CANADIAN CONSULTING ENGINEERING AWARDS 2013

Sydney Harbour Channel Dredge

CBCL LIMITED

Consulting Engineers

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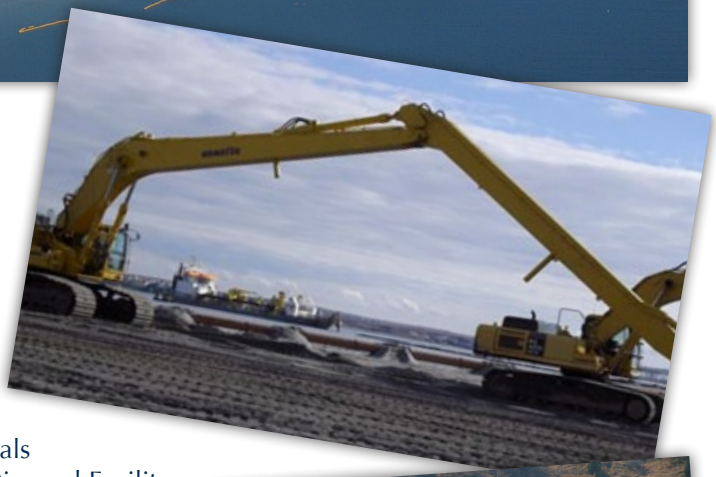
Sydney Harbour Channel Dredge
Sydney, Nova Scotia

Client	Sydney Ports Corporation	Completed	March 2012
Sector	Special Projects	Construction Cost	$38 million



The Project

The Sydney Ports Corporation (SPC) retained CBCL Limited as Owner's Engineer for the Sydney Harbour Channel Dredge Project in Sydney, Nova Scotia. The project, which is believed to be the largest capital dredge project in Eastern Canada, involved the removal of over 4 million cubic metres of sedimentary material from a 9 km long portion of the harbour channel. Dredged materials were placed in a newly constructed Confined Disposal Facility (CDF) which was designed to safely house the dredged material and to ultimately serve as the founding surface for a future marine terminal.

Operating on a 24 hour, 7 days per week basis, more than 400 trips were made to deposit dredged materials at the CDF

Construction activity commenced in the spring of 2011 with the completion of the land based construction activity in the summer of the same year. The Dutch based dredge contractor, Boskalis International, was granted control of the upland site in July 2011 and commenced dredge operations on 2 October 2011. Operating on a 24 hour, 7 days per week basis, more than 400 trips were made to deposit dredged materials at the CDF. The channel dredge was essentially completed on 20 January 2012, followed by completion of the CDF revetment work in April 2012.

The dredging work was completed in less than 4 months utilizing Trailing Suction Hopper Dredge (TSHD) technology. This technology was instrumental in the achievement of substantial cost savings and the very agressive construction schedule. Cost savings were further realized by utilizing an alternate "soft sea defence" beach design for construction of the CDF, as opposed to the more traditional armoured "hard sea defence".

The management of multiple issues such as compliance with environmental/regulatory requirements, and the on-going management of geotechnical, archaeological, quality control and engineering design issues added to the complexity of the project. Provision of ongoing technical support and communication of project progress to key stakeholders was fundamental to the success of the project. Key stakeholders included local community members, regulatory authorities and funding partners as well as local fishers who rely on commercial fisheries within the dredge zone.

The Need for the Project

CBCL Limited's involvement in the project dates back to the preparation of the Ports of Sydney Master Plan by a team led by TEC Inc in 2007. The completion of the Master Plan was spearheaded by a group of local terminal owners and operators collectively known as the Sydney Marine Group. The Master Plan was intended to serve as the "road map" for port development and an increase in port commercial activity. The Ports Master Plan Study recognized the importance of commercial port activity to the existing economy. It also emphasized the potential for future development based on the natural attributes of the port, including a deep sheltered harbour with undeveloped available land, existing rail connection and the geographic position of the Ports of Sydney. The Study also identified barriers to future development and established that the key constraint was the limiting 11.8 metre draft near the mouth of the harbour. The Master Plan's predominant recommendation was to deepen the navigation channel to enable access to the naturally deep waters of the South Arm of Sydney Harbour by larger, deep drafting vessels.

