IMPORTANT FACTORS IN SPECIFYING AND CONTRACTING ENVIRONMENTAL DREDGING PROJECTS AND PROJECT EXAMPLES

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ABSTRACT

Environmental dredging projects, when compared to navigational (maintenance) dredging projects, are often times more complex due to additional work elements and factors that must be considered in achieving project success. For example, navigational dredging can be as simple as moving sediment from Point A (a defined area and cut depth) to Point B (an aquatic or upland deposit area), where project success is determined by post-dredge survey verification. The dredging contractor's financial success hinges on meeting or beating his solids production goal. On the other hand, working fast on an environmental dredging project, although desired, is not the primary goal. Further, environmental dredging frequently requires that the dredged sediments be dewatered or solidified so they can be transported and disposed as solid waste in a secure facility, and the dredge water frequently requires treatment for more than solids removal prior to permitted discharge. Dredge operational controls are often specified to minimize contaminant losses from sediment re-suspension. Beyond post-dredge survey verification that the dredge prism has been removed, frequently project success is determined by post-dredge sampling and comparison to an established clean-up limit (CUL) and/or to an overall mass removal goal (MRG) for the contaminant(s) of concern (COCs). Uncertainties in establishing the dredge prism, and residual contamination even following best method practices in dredging, can be factors causing an exceedance of the CUL/MRG, through no fault of the dredging contractor. Contingency plans must balance the cost effectiveness, for example, of additional dredging or alternative placement of a thin sand cover to improve exposure conditions.

This paper describes important factors that must be considered in developing fair and reasonable specifications and contract payment strategies for environmental dredging projects. Several project examples are also discussed.

Key Words: Navigational dredging, dewatering, water treatment, disposal, monitoring.

INTRODUCTION

Dredging contractors with proven qualifications and experience in the navigational dredging business should educate themselves to the subtle and not so subtle differences of environmental dredging before contemplating a project to remove contaminated sediments. If contractors do not, the experience could be eye-opening and financially troublesome. Certainly, a few maintenance dredgers have successfully made this transition and now perform both navigational and environmental dredging, whereas other maintenance dredgers have elected to stay close to their core competencies and leave environmental dredging to other specialists. The purpose of this paper is to highlight key differences between navigational and environmental dredging for not only the benefit of contractors, but also for consulting engineers, regulatory agencies, owners, and other stakeholders associated with clean up of contaminated sediments. Dry excavation methods, although a possible consideration for environmental projects depending on site conditions, are not considered dredging in the classical sense and therefore are outside the scope of this paper.

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DREDGING PROJECT ELEMENTS

Basic elements of dredging projects are listed in Table 1. Certain elements common to a project, such as mobilization and demobilization, and preparation of an upland staging area, are excluded. While every element listed would be expected to be part of an environmental dredging project, some of the elements may or may not be included in the scope of a navigational dredging project. Each of the elements is briefly explained below.

Table 1. Dredging Project Elements

Element	Navigational	Environmental
Sediment Removal	Yes	Yes
Sediment Dewatering	Maybe	Yes
Water Treatment	Yes	Yes
Sediment Management and Disposal	Yes	Yes
Post-Removal Verification	Yes	Yes
Operational Controls and Monitoring	Maybe	Yes
Environmental Windows and Monitoring	Maybe	Yes

Sediment Removal

The heart of a dredging project obviously involves sediment removal. The two basic and most frequently used dredging methods are hydraulic with pipeline transport and mechanical with barge transport. Hybrid methods have also been used to a lesser degree, such as mechanical removal combined with pipeline transport or hydraulic pump-out of transport barges. With each basic method are numerous variations that are selected to fit the project-specific goals and site conditions, such as production schedule, water depth, sediment thickness, physical properties of the sediment, and presence or absence of debris. Numerous references are available elsewhere on variations of dredge equipment.

The greatest difference between sediment removal for navigational and environmental purposes comes not from the equipment specified or selected, but rather with the project goals associated with sediment removal. For navigational dredging, it often is as simple as achieving the desired geometry – e.g., all sediment within the federally-defined navigation channel between Point A and Point B must be removed to Elevation Z. An environmental dredging project most likely also has a geometric component, but more importantly to achievement of project success (remedy effectiveness and risk reduction) is also a clean-up limit (CUL) (i.e., chemical concentration) or a mass removal goal (MRG) (i.e., chemical mass) for the contaminant(s) of concern (COCs). The CUL or MRG drive the geometry, not the other way around. They are tied to project remedial goals (RGs), which are tied to remedial action objectives (RAOs) (Palermo and Ells 2005).

