LISA F. GLAHN AND JOHN A. DERUGERIS

PRACTICAL CLAIMS AVOIDANCE TECHNIQUES: HOW TO PREVENT EXCESS COSTS AND UNNECESSARY DELAY ON DREDGING PROJECTS

ABSTRACT

Despite advancement in dredging and survey technology, contract disputes over increased costs continue to plague dredging contractors and stall owners' time-sensitive projects when after-dredge surveys fail to produce accurate, repeatable results. The challenges of many of today's projects, such as deeper channels, tighter dredge envelopes and environmental restrictions, put contractors and owners at ever increasing risks. One of these risks – and one of the more critical components of any dredging project – is the no longer simple process of measuring the completed work to be sure that it complies with the design intent. It is often unrecognised that the ever increasing complexity of this measuring (survey) presents challenges of its own that can often make or break the entire process. Weaknesses and ambiguity in data streams collected by very sophisticated multibeam systems coupled with varying interpretations of the governing Engineering Manuals also commonly lead to disputes over survey methodology, quality control procedures and operational protocols.

This article is based on a study of industry trends, advancement in dredging and survey technologies, and the underpinnings of historical dredging disputes in order to present a streamlined approach to minimising claims and maximising efficiency and profitability. The basic techniques explored here are:

(1) early project communication and participant buy-in of dredging and survey means and methods;
(2) proactive requests for contract clarification and the implementation of protocols to maximise information sharing;
(3) understanding and reconciling the interplay between error budgets and regulatory limits;
(4) expert, in-the-field review of raw survey data to determine shoal validity; and
(5) increased communication between contractors, surveyors and project management personnel.

Both practical legal and engineering guidance on ways to implement offensive strategies for project success are offered.

Above: The Port of Savannah is one of several ports hoping for development to meet the demands of the Panama Canal expansion. The challenges of maritime construction have become compounded by new growth demands on waterways and ports, where deeper and wider channels are required to handle larger and larger ships.

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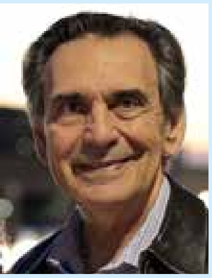
INTRODUCTION

Because dredging is vital to both socio-economic development and environmental health, the dredging industry is uniquely situated at the heart of the world's largest and most complex infrastructure systems. Owing to the size and difficulty of such projects, the long lead time that often exists between initial design, project funding and actual construction, as well as the rise in environmental restrictions, dredging projects are inherently susceptible to increased disputes arising out of project tolerances and limitations that are often incongruous with the technology being used to measure success. As our waterways have been one of the hardest hit areas of pollution, the rise in environmental awareness has led to increased conservatism amongst regulators and, in turn, heightened regulatory restrictions for dredging projects. These restrictions may not

LISA F. GLAHN
is a Member/Construction Litigator at Mintz, Levin, Cohn, Ferris, Glovsky and Popeo, P.C. in Boston, Massachusetts, USA. As a leader of the firm's Construction Law Practice Group she has represented contractors, developers, and project owners in both the public and private sectors. She received her BA in Peace Studies/Political Science, 1997 from Bucknell University, Pennsylvania and her JD (Juris Doctor) in 2000 from Northeastern University, Boston. She is a member of the Bar in the Court of Federal Claims, Massachusetts and the United States District Court for the District of Massachusetts.



JOHN A. DERUGERIS
is Founder/Principal Engineer, CLE Engineering, Inc. and graduated in 1964 from Temple University in Pennsylvania with a degree in Mechanical Engineering. Since 1986 he has worked at CLE Engineering and been heavily involved in the design, consultation and management of over 300 marine dredging, design and structural projects, hydrographic surveys and hazardous waste projects across the USA.

only impede progress and practicability, but may also introduce significant constructability issues.

As new restrictions are increasingly being placed on maritime construction, the technology being used on projects – if outdated even by a couple of years – often fails to buttress innovative solutions for dealing with such changes. When the technology does get close to catching up, projects that are more difficult than the routine variety suffer as designers are put in the position of not having adequate specifications, experience or equipment available to meet project needs.

The difficulties of maritime construction are therefore at the extreme end of the construction industry spectrum. These conditions have become compounded by new growth demands on waterways and ports, where deeper and wider channels are required to handle larger and larger ships. This, in itself, generates more challenges for technology as deeper waterways in many cases require removal of rock or rock-like material, which is extremely difficult and expensive to dredge. Additional clearances then have to be considered because harder bottom materials are unforgiving and therefore increase the potential for contaminant releases.

This is the complicated backdrop against which many modern dredging projects must be performed. On very large projects with complex funding structures, design often takes place years before construction causing a range of factors to shift such that the basic design specifications are likely outdated by the time construction actually begins. This means that many of the projects currently underway in the market were designed when certain technologies, like multibeam, were in their infancy and when funding requirements and environmental restrictions were vastly different. If the specifications for such projects have not been updated (and likely they have not as design budgets have undoubtedly long since been exhausted), the specifications may reflect decade-old technology and methodology.

Compound this with the potential disconnect that may occur between the owner's/designer's survey team and its design/project management groups, along with a growing demand on ageing survey vessels and project managers who may not be intimately aware of the project design criteria: The potential for conflict and claims is multiplied exponentially.

Such impasses often occur on complex dredging projects and claims have, in turn, become all too common in the industry. This does not mean to say that disputes on dredging projects cannot be avoided. Claims on dredging projects can be avoided: Simple techniques for increasing