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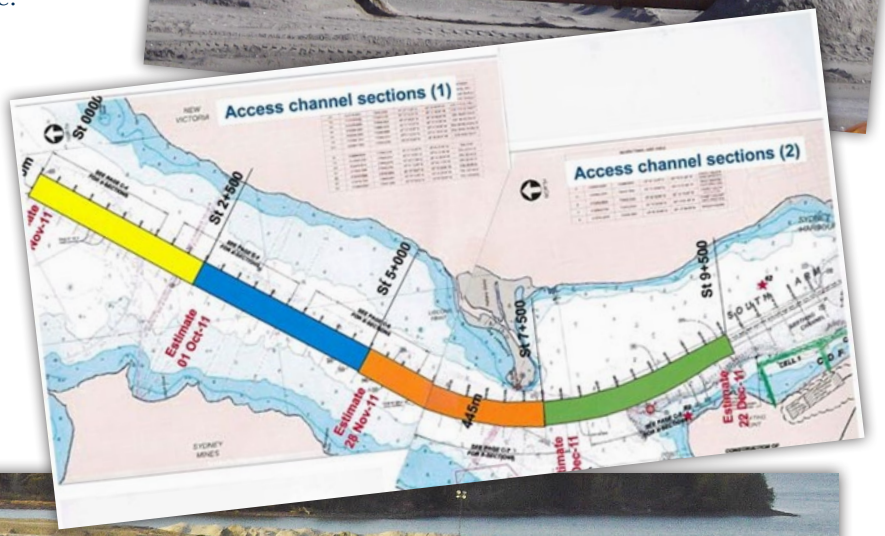
In 2008, the Laurentian Energy Corporation (LEC), a constituent member firm of the Sydney Marine Group, advanced the dredge initiative as part of the overall Sydney Harbour Channel Deepening and Marine Terminal Development Project. LEC envisioned the development of a marine container terminal in Sydney Harbour which could take advantage of Sydney's geographic position. Phase-1 of the overall project involved the dredge of the navigation channel and construction of the Confined Disposal Facility. Phase-2 of the project would follow and involve the construction of a container terminal at the CDF site.



In response to grass roots community support for advancement of the project, and recognizing the economic opportunities that accompany port development, the Federal Government of Canada, Province of Nova Scotia, Cape Breton Regional Municipality and Nova Scotia Power, committed the funds necessary for the dredge project.

CBCL Limited was subsequently retained by the Sydney Ports Corporation (the contracting body) in 2009 to act as the Owner's Engineer for the dredge project and since that time has provided technical advice and engineering and project administration services on an ongoing basis

Scope of Services

CBCL Limited supported by TEC Inc., in a sub consultant capacity, were retained in 2007 as the engineering design consultants for the dredging project to serve as technical consultants throughout the regulatory permitting and Environmental Assessment (EA) process. EA approval was granted in April, 2009. CBCL Limited was subsequently retained by the Sydney Ports Corporation (the contracting body) to act as the Owner's Engineer for the project. Since that time, CBCL Limited has provided technical advice and engineering and project administration services on an ongoing basis.

When the project advanced to the construction phase in 2011, the scope of services provided by CBCL was expanded to include the following key responsibilities:

- Contractor negotiations
- Construction oversight and environmental monitoring
- Negotiation of project changes to ensure project schedule and budget were met
- Review and approval of progress claims
- Coordinatation of sub-consultants (archaeological, geotechnical, survey, etc.)
- Management of contractor queries and clarification of issues
- Coordination of material quality assurance testing
- Obtain and review contractor submittals
- Resident inspection services for land based and marine construction
- Communication of project progress to key stakeholders, including funding partners and regulatory agencies
- Monitoring project activity relative to regulatory/permit requirements
- Adjudicate contractor/owner disagreements as a fair and impartial administrator of contract

Sub-consultants for this project included McGregor Geoscience Ltd. who provided specialized bathymetric survey services; Davis MacIntyre & Associates who conducted both land based and marine archeological investigations, and; Maritime Testing who provided material testing services.