Geographical information system (GIS) computer models are used to define the geometry or dredge management unit (DMU) for environmental projects. By statistical interpolation and extrapolation of a spatially-related data set (X, Y, Z and chemical concentrations) from remedial investigations (RIs), the predicted plan view locations and depths/elevations are established for a given CUL or MRG. It is the design engineer's responsibility to smooth the modeled DMU into practical horizontal (e.g., swing width of a hydraulic dredge) and vertical increments, balancing limitations on dredge precision with the desire to minimize removal of un-impacted sediments. Because of inherent variability in contaminant fate and transport in aquatic environments, and practical limitations on scope and budget during RIs, there is always an element of uncertainty to the dredge model results. Regardless, the CUL or MRG may or may not be achieved, even if best dredging practices are used to remove sediment within the DMU, due to this uncertainty, and due to potential deposition of re-suspended contaminants. Provisions in contracting to respond to these circumstances, should they occur, are described later in this paper.

Sediment Dewatering

Sediment dewatering may or may not be required for a navigational dredging project, but would more than likely be required for an environmental project. A navigational project may include hydraulic or mechanical transport and disposal of sediment in a confined disposal facility (CDF) or confined aquatic disposal (CAD) facility, or may include near shore beneficial reuse such as beach nourishment. These cases would not require dewatering. On the other hand, dewatering would more than likely be required if the navigationally-dredged sediment was beneficially reused in an upland setting, such as fill material or topsoil amendment. The degree of dewatering, and therefore the method used, is dependent on whether mechanical or hydraulic dredging is used. With mechanical dredging, dewatering may include simple gravity drainage and air drying, or solidification with an amendment (e.g., lime, fly ash, compost). With hydraulic dredging, dewatering may include passive dewatering in large basins or geotubes, or active mechanical dewatering using belt or recessed chamber filter presses.

For an environmental dredging project with the requirement of upland disposal, the sediment must have sufficient solids content to pass the paint filter test for transport to, and disposal in, a landfill. Again, passive or mechanical dewatering methods may be employed. The design engineer or the dredge contractor should evaluate the potential economic benefits for segregating the sediment by grain size using wash screens and/or hydrocyclones, for example, to minimize disposal volume and cost for hydrophobic COCs (e.g., polychlorinated biphenyls or PCBs, which exhibit a preference for binding onto the finer-grained sediment fraction).

Another dewatering concept for an environmental hydraulic dredging project may be the “wet landfill” concept, where the passive dewatering basin and landfill are the same. The basin/landfill would be sized based on analysis of compression, zone, and flocculent settling behavior of dredged material slurries using data from column settling tests. The water treatment system would operate during dredging, as well as following dredging when the ponded water has been removed and pore water (leachate) is removed via an underdrain system. The wet landfill must be designed and permitted for containment of both liquid and solid wastes.

Water Treatment

As a minimum, total suspended solids (TSS) likely must be reduced in the free water from mechanically-dredged sediment, or in the supernatant water from hydraulically-dredged sediment, to comply with a discharge standard in a general permit or project-specific water discharge permit. That is all that would typically be required for a navigational dredging project.

It is assumed the design engineer would obtain, on behalf of the owner or responsible party (RP), the National Pollution Discharge Elimination System (NPDES) permit for an environmental dredging permit - either a general or project-specific permit. The monitoring list would likely include TSS and the project-specific COCs, as a minimum. Depending on several factors including whether the water is only pre-treated and discharged to a publicly-owned treatment works (POTW) or fully treated and discharged back to the source water, the monitoring list may also include flow quantity/rate, and possibly biological oxygen demand, ammonia nitrogen, oil and grease, and pH.

It is important that the project specifications clearly outline responsibility for design, installation, operation, maintenance, and monitoring of the water treatment system, and compliance with all, or only certain, parameters in the discharge permit. If the dredging contractor is responsible for these elements, he may need to subcontract this responsibility if he does not have the appropriate personnel and equipment. The water treatment design may require the signature and seal of a professional engineer, registered in the state where the project is located. The water treatment process equipment would typically include basic solids removal (e.g., polymer addition and settling, filtration via bags or granular media) and polishing with granular activated carbon. More complex physical, chemical, and/or biological treatment processes may be required for certain organic or inorganic contaminants. Further, the treatment system discharge rate/velocity may need to fall within a range (minimum and maximum) to comply with an allowable waste load allocation or zone of initial dilution for the receiving water.

