket lowered onto these tubular piles and secured in place.

The major challenge with this method – at high seas and at significant depths – is drilling the pin-piles so precisely that the 4 legs of the jacket can be fit over them perfectly. The traditional way of drilling took a week for 4 piles. Experts of the dredging contractor developed an improved system that cut down this time: a large rigid square steel pile frame was suspended underneath a jack-up platform that could be lowered to the seabed with great precision. The major advantage of this approach is that driving piles and placing jackets are executed simultaneously. The use of the pre-driven piles caused a revelation in foundation techniques. The invention was awarded with a subsidy from the EU for its innovative nature.
Good news came also from the side of the turbine supplier. C-Power had considered using a 5MW instead of the 6 MW turbine. The supplier however managed to design a 6.15 MW turbine maintaining the same external measurements of the 5 MW turbine.

The innovative work methods and inventions mentioned above are some examples of the benefits of an early involvement of the contractor. In his book ‘Giants on the Thornton Bank, Wind Energy for the Future,” Jan Strubbe gives a detailed description of the whole project: The book gives an comprehensive description of the installation of the 54 wind mills, placed 500 to 700 m from one another. Partially as a result of the contributions of various contractors at an early stage, this is the first wind farm project realised on time and within budget (€1.289 mln).

Case Study 2 - THE ICHTHYS PROJECT VAN OORD

The Ichthys LNG Project is a Joint Venture between INPEX group companies (the Operator), major partner TOTAL and the Australian subsidiaries of Tokyo Gas, Osaka Gas, Chubu Electric Power and Toho Gas. Gas from the Ichthys Field, in the Browse Basin offshore Western Australia, will undergo preliminary processing offshore to remove water and raw liquids, including condensate. The gas will then be exported to the onshore processing facilities in Darwin via an 889km pipeline. The Ichthys LNG Project is expected to produce 8.4 million tonnes of LNG and 1.6 million tonnes of LPG per annum, along with approximately 100,000 barrels of condensate per day at peak. Detailed Engineering, Procurement and Construction (EPC) of the Ichthys LNG Project is ongoing and production is scheduled to commence by the end of 2016.

Dredging scope

To support the nearshore infrastructure at Blaydin Point, dredge sediment disposal of approximately 14.6 Mm3 of material is required and involves the dredging of five “separable portions” (SPs) as summarised below and shown in Figure 11.

- SP 1 – module offloading facility (MOF)
- SP 2 – jetty pocket
- SP 3 – jetty pocket berthing area
- SP 4 – approach channel
- SP 5 – Walker Shoal.
The material dredged from these areas is disposed of at the designated disposal ground located to the north of Darwin Harbour, within Beagle Gulf, approximately 12 km north-west of Lee Point (Figure 2).

**Project Objectives**

The Ichthys Darwin Harbour Dredging Project aims to ensure its activities in and around Darwin Harbour are minimising disturbance to water quality and marine life. Commitments specifically related to dredging and sediment disposal activities are combined with Northern Territory recommendations and the Commonwealth conditions relevant to the dredging and sediment disposal conditions to form the Dredging-Specific Environmental Commitments and Conditions Register. This Register underpins the Compliance Manual – Dredging which together form the basis for the Dredging and Spoil Disposal Management Plan (DSDMP), relevant management plans and work procedures.

Monitoring programmes record changes in the environment so that any impacts from Project dredging activities can be quickly identified.

**Contractor Consultancy**

In a case of Competitive Dialogue, Van Oord Australia has been engaged as a consultant by Inpex as one of two potential contractors in the tendering process to assist with the development of the DSDMP.

The DSDMP relates to the management and monitoring of both dredging operations as well as to the disposal of the dredged material. The aim was to demonstrate that all reasonable and practicable steps would be taken to manage the risks associated with, and the potential environmental impacts arising from, the dredging and sediment disposal activities undertaken in the project area of Darwin Harbour and offshore disposal area during the construction phase of the project.
The DSDMP also details how the potential impacts of the dredging and sediment disposal activities will be minimised by the identification and implementation of appropriate management and monitoring controls. It describes the proposed management, monitoring, reporting, review and auditing requirements for the dredging and sediment disposal activities in order to meet the conditions of the various environmental approvals.

This DSDMP and supporting documentation was then submitted to the Ichthys Project Dredging Expert Panel (IPDEP) for review and to the Northern Territory and Commonwealth Governments for approvals respectively.