Project Components

The three key components of the Sydney Harbour Dredge project included i) the construction of the site access road and laydown area at the upland site, ii) deepening of the navigation channel to a minimum -16.5 metres Chart Daturm (CD), and iii) construction of the near shore Confined Disposal Facility (CDF) to safely store the dredged materials.

Land based Work

Prior to the start of dredge activity, preparation of the upland green field site, located adjacent the CDF infill, was needed to support the marine works. An access road and laydown area was developed on the upland side of the CDF location. The work was completed by a local contractor in the Spring/Summer 2011. CBCL Limited was responsible for the engineering design, development of construction contract documents, construction oversight and contract administration.

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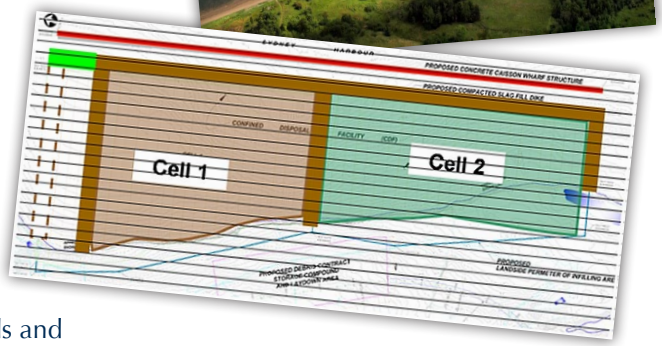
Marine Work

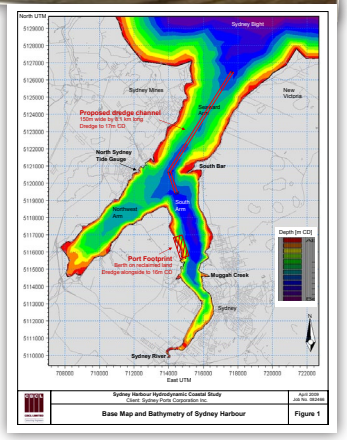
Dredging - The dredge component of the project involved deepening of the navigation channel leading to the deep waters of the South Arm of Sydney Harbour. Over 4 million cubic metres of material over 9 km of the 12 km long channel was removed to achieve a minimum depth of -16.5 metres (CD). The CBCL/TEC Inc. team led the design of the navigation channel and the development of the construction contract documents. CBCL Limited served as Owner's Engineer for the duration of the dredge contract.

CDF - The dredged materials were deposited in a Confined Disposal Facility (CDF) located on the western shores of the South Arm. From the early stages of project development, it was envisioned that the channel dredge work would support the future development of the infill site. The CBCL/TEC Inc. team was responsible for the development of the concept design and design/build contract documents for the CDF construction. The dredge contractor was subsequently responsible for advancing the CDF construction under the design/build contract. Key elements of the CDF conceptual design included the location of the CDF and future marginal wharf and the inclusion of 2 containment cells for separation of dredged materials — Cell-1for coarse material (sands and gravels) suitable for the first phase of site development, and Cell-2 for the deposit of softer materials (silts) which would consolidate with time and provide for development at a later date.



Innovation

Original estimated costs to complete the channel dredge using conventional "clam bucket" dredge technology were estimated to be in the $80 - $90 Million range versus an estimated $26 Million using Trailing Suction Hopper Dredge (TSHD) technology. The significant cost savings and limited duration of in-water work were key benefits realized by using a TSHD vessel to complete the project. Arguably, TSHD was the enabling technology for the project which otherwise may not have proceeded due to financial and schedule limitations.