Sediment Management and Disposal

Sediment management (once the sediment is brought to shore) and disposal are often specified, whether it is a navigational or environmental dredging project. And as described above, the sediment dewatering approach is often dictated by the sediment disposal method and location.

If the sediment disposal site is not specified for an environmental dredging project, the contractor must make these arrangements and price the project accordingly. Permitting and construction of a monofill on the owner or RP's property may be an option. Otherwise, disposal in a licensed special waste (non-hazardous) or hazardous waste landfill will be required. If the COCs include PCBs with concentrations above 50 parts per million (PPM), the landfill must be licensed under the Toxic Substances Control Act (TSCA).

Transportation of the contaminated sediment by truck or rail must be in accordance with pertinent state and federal regulations, and the hauler must be licensed. Each load must be manifested. The truck trailer or rail car may also require a plastic bed liner, the gates sealed, and the top covered by a tarp. There may also be a requirement for washing the tires/wheels and outside of the truck trailer/rail car so contaminated sediment is not lost during transportation. A transportation plan would likely be prepared and submitted to the lead regulatory agency, and would contain a contingency plan in case of accidental release.

Post-Removal Verification

Post-removal verification for both navigational and environmental dredging projects generally would consist of a bathymetric survey to confirm that the specified minimum geometry has been achieved. The pre- and post-dredge conditions would be compared to determine compliance with the specified plan view limits and depths/elevations. Verification work is typically done by the design engineer or a qualified independent third party on behalf of the owner or RP to confirm contractor progress surveys and statements regarding completion. It is important that consistent equipment and methods be used (e.g., single-beam or multi-beam sonar, sonar frequencies, line/grid spacing, etc.), and consideration should be given to performing the verification bathymetric surveys as soon as a reasonable-sized dredge area is completed, especially in dynamic systems (e.g., rivers, shallow lakes). This is to eliminate as many variables as possible (e.g., sideslope sloughing, re-deposition from upstream), which could lead to disputes between the dredging contractor and the owner or RP. The pre- and post-bathymetric surveys would also be used to compute pay quantities and to deduct payment for over-dredging beyond the specified vertical allowance.

After verification that the specified dredge geometry has been achieved, an environmental project would most likely also include post-removal sampling and analytical testing to determine whether the concentration-based CUL or MRG has been achieved at the sampling locations. It is important for the dredging contractor to know and understand the sampling protocols (e.g., sampling method, sampling depth, grab or composite sample, laboratory turn-around time, etc.), even though the sampling would again most-likely be performed by the owner or RP's representative. For example, depending on laboratory turn-around time and project conditions, it may be prudent to have the dredge standby until analytical results confirm project completion of an area before moving onto the next area. An alternative would be to keep the primary dredge working and have another dredge available for clean-up passes as necessary.

Operational Controls and Monitoring

In the context of this paper, dredging operational controls include precise control of the dredge bucket or cutterhead (X, Y, Z), and prevention or minimization of particle re-suspension away from the dredge. For a navigational project, dredge precision would be important, but less so than for an environmental dredging project where the expense of handling extra sediment is cost prohibitive. Horizontal layout of the dredge prism could be as simple as visual triangulation on upland or fixed water features (e.g., buildings, bridge piers, light house), to using a dredge-mounted global positioning system (GPS). Vertical control for the dredge operator would often be by depth markings on the crane cable or a depth gauge on the dredge ladder.

In an environmental project, often the dredge itself is equipped with a differential or real-time kinetic GPS to control horizontal and vertical positioning, for example to within 30 cm laterally and 7 cm vertically. A computer onboard the dredge is integrated with the GPS and dredge prism design model to direct the dredge operator. As noted above, a post-dredge bathymetric survey would be used in any case to verify final conditions and compliance with the specified geometry.

A sediment re-suspension specification may or may not be used for a navigational dredging project, but it would be unusual not to have one for an environmental dredging project. The specifications are usually linked to background conditions up current from the dredge. The value may be turbidity, which is easy to monitor with fixed real-time or hand-held equipment, or TSS, which must be measured in the laboratory on a water column sample. TSS, therefore, has much less utility for timely response to an upset condition. The dredging contractor is responsible for re-suspension control, but monitoring is often done by the owner or RP's representative. Where water depths and currents do not render this option technically or financially impractical, silt curtains may be specified, or they may be used at the option of the dredging contractor, to reduce the frequency of monitoring. However, because silt curtains must be properly installed and maintained to be effective, and because they do not block passage of all re-suspended particles, some re-suspension monitoring would likely still be needed.