The DSDMP described the types of proposed equipment and work methodologies for each of the identified dredging locations, the materials to be dredged and the relevant environmental considerations. The proposed work methods were determined in a joint PIANC 100 assessment between the Contractor, the Company and a PIANC contributing author in accordance. Special consideration has been given to potential impacts on dolphins, turtles and dugongs such as vessel strike, propeller strike, entrainment, underwater noise and impact to sensitive receptors and habitats resulting from sediment plumes.

While it was considered to be highly developed, and included salient features such as seasonal dredging and restrictions on the use of overflow, the methodologies were not definitive. Depending on on-site conditions, some modifications would be required during the execution; any such modifications managed within the requirements of this DSDMP.

Table 2 shows the (seasonal) dredging programme for the Contractor to complete the various separable portions.

<table>
<thead>
<tr>
<th>Description</th>
<th>Duration</th>
<th>2012</th>
<th>2013</th>
<th>2014</th>
</tr>
</thead>
<tbody>
<tr>
<td>SP 1 - MOF</td>
<td>24 weeks</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SP 2 - Jetty Pocket</td>
<td>10 weeks</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SP 3 - Berth Area</td>
<td>18 weeks</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SP 4 - Approach Channel</td>
<td>45 weeks</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SP 5 - Walker Shoal</td>
<td>5 weeks</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 2: Indicative schedule for dredging and sediment disposal activities

The sequence of the various dredging activities would vary during the works depending on site conditions, progress of the works and compliance with environmental commitments. To ensure that modelled impacts would be within allowable limits, high intensity dredging works (for Separable Portions 3 and 4) were planned to be carried out only during the wet season unless modelling validation revealed that predictions were conservative or monitoring results demonstrated that environmental receptors were capable of tolerating SSC and sedimentation above the assumed trigger levels.

In order to adequately assess the potential environmental impacts, the projected amount of fines released during the dredging and disposal activities was modelled. This hydrodynamic modelling was used to predict the magnitude and locations of potential environmental impact. Predicted areas of impact showed that, using the combination of proposed equipment, dredging methodology, schedule, spill released at the dredging and disposal site and the predicted areas of impact were not significantly different than those proposed in the EIS.

PIANC 100 Workshop

As part of the (Client – Contractor) Consultancy agreement a workshop was organised based on PIANC Report 100: Dredging Management Practices for the Environment (PIANC 2009).

This PIANC 100 Report was published by PIANC’s Environmental Commission and members of the working group are acknowledged experts in their profession from several countries. PIANC 100
provides information and recommendations on good practice and is viewed as expert guidance for selecting appropriate “management practices” (MPs) and “best management practices” (BMPs) for dredging operations in order to manage environmental impacts. The PIANC 100 Report provides expert guidance for the selection of MPs to assist with justifying best-practice dredging methods. MPs identified in PIANC 100 are categorised into a planning and design phase, a construction phase and a post-construction phase as presented in Table 1 (as it appears in the PIANC 100 report).

<table>
<thead>
<tr>
<th>Planning and design phase – Section 2.1.1</th>
<th>Construction phase – Section 2.1.2</th>
<th>Post-Construction phase – Section 2.1.3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Impacts of the project phase</td>
<td>Project construction will cause temporary or permanent physical changes to occur. Temporary physical changes with adverse environmental effects should be mitigated by implementation of BMPs</td>
<td>Physical changes may result in long-term environmental effects that should be mitigated by appropriate project design, planning, and execution.</td>
</tr>
<tr>
<td>Scope of activities</td>
<td>Tendering and Contract Award</td>
<td>Infrastructure in service may have additional modes of impact. Maintenance of the infrastructure may have additional modes of impact. Long-term monitoring and feedback may be needed to evaluate success of MPs.</td>
</tr>
<tr>
<td>Planning &amp; Design Toolbox MPs to prevent or reduce the environmental impacts of the entire project.</td>
<td>Construction Toolbox MPs to prevent or reduce the environmental impacts caused by temporary physical changes</td>
<td>Certain MPs may be applied to mitigate impacts during future maintenance.</td>
</tr>
</tbody>
</table>

Table 3: The role of MPs in a dredging project

An overview of the MP selection process is shown in Table 3. It also shows how the process is repeated to achieve a project that optimally conforms with acceptable environmental risks. This framework serves as a road map to identify, select, and implement appropriate MPs for dredging, dredged material transport, and dredged material placement.
During the planning and design phase the Client reduced the environmental impacts of the project as far as possible by selection of the location of the works, design of dredge footprint to avoid known heritage sites and minimise overlap with Walker Shoal, site layout, minimisation of dredging footprint and reduction in shipping channel depth to reduce dredging volume.

During the tendering process the Contractor selected the best management practices with regard to equipment selection and overall methodology. Primary selection criteria included the minimisation of sediment dispersion and potential impacts on marine life.