The TSHD technology involves mobilization of a specialized dredging vessel to remove, transport, and dispose dredge spoils. A trailing draghead (1) on the end of a large suction pipe (2) is dragged over the seabed while under way and the sediments are loosened by the suction nozzle. Large centrifugal pumps transport the dredged material, in a sludge form to the hopper (3) from where it is later discharged (through bottom doors) (4) or pumped through a pipeline from the bow of the vessel to the CDF. (Source: BOSKALIS WEB SITE)

The Request for Proposals (RFP) for the completion of the Sydney Harbour Channel Dredge project was developed and distributed to international dredge contractors capable of providing TSHD services. CBCL led the development of the RFP document, which communicated the requirements of both the navigation channel deepening and CDF construction. The construction of the CDF was advanced as a design/build contract with the dredge contractor responsible for implementing the key requirements defined in the concept design. The RFP assumed a rubble mound structure with armour stone protection for the perimeter berms of the CDF, commonly referred to as a "hard sea defence" and traditionally used for this type of marine structure in Eastern Canada.

The RFP request for alternates to the traditional hard sea defence design proved to be a key component of the project that enabled innovation and resulted in further reduction in construction schedule, advantages for future site development and $12 million dollar savings to the client on a $38 million dollar project

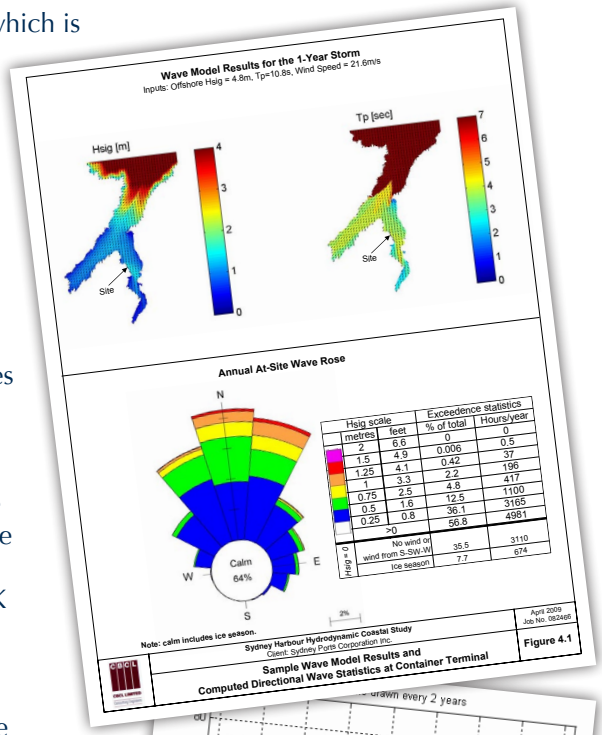
Recognizing the diverse experience and specialized skills the international dredge contractors could offer, the RFP requested that "alternate" CDF designs be submitted for consideration. The RFP request for alternates to the traditional hard sea defence design proved to be a key component of the project that enabled innovation and resulted in further reduction in construction schedule, advantages for future site development and $12 million dollar savings to the client on a $38 million dollar project.

CDF "Alternate" Beach Design

As an alternate to the traditional rubble mound "hard sea defence", Boskalis International, the successful bidder, proposed the use of an alternate natural beach or "soft sea defence". The proposed Beach design eliminated the need for imported fill materials to construct the core of the berm by using coarse dredged material instead. Another significant effect of the beach design was the elimination of the armour along the eastern beach, depending instead on groins, or breakwaters, constructed on the seaward ends of the North and South berms. The groins were designed to protect the eastern beach from the energy of the sea. The elimination of armour along the eastern berm also benefits future development of the site by negating the need to remove armour for marginal wharf construction.