Environmental Windows and Monitoring

Environmental windows are often specified for dredging projects, regardless of whether they are for navigational or environmental dredging purposes. Often referred to as dredging windows, they are probably more commonly used in ocean tributaries, for example to protect salmon migration in the Pacific Northwest. However, seasonal dredging restrictions can be placed in inland fresh water environments as well to protect migrating game species, such as walleye or bass, and their spawning grounds. A dredging window may be specified for secondary reasons as well, for example to avoid blockage or restricted use of a heavily-used boat launch facility during a fish spawning run, or a popular marina during summer holidays.

Various media may be monitored and tests performed on an environmental dredging project, which are not pertinent to a navigational dredging project. The media include water, sediment, and air.

For water, there is water column sampling in the source water during dredging and effluent sampling from the water treatment system. In addition to turbidity or TSS monitoring described previously, water column samples may be collected for analytical testing of the COCs for mass balance computations. The dredging contractor would not likely be performing these tests, nor would he likely be responsible for compliance with any sort of standard. As described previously, responsibility for water treatment plant effluent sampling and compliance with discharge permit limits must be clearly spelled out in the project specifications, so that risk, and thus personnel, equipment, and costs, can be properly allocated.

Sampling and testing of the dewatered sediment would likely include, at a minimum, the paint filter test to verify the material can be disposed as solid waste in an upland landfill, and analytical testing for the COCs for mass balance computations and project documentation. Percent solids and strength tests may also be performed, if the landfill has established these as additional criteria. Monitoring of the ex-situ dewatered sediment would likely be performed by the owner or RP's representative, and the dredge contractor would be responsible for compliance with all results, other than concentration or mass of the COCs.

Air monitoring would likely only be required of the upland work area in certain circumstances for an environmental dredging project. The purpose of air monitoring would be for respiratory protection of construction workers and nearby residents. If odors at the upland work area are suspected or become an issue, then neutralizing or masking agents may be necessary. Air monitoring is typically performed more intensely at project start-up or at changes in process conditions, and then reduced or eliminated based on the measured results. Again, air monitoring, if required, would likely be performed by the owner or RP's representative. The dredging contractor would typically not be responsible for exceedance of specified emission limits or odor thresholds unless he was using improper practices as the source of the exceedance. Otherwise, the dredging contractor may be asked to cease operation until an agreement is reached on appropriate work modifications and corresponding compensation.

APPROACHES TO SPECIFICATIONS

In any project, the plans and specifications are intended to direct the contractor to meet the owner's needs and requirements. The specifications describe these requirements using either a design specification (often referred to as a "means and methods" specification) or a performance specification, and sometimes both. Unfortunately, there are times when a project incorporates both design and performance specifications which create conflict in meeting the owner's goals.

Means and methods specifications set forth precise measurements, tolerances, materials and other specific information, and under this type specification, the owner is responsible for design and related omissions, errors, and deficiencies in the specifications and drawings. By contrast, performance specifications set forth the operational characteristics desired by the owner, and the design, measurements, and other specific details are not stated nor considered important so long as the performance requirement is met (Abernathy 2001).

Performance specifications are used for most dredging projects, regardless whether their purpose is navigational or environmental. The differences will be in the performance criteria. Both types of dredging projects would have dredge geometry or DMU defined. Examples of key performance criteria for only the dredging element are listed below for a typical U.S. Army Corps of Engineers (USACE) navigational dredging project, and for a hypothetical environmental dredging project performed for an RP.

Example Dredging Performance Criteria – Navigational

- No dredging may occur between May 1 and July 15.
- Project must be substantially complete 185 days after notice to proceed.
- Contractor to remove all material within the template and areas shown on the project drawings.
- Contractor will be compensated for up to 30 cm of over-dredge below the template cut line.
- Contractor must monitor the disposal area for migratory bird nesting during the project duration.
- Discharge from the disposal area must be less than 29 nephelometric turbidity units (NTU) above background conditions in the receiving water.
- Contractor must monitor turbidity 150 m and 300 m downstream, and 150 m upstream, of the dredge and must maintain turbidity less than 29 NTU above upstream background at the downstream locations.
- Contractor surveys shall be approved for progress payments. Final survey at completion of project by owner shall be the basis of final acceptance.