The joint PIANC 100 workshop in January 2012 was hosted by a member and contributing author of the PIANC 100 working group and was undertaken to identify and determine the best management practices for the dredging and sediment disposal activities.

The main conclusions of the workshop are outlined below.

Dredging method selection
The workshop determined that the optimal methodology would include a combination of Backhoe dredgers (BHD), Trailing Suction Hopper Dredgers (TSHDs) and Cutter Suction Dredgers (CSDs).
Four options were defined, each with a different combination of equipment and execution methods for consideration.

- **Option 1** was based on dredging the MOF with a combination of a BHD and a CSD loading TSHDs. The loading of the TSHDs would be carried out by transporting the dredged material from the CSD to the TSHDs through a pipeline consisting of a combination of floating pipeline and sinker line. Loose sediments in separable portions 2 to 5 would be dredged by TSHD with a maximum of 15 minutes’ overflow. All other material would be dredged by CSD and loaded directly through a floating pipeline into TSHDs, again with a maximum of 15 minutes’ overflow.

- **Option 2** was a variation on Option 1 whereby the use of the CSD loading TSHDs in separable portion 1 (the MOF) has been eliminated and replaced entirely by a BHD operation, while still meeting the required Project milestones. Loose sediments in separable portions 2 to 5 would be dredged by TSHD with maximum of 15 minutes’ overflow. All other material would be dredged by a CSD and loaded directly through a floating pipeline into TSHDs, again with a maximum of 15 minutes’ overflow.

- **Option 3** investigated the use of BHDs for dredging phyllite materials in other areas within equipment capabilities, schedule or economic limitations. The MOF area (separable portion 1) would be entirely dredged by BHDs. These would be further deployed to dredge loose and weak materials in separable portions 2 to 5 where it could be achieved subject to material strength. The remaining loose sediments would be dredged by TSHD with a maximum of 60 minutes’ overflow. All other material would be dredged by CSD and loaded directly through a floating pipeline into TSHDs with no more than 15 minutes’ overflow.

- **Option 4** was similar to Option 3, however, the CSD would be deployed in dry-crushing mode and the dredged material would be re-handled and transported to the disposal site by TSHD. During the (direct) dredging of loose materials the TSHD would overflow for 60 minutes, and 90 minutes when rehandling crushed materials.

### Method selection summary

For each of the four options, two scenarios were developed to seek a balance between MP implementation and the effect on the specific nature of the Project site. Scenario A includes only the standard range of PIANC 100 MPs and scenario B includes the most extensive range of PIANC 100 MPs.

The optimal dredging plant was selected based on key criteria including functional requirements, site conditions and environmental objectives. In the PIANC 100 workshop, all scenarios were rated according to multicriteria analyses in which all major environmental risks were included (Figure 13). Figure 13 is based on the conceptual approach to balancing effectiveness and effort as presented in the PIANC 100 Report (PIANC 2009). The effectiveness plotted on the Y-axis is a measure of how well the identified environmental risks are being addressed by the respective option. The effort plotted on the X-axis is a measure of both cost and time.

![Figure 13: Effort-effectiveness plot for various methodology options](image-url)
By applying the multicriteria analyses it was concluded that in general the environmental effectiveness of the options is increased when the extensive range of MPs are applied. Options 1A, 3A and 4A fail to provide the desired effect as do options 3B and 4B with respect to their effort level. Of the remaining options—2A, 1B and 2B—Option 2B is preferred on the basis of its effectiveness at only a relatively minor increase in effort compared to Option 2A and Option 1B.

The conclusion of the PIANC 100 assessment was that Option 2B was selected as the most effective in attaining the environmental goals of the Project while still requiring an acceptable level of effort in its implementation. The preferred work methodology (Option 2B) is thus implemented and can be summarised as follows:

- The MOF area (SP 1) will be completely dredged by BHD. In the channel of SP 2 to SP 5 loose sand will be dredged by a TSHD using an agreed maximum overflow time (15 minutes).
- The remaining materials will be dredged using a CSD loading TSHDs via a floating pipeline using an agreed maximum overflow time (15 minutes).
- All material will be taken to the disposal site and placed via bottom doors.

During the execution of the works, situations were anticipated to arise that merited optimisation or modification of the proposed methodology. Any refinements to the dredging methodology recommended by the Contractor would however always be within the agreed environmental parameters of this DSDMP and in consultation with the Client.

**Sediment placement method selection**

Outcomes from the PIANC 100 workshop identified that sediment disposal via bottom doors on TSHDs or hopper barges is the optimal method for unconfined ocean disposal in high-energy environments.