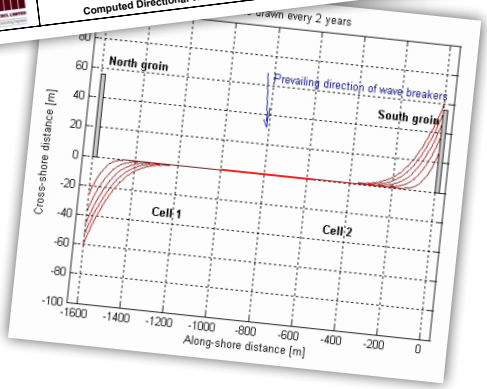
The safe containment of dredged materials, including soft sediments of the inner channel which contained low levels of contaminants, was a fundamental consideration for the project. Although new to Eastern Canada, the proposed CDF beach design is not unique. Projects located at the Port of Rotterdam Netherlands, and the Amager Beach project in Copenhagen, Denmark, utilized beach designs similar to the Sydney CDF application.

The CDF location in the South Arm of Sydney Harbour, which is well protected from large offshore waves, presented a unique opportunity for a soft sea defence. This of course assumes workable coastal sediment processes. To ensure the proposed alternate CDF Beach design met the design and regulatory requirements of the project, an extensive engineering design and regulatory review was completed.



A peer review of the Boskails technical approach and completion of risk assessment modeling was led by CBCL's in house coastal engineering expert. The objectives of the assessment were to reduce uncertainly concerning the predicted sediment transport rates at the beach, assess the design of the groin, and predict the potential maintenance required. The risk assessment confirmed the technical feasibility and structural integrity of the alternate beach design under a range of oceanographic conditions using state of the art Danish Hydraulic Institute's LITPACK software hydrodynamic models and site specific baseline data.

Implementation of the alternate beach design reduced the construction schedule by 2 – 3 months, significantly reduced the requirement for imported materials (core materials, armour and filter stone), reduced construction costs significantly with very limited risk of leakage of the dredged material into the marine environment.



Complexity

The core work activity, involving the removal of seabed material from the channel to achieve the design depths, is relatively straight forward. The complexity was escalated by the implementation of relatively new and innovative technology such as the use of a TSHD vessel and the alternate beach design for the CDF construction.

The complexity of the project begins to grow considering the implementation of relatively new and innovative technology to complete the project, including the use of a TSHD vessel and the alternate beach design for the CDF construction.

The Environmental Assessment approval and permitting process established the terms, conditions and requirements for advancing the project. The complicated regulatory process included on-going interaction with both Provincial and Federal authorities with CBCL Limited being responsible for coordinating permit approvals from Transport Canada under the Navigable Waters Protection Act (NWPA) and Part V approval from Nova Scotia Environment (NSE). Additional approvals were obtained by CBCL from NSE for culvert installation, Nova Scotia Department of Transportation and Infrastructure Renewal (NSTIR) for "Breaking Soils Permit" and from the Department of Natural Resources (DNR) under the Beaches Act.

The archaeological component of the project proved particularly challenging and required careful attention. Archaeological investigations of the marine and terrestrial environments identified sites of significance, including an early 19th century ship wreck located in the middle of the proposed dredge channel and likely Loyalist habitation dating back to the 1700's on the upland site. Davis MacIntyre completed the archaeological investigations under a Heritage Research Permit issued by the Nova Scotia Department of Tourism, Culture and Heritage.

The day to day administration of the dredge contract included the management of multiple onging elements including: archaeological investigations; geotechnical assessments and confirmations, and quality assurance assessments including material testing and review of bathymetric surveys. Contract work was managed to be in conformance with contract requirements, environmental and regulatory commitments, and Health and Safety requirements. The relatively short duration, and round-the-clock schedule of dredge and infill operations, added to the complexity of the work–which became more challenging as the project progressed into winter and deteriorating weather conditions.

The location of the dredge project in itself contributed to the overall complexity with a key consideration being the alignment of the dredge path through an active commercial fisheries zone. The project proponents were, from the onset, cognizant of the fishers concerns and, as such, local fishers and university researchers were included as key stakeholders in the planning process. CBCL Limited provided technical support as required for the duration of the project to support the ongoing involvement of the fishers and the related research work. The proximity of the dredge project to an area closed to commercial fisheries due to contaminant levels and the recently remediated Tar Ponds Cleanup Project, commonly viewed as the largest contaminated site in Canada, also presented both real and perceived challenges to the dredge project.