Example Dredging Performance Criteria – Environmental

- Begin dredging no later than July 1 and complete dredging no later than November 1.
- Remove an estimated 51,500 cubic meters (m^3) from the DMU to the target elevations defined on the project drawings. The DMU is divided into sub-areas as shown.
- Target dredge elevations correspond to attaining a residual PCB concentration of $\leq$1.0 parts per million (PPM) dry weight basis.
- The cut slope of the dredge perimeter shall not be steeper than 4H:1V.
- The owner's representative will periodically perform turbidity measurements within 75 to 150 m of the dredge, both down-current and up-current.
- Suspend dredging and modify operations if down-current turbidity exceeds up-current turbidity by 25 NTU.
- Perform minimum weekly quality control (QC) bathymetric surveys to monitor work progress.

- Do not dredge more than 15 cm below the target elevations (over-cut allowance), unless directed otherwise by the owner's representative.
- Owner's representative will perform a quality assurance (QA) bathymetric survey of each sub-area within the DMU within 7 calendar days of contractor's notice of completion.
- Upon verification that the target elevations have been achieved everywhere within the sub-area of the DMU, owner's representative will collect 4 discrete core samples (1 per quadrant, target depth 30 cm) and analyze for PCBs.
- If post-dredge verification samples show > 1.0 PPM PCBs, contractor shall perform additional dredging (i.e., second pass) of the affected area(s), lowering the elevation no more than 30 cm below the original target elevation.
- Upon completion, the owner's representative will re-survey and re-sample/analyze the affected area.
- If the results of second round post-dredge verification samples still show > 1.0 PPM PCBs, contractor shall place a thin sand cover over the affected area to a target thickness of 20 $\pm$ 5 cm.
- Areas/volumes found during post-dredge QA bathymetric surveys to exceed the 15 cm over-cut allowance, or 30 cm below the target elevation in the event of a required second dredge pass, shall be deducted from the contractor's pay quantities.

CONTRACTING METHODOLOGIES

Navigational dredging projects for governmental agencies are generally advertised publicly and bid, with the lowest qualified bidder being awarded the project. Capable navigational dredging contractors of all sizes are located around the U.S. (and world), as evidenced by the membership list of the Western Dredging Association (and sister organizations). Navigational dredging for a private party on the other hand, such as a marina, may or may not be bid. It would not be uncommon for this work to be loosely scoped and subsequently negotiated with a familiar contractor in the general locale of the work.

The cadre of contractors qualified and experienced to perform environmental dredging work is smaller than that of navigational dredgers. The list becomes shorter as the project size and complexity grow. As a result, governmental agencies and owners or RPs needing environmental dredging services often go through a pre-qualification phase to sort qualified and interested/available contractors, from around the country. It is not uncommon for a large engineering firm to act as the prime contractor and add a dredger as a joint venture partner or subcontractor to his team. Other subcontractors may be added to the team if the dredger does not have the requisite skills, experience, and equipment for dewatering, water treatment, and disposal. Short-listed contractors are typically invited to submit a proposal in response to the project design and performance criteria, and may be encouraged to submit alternatives to the base design. The proposal will include elements necessary for the agency, owner or RP to evaluate the responses, including the contractor's pricing. If selection is not clear at this point, the final short-list of contractors will likely be invited to make a presentation and participate in an interview with the selection panel. At this point, a governmental agency is often bound to award the work to the lowest-cost qualified contractor, whereas a private entity has more flexibility in this regard.

Payment methods for a dredging project could include:

- Time and materials;
- Cost plus fixed fee;
- Unit price;
- Lump sum; or
- Combination of above.

The most common method, regardless of a navigational or environmental dredging project, seems to be a combination of unit price and lump sum. Lump sum work elements typically include mobilization/ demobilization, preparation of the upland work area, upland site restoration upon completion, and bonds. An environmental dredging project may also include lump sum items for project insurance (e.g., high limits on contractor's general liability, and pollution liability), work plans (written details of a contractor's means and methods to comply with the performance criteria for the various project elements, and a health and safety plan), final design and permitting of the water treatment system, installation and maintenance of a silt curtain, protection of a water intake or sewer outfall, and project meetings and reporting (e.g., weekly progress meetings and reports, and a final construction completion report).

ISSUES UNIQUE TO ENVIRONMENTAL DREDGING

Unit price work elements typically include those listed in Table 1, described previously. For a navigational dredging project, more often than not, these principal work elements are combined, with payment simply based on measured in-situ dredge volume. For an environmental project, the same may be true. However, additional unit price work elements may be added. For the water treatment system, this may include system operation (time scale), replacement of granular activated carbon (weight basis), and addition of treatment chemicals (weight or volume basis). Dewatering may be broken out on a dry-weight basis to avoid paying for marginal dewatering and landfill disposal of excess water. Finally, the loading, transportation, and disposal of the dewatered sediment may be paid for on the basis of scaled weights at the landfill instead of in-situ volume.