Bottom door placement involves the direct release of sediment from the hopper or barge by opening of bottom doors, gates or by hopper/barge splitting. The sediment is then released into the upper part of the water column, from where it quickly descends towards the bottom and subsequently settles and deposits on the seafloor within the boundary of the designated disposal site. The optimal sediment placement method was selected based on environmental, operational and safety considerations. Alternative disposal methods such as hydraulic placement of materials into the disposal area have been rejected on the basis that these filling methods would cause further break up of dredged materials.

**Adaptive Management**

Key environmental objectives and targets for the Project have been defined with consideration of the following:

- the Company's and the Contractor's environmental policies
- environmental impacts and risks
- relevant Australian and International standards
- legal and other requirements
- the measurability of objectives
- achievable outcomes
- the drive for continuous improvement.

The DSDMP has been designed to incorporate adaptive management processes whereby monitoring results inform whether a dredging and sediment disposal management response is necessary to mitigate environmental impacts.

In addition, Environmental Management Frameworks (EMFs) have been developed to capture the commitments and requirements of the Project into objectives and actions in more detail. The EMFs have been instrumental in the effective management and mitigation of environmental risks to sensitive receptors. Prior to, and during the dredging and sediment disposal activities, actions required by the contractor within the EMFs were to be adopted and implemented as applicable.

Management of sediment related impacts have been captured in EMFs which specifically focus on adaptive and contingency management measures for mangroves, channel island coral, and
seagrasses. These EMFs manage all potential impacts to these reactive receptors that are vulnerable to sediment related impacts such as sedimentation and turbidity.

Not all receptor sites have the same sensitivity and therefore appropriate management actions vary amongst sites. A range of management options that are considered practical have been developed and are considered as options to influence the sediment related impacts by adapting the sources of sediment (here to referred to as source terms or sediment spill) with regard to their timing, location, duration or magnitude. Not all options will have similar effects in all circumstances and locations. Consequently, any option implemented will require evaluation and subsequent modification where appropriate.

Project in Operation

Figures 14 and 15 describe how all relevant documentation relate to each other, and more importantly how the DSDMP and EMF’s get translated into work-specific management plans and procedures.

Figure 14: Overview of the environmental management system
After the client awarded the contract, having used the contractor's experience that was gained as a "Consultant", Van Oord as the contractor was able to efficiently and accurately capture all requirements in the project execution plans. This enabled a smooth start of the project on the one hand, and on the other hand, gave Inpex, the Client, confidence that all requirements were well understood and adequately covered and incorporated.

During project execution marine monitoring programmes were set up to identify early changes of the marine environment caused by potential impacts from dredging and construction activities. Early detection of changes to the marine environment from dredging- and construction-related activities enabled appropriate management responses to be identified.

Environmental inspections and auditing were to be undertaken by the contractor, the client and regulators to assess the nature and extent of impacts on the environment, and compliance with set procedures and guidelines. Corrective and preventative actions were applied, and implementation of opportunities for improvement including the effectiveness of actions.

In March 2014, with about 75% of planned dredging completed, monitoring results indicate that impacts are minimal – in line with or less than original predictions. This is a very good result for all stakeholders, and could only have been achieved by early involvement and close cooperation between client and contractor and by their cooperation throughout the tendering and construction processes.
CONCLUSIONS

As demonstrated in the above case studies, the engineers and experts at the major dredging companies are highly knowledgeable and can support a client in finding cost-effective, environmentally sound and efficient means of operations when they are brought in a timely manner – that is, before all decisions are etched in stone. By carrying out certain development processes simultaneously, preparation time can be reduced and decision making improved.

Once a less optimal decision is made, the ability to turn it around, seek alternatives and get everyone on board with the changes is time consuming and costly.

ECI also increases the potential for innovation and facilitates value management and engineering. It creates an atmosphere where the client and suppliers work as a team. This leads to an open and honest process so that real costs are highlighted early and unnecessary risks – financial and otherwise – can be reduced.

By treating contractors as experts, their knowledge can be used to facilitate the translation of functional requirements into real construction work thus reducing risk. Experts can identify risks that are out of their control and suggest mitigating measures.

Although, in general, the legislation for competitive bidding does not wholly support this means of involving contractors, the tide is turning and legislators are seeking more flexibility in contract negotiations and tendering which allows the client to take advantage of the expertise of the people who are actually going from the drawing board to the operational implementation. This is a positive development because, paraphrasing Dean Kashwagi: If a client hires a contractor who knows what they are doing, the project has a greater probability of being successful.

REFERENCES