Finally, in addition to the fishers, there was a vast array of stakeholders, including local community groups, funding partners and regulatory authorities, all of which required open and effective communication management as part of the design, approval, and construction processes.

Social and Economic Benefits

There was significant grass roots community support for the project as it was generally viewed as "enabling" and key for future economic development of the area. This support is being substantiated by the planned expansion of the Provincial Energy Ventures (PEV) coal transhipment facility in Sydney. Announced in January 2012, the development is intended to take advantage of the newly dredged channel. As part of the project announcement, Ernie Thrasher, PEV President, was quoted to say, "I believe the recently completed channel dredging has laid the foundations to create the next era of economic development and economic renaissance for this region." (*Cape Breton Post 26 January 2012*). Another significant projects under consideration and directly attributable to the dredged channel is an Iron Ore Processing Plant and marine terminal (*Cape Breton Post 18 March 2013*).

Given the environmental features of the project area and the anticipated interactions between several valued ecosystem components (VEC), socio-economic issues had to be considered.

The construction associated with the dredge project resulted in direct employment opportunities for local contractors who supplied labour and equipment for the works. Local engineering firms, employed by the project proponent and the dredge contractor, provided engineering, environmental monitoring and administrative support. The services of local steel fabricators, stevedores, divers, surveyors and marine support resources including barge and tug services were all locally engaged. The local fishers played a key role in the completion of marine research and supported the day to day operations of the dredge vessel and marine environmental monitoring work. The project also required the supply of materials from a local quarry. Foreign workers required accommodations and all associated services for long term stays that included dentists, doctors, and so on. In total the dredge contract involved an estimated 110,000 manhours, 70% of which were provided by Canadians, the remaining coming from European ranks of the dredge contractor.

Environmental/Sustainability

From a sustainable design perspective, construction of the CDF utilizing the dredged materials for construction, essentially eliminated the environmental component associated with mining, transport, and delivery of imported fill materials for the core construction. It further eliminated the need for armour and filter stone on the eastern berm reducing the requirement for filter and armour stone by over 120,000 tonne. Considering the quarrying and transport of rock alone, the beach option resulted in a significant reduction in environmental impact.

A fundamental challenge for the dredge project was the mitigation of the potential impact on the marine environment which supports a commercial fishery in and around the dredge footprint. The dredge contractor was contractually prohibited from dredging during the active lobster season and a further delay in the commencement of dredging until October respected the fishers concerns of potential impact on lobster larvae in the water column in late summer.

A key consideration of the engineering design for the land based work was the avoidance of sensitive environmental receptors identified during the EA process, including rare plants and archaeological features dating back to the 1700s

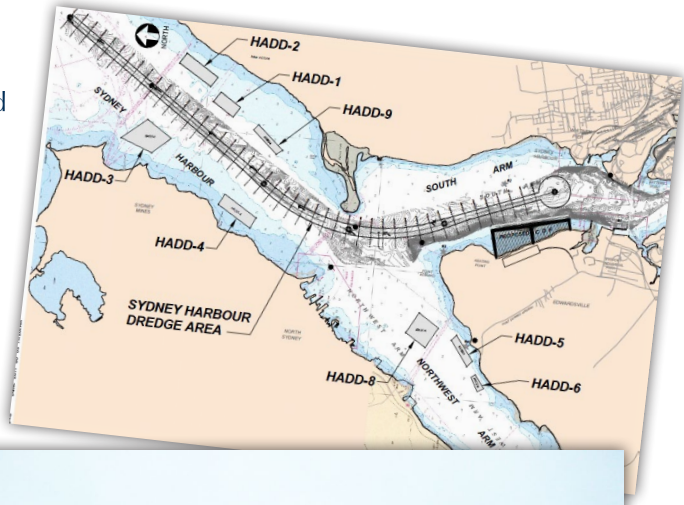
To help mitigate turbidity levels, the dredge contractor was responsible for monitoring of turbidity for the duration of the dredge operations and overflow from the dredge vessel was prohibited during dredging of the soft sediments of the Inner Channel. The CDF was designed to safely contain the fine sediments with dewatering controlled by an overflow weir and double silt curtains used to control turbidity at the CDF discharge.