As noted, dredging for an environmental project is often also paid on the basis of in-situ volume removed. However, because of the need to achieve a CUL or MRG, and the uncertainty whether removal of the specified geometry will accomplish this, the dredging contractor should be paid for additional dredging to achieve the CUL or MRG. An over-cut allowance would still apply, so that the owner or RP is not paying excessively for removal, dewatering, and disposal of uncontaminated sediment.

In the environmental project example above, the additional "second pass" dredging was limited to a maximum of 30 cm below the target elevation. If the maximum 15 cm over-cut allowance had been performed in the first pass, the second pass would have only been an additional 15 cm cut. In this example, solids removal production would be considerably less in the second pass, and unless the project pay items included a separate line item for second-pass dredging, the contractor should factor this into his initial pricing scheme or suggest an alternative pricing scheme in his proposal.

Also in the environmental project example above, the additional dredging to achieve the CUL or MRG was limited to a second pass. Experience has shown diminishing returns with more than a couple dredge passes, due to residuals from limitations on dredging precision and re-settling of contaminants. A thin sand cover (residual cap) was specified if the CUL or MRG was not achieved after the second pass. The purposes of the thin cover are to limit exposure of organisms to surficial contaminants and to accelerate natural recovery.

Another concept increasingly used on environmental projects is to specify a lower surface-weighted average concentration (SWAC) as a secondary goal if the CUL is not achieved in a particular DMU (Wisconsin Department of Natural Resources (WDNR) and U.S. Environmental Protection Agency (USEPA) 2003). The SWAC is lower than the CUL because a SWAC is computed as an average concentration over the entire area of concern (or operable unit), after the removal of sediment to the CUL from specific DMUs within the area of concern. This includes averaging surface concentrations outside the DMUs that are less than the CUL. In application, this would allow no further dredging in a particular DMU having a post-dredge residual concentration above the CUL, as long as the SWAC is achieved. There is obviously a limit on how frequently this could be used without exceeding the SWAC and thus requiring more dredging or alternative placement of a thin sand cover.

Contractor personnel on environmental projects generally are required to hold certificates demonstrating 24-hour to 40-hour training for work in potentially hazardous work environments in accordance with Occupational Safety and Health Administration rules (e.g., 29CFR1910.120), in addition to annual 8-hour refresher classes and medical monitoring. These contractor training and medical monitoring costs can be substantial, but are incidental to other environmental project pay items and therefore should be built into the rates.

PROJECT EXAMPLES

Attached are six dredging project examples (two navigational and four environmental). Each example lists general project information, details of the various project elements, contracting and responsibilities, and unique project issues if any. These examples highlight likenesses and differences between navigational and environmental dredging projects. All but one of the project examples were contracted by a governmental agency. Project information from public agencies is generally more readily available, whereas private owners and RPs often protect project details to maintain confidentiality. Although procurement methods may differ between public agencies and private parties, the performance and payment criteria are often similar.

CLOSING

An attempt was made in this paper and the attached project examples to highlight important differences between navigational and environmental dredging projects. These differences are by all means not exhaustive and the authors would welcome feedback from others in the dredging community.

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Project #1
Lake Trafford
(Environmental Dredging)

General Information	
Project Name	Lake Trafford Restoration.
Owner	South Florida Water Management District.
Location	Collier County, Florida.
Year(s) of Completion	State fiscal years 2004, 2005, and 2006.
Volume	2,200,000 m^3 without over-depth.
Purpose of Project	Restore lake water quality by removing organic sediment from 650-hectare shallow lake with placement in CDF on 250-hectare site north of lake.
Contaminant(s) of Concern	Excessive decomposing organic matter from killing aquatic vegetation with chemicals, as well as phosphate, copper, and ammonia.
Project Elements	
Dredging Method	Hydraulic with pipeline transport to CDF.
Sediment Dewatering Method	Natural drainage in CDF.
Water Treatment Method	Base bid natural settling in CDF with effluent meeting criteria of less than 29 NTU above background. Bid allowance for chemicals needed to address phosphate or copper reduction.
Sediment Disposal Method	Dewatering in CDF with owner taking responsibility for final disposition.
Contracting and Responsibilities	
Procurement Method	Public bid advertisement (contractor required to be licensed in the State of Florida).
Method of Contract	Lump sum with bond and allowance for water quality treatment and shallow water vegetation removal.
Specification Approach	Specifications and drawings showing quality of work expected and area and depth of removal (performance specification).
Schedule	From notice to proceed – 690 days to substantial completion and 720 days to final completion.
Permitting	By owner.
Environmental Compliance	By contractor, including migratory bird and turbidity monitoring.
Pay Items	Percent complete by acceptance section (5,000 m^2 area) with pay allowance of ± 7.5 cm.
Unique Project Issues	Liquidated damages of $1,000 (US dollar)/day plus owner's direct costs. Sediment moved in lake due to wind traction on lake surface, making it difficult to meet the criteria for removal of sediment.

Project #2
New Pass/Gordon Pass
(Navigational Dredging)

General Information	
Project Name	New Pass/Gordon Pass Maintenance Dredging.
Owner	United States Army Corps of Engineers – Jacksonville District.
Location	Naples and Sarasota, Florida.
Year(s) of Completion	2003.
Volume	New Pass 180,000 m^3/Gordon Pass 88,000 m^3 (volumes include 30 cm over-dredge allowance of 55,000 m^3 and 42,000 m^3 at New Pass and Gordon Pass, respectively).
Purpose of Project	Maintain entrance channels at Naples, Florida and at the South end of Sarasota Bay.
Contaminant(s) of Concern	None (sediment suitable for beach nourishment).
Project Elements	
Dredging Method	Hydraulic with pipeline transport to beach.
Sediment Dewatering Method	Natural drainage on beach.
Water Treatment Method	None.
Sediment Disposal Method	Grade to required profile on beach.
Contracting and Responsibilities	
Procurement Method	Public bid advertisement.
Method of Contract	Lump sum and unit price with bond.
Specification Approach	Specifications and drawings showing quality of work expected and area and depth of removal (performance specification).
Schedule	Completion by specified end date (no dredging during sea turtle restriction dates).
Permitting	By owner.
Environmental Compliance	By contractor, including migratory bird, sea turtle and turbidity monitoring.
Pay Items	Percent complete progress payments based on contractor-surveyed completion with final acceptance by owner at end of each project. Pay allowed for up to 30 cm of over-dredge.
Unique Project Issues	Operating in the surf zone at the mouth of the channel could cause substantial project delay.

Project #3
White Rock Lake
(Navigational Dredging)

General Information	
Project Name	White Rock Lake Restoration.
Owner	City of Dallas, Texas.
Location	Dallas, Texas.
Year(s) of Completion	1998.
Volume	Base volume 1,250,000 m^3 (four options to increase volume by 1,225,000 m^3).
Purpose of Project	Remove accumulated sand, silt, and clay from impounded lake.
Contaminant(s) of Concern	None.
Project Elements	
Dredging Method	Hydraulic with 27-kilometer pipeline transport to gravel pit.
Sediment Dewatering Method	Natural drainage at gravel pit.
Water Treatment Method	Water recharges ground water by infiltration.
Sediment Disposal Method	Remains in disposal cells at former gravel pit.
Contracting and Responsibilities	
Procurement Method	Public bid advertisement.
Method of Contract	Lump sum unit price with bond.
Specification Approach	Specifications and drawings showing quality of work expected.
Schedule	From notice to proceed – 510 days for base bid.
Permitting	By owner.
Environmental Compliance	None.
Pay Items	Mobilization/demobilization, installation of booster pump stations, and road crossings by lump sum. Pipeline installation by feet installed, and dredging and pipeline operation by in-situ cubic yards moved.
Unique Project Issues	Unusually long pump distance and no allowance for overflow of disposal area (using old gravel pits).

Project #4
White Lake – Tannery Bay
(Environmental Dredging)

General Information	
Project Name	Tannery Bay.
Owner	Michigan Department of Environmental Quality.
Location	Whitehall, Michigan.
Year(s) of Completion	2002 – 2003.
Volume	Base volume 61,000 m^3 (additional volume possible based on testing by owner after removal of base volume).
Purpose of Project	Remove sediment and waste from former tannery operation
Contaminant(s) of Concern	Hair and hides, arsenic, and chromium.
Project Elements	
Dredging Method	Not specified (contractor used a combination of hydraulic and mechanical dredging).
Sediment Dewatering Method	Recessed chamber filter presses (hydraulic removal) and lime addition (mechanical removal).
Water Treatment Method	Water treated to meet industrial pre-treatment standards with disposal to local sewer authority.
Sediment Disposal Method	Disposal in Subtitle D landfill.
Contracting and Responsibilities	
Procurement Method	Public bid advertisement.
Method of Contract	Lump sum and unit price with bond.
Specification Approach	Specifications and drawings showing quality of work expected and removal areas and depths.
Schedule	From notice to proceed – substantial completion by June 30, 2003 and final completion by September 30, 2003.
Permitting	By owner.
Environmental Compliance	Turbidity control using silt curtains and turbidity monitoring by contractor. Responsibility by owner for extra water treatment costs to meet industrial pre-treatment standards.
Pay Items	Mobilization/demobilization, site preparation, site services, and restoration by lump sum. Dredging on an in-place cubic yard basis, dewatering transport and disposal on a dry-ton basis, water treatment on a gallon basis. Allowance for installation of steel sheet-pile to support shore.
Unique Project Issues	Owner took risk for water treatment being acceptable for discharge to the sanitary district and paid a substantial charge for a system not under owner control. Arsenic and chromium concentration removal objectives were not met due to the very soft nature of the sediment below the designated dredge elevation.

Project #5
Saginaw River Dredging
(Environmental Dredging)

General Information	
Project Name	Saginaw River.
Owner	U.S. Army Corps of Engineers.
Location	Saginaw, Michigan.
Year(s) of Completion	2000.
Volume	Base volume to neat line 170,000 m^3. Allowed over-dredge volume 74,000 m^3.
Purpose of Project	Remove sediment from main channel bank deposits where contamination exceeds 1 PPM.
Contaminant(s) of Concern	Polychlorinated biphenyls (PCBs).
Project Elements	
Dredging Method	Contractor required to use mechanical dredging with environmental clamshell bucket from specific manufacturer.
Sediment Dewatering Method	No dewatering required.
Water Treatment Method	No water discharge allowed.
Sediment Disposal Method	Disposal in existing CDF in Saginaw Bay.
Contracting and Responsibilities	
Procurement Method	Public bid advertisement.
Method of Contract	Lump sum and unit price with bond.
Specification Approach	Specifications and drawing showing desired removal with dredging specifications setting forth the means and methods to use in completing the work.
Schedule	Completion by specified end date.
Permitting	By owner.
Environmental Compliance	Turbidity control using silt curtains required. Contractor performed water quality monitoring and air quality monitoring.
Pay Items	Mobilization/demobilization, site preparation, and water quality sampling by lump sum. Dredging, barge transportation, and unloading at CDF by unit price based on in-situ cubic yards. Allowance for payment of up to 30 cm of over-dredge.
Unique Project Issues	Sediment contained on average 70% sand by weight and the specified bucket type would not dig the side-bank sediment. Changes in the dredging method had to be made to complete the project.

Project #6
Confidential Project
(Environmental Dredging)

General Information	
Project Name	Turning Basin Sediment Dredging.
Owner	Confidential.
Location	Great Lakes.
Year(s) of Completion	1999.
Volume	Base volume to neat line 12,000 m^3. No over-dredge payment allowed. Owner paid for additional dredge volume requested as a result of completion testing by owner's representative.
Purpose of Project	Remove sediment from a harbor turning basin contaminated by coal tar.
Contaminant(s) of Concern	Polycyclic aromatic hydrocarbons (PAHs).
Project Elements	
Dredging Method	Specifications and permit required hydraulic dredging.
Sediment Dewatering Method	Mechanical dewatering required prior to disposal.
Water Treatment Method	Water discharged to owner's water treatment facilities after meeting pre-treatment standards.
Sediment Disposal Method	Licensed solid waste landfill.
Contracting and Responsibilities	
Procurement Method	Private party procurement by invitation only.
Method of Contract	Lump sum and unit price with bond.
Specification Approach	Specifications and drawings showing desired performance goals. Bidding allowed alternative use of mechanical dredging provided all performance specifications met.
Schedule	By specified date.
Permitting	By owner.
Environmental Compliance	Dredging-induced turbidity to be no more than 30% greater than background turbidity outside of re-suspension control system using silt curtains. Contractor responsible for monitoring and maintaining compliance.
Pay Items	Mobilization/demobilization by lump sum. Dredging by the cubic yard in-place with one rate for the base volume and a second rate for a clean-up pass if required by owner. Disposal by the dry ton with an allowance for disposal as solid waste or hazardous waste.
Unique Project Issues	Harbor depth (average of 10.6 m) led to problems with hydraulic dredge approach used by selected contractor. No allowance to pay for over-dredging in a soft deposit.