A key consideration of the engineering design for the land based work was the avoidance of sensitive environmental receptors identified during the EA process, including rare plants and archaeological features dating back to the 1700s. A 250 metre exclusion zone was established around an active eagles nest. The owner was also responsible for the implementation of a Wetland Compensation plan to mitigate unavoidable impact to on-site wetlands. CBCL Limited contributed to the development of the project Environmental Management Plan (EMP) and was responsible for communicating responsibilities to site personnel during construction.

Upon completion of the CDF construction, the post construction monitoring of the CDF facility commenced as committed to in the project Environmental Monitoring Plan (EMP). The CDF monitoring commitment includes monthly physical inspections and bi-annual topographic and bathymetric surveys that will be used to verify actual sediment transport rates and assess maintenance requirements.

The completion of the dredge project did result in an alteration of fish habitat within the footprint of the dredged channel and permanent destruction of habitat at the CDF infill location. To satisfy the policy requirement of ‘no-net loss” of fish habitat, DFO and the proponent negotiated a $3.5 million HADD (harmful alteration, disruption or destruction) of fish habitat compensation project–the largest HADD to date in Canada. The project involved the placement of 75,000 tonnes of rock at 9 selected sites within the Sydney Harbour. Rock placements included piles and ridges of various sizes and orientations designed to provide lobster habitat and support ongoing research. The implementation of the HADD was based on the detailed biological research of Sydney Harbour and the knowledge of the local fishers. On behalf of the Sydney Ports Corporation (SPC), CBCL was responsible for the development and administration of the construction contract that communicated the requirements of the HADD compensation work.

The construction involved the transport of rock from the quarry to the staging area at the nearby Sydport Industrial Park where rock was loaded into barges and transported to the HADD sites for installation. NWPA approval from Transport Canada was required prior to the start of construction, which commenced in December 2011 and was completed in March 2012. The construction contract included requirements for a full time fishers observer for the duration of the contract work.



Meeting Clients Needs

CBCL Limited met the Owner's needs by ensuring through ongoing quality assurance checks that the contractual requirements were met. The fundamental requirement of this project was the achievement of a minimum depth of -16.5 metres (CD) within the navigation channel as designed. Ongoing reviews of the contractor-provided surveys of the navigation channel and CDF infill area were conducted to monitor progress with respect to schedule and progress payment. To verify that the contractually required depths were achieved, a third party surveyor was retained to complete a verification survey of the navigation channel. CBCL Limited coordinated the sharing of contractor-provided survey and third party verification survey data with the Canadian Hydrographic Service in an attempt to ensure a timely update of the new navigation chart for Sydney Harbour. The completion of the harbour dredge also involved the coordination and sharing of information with the Atlantic Pilotage Authority and Canadian Coast Guard concerning the installation of new navigation aids.

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Additional quality assurance monitoring included the testing of armour and filter stone for physical properties and gradation using the European Rock Manual. Continuous monitoring of rock production relative to project schedule was critical to meeting timelines for revetment work. Ongoing Health and Safety audits, monitoring and investigation of incidents/accidents/damage reports, infield safety drills and participation in the Contractor NINA safety training program helped in achieving project completion with no significant worker injuries.

Implementation of environmental monitoring as per the Project EMP including marine water quality monitoring, bio-assay testing, sample collection for chemical analysis and continuous monitoring of twice daily acquired turbidity data provided by the contractor was critical to ensure adherence to contractual and regulatory requirements.

Typical TSHD Vessel – Source Boskalis 1

Oranje TSHD lifting drag head 2

View of the Eastern Berm "Beach" under construction looking north. 3

Aerial view of site upon completion of dredge project 4

View of the revetment construction on the North Berm 5

Discharge from the CDF wier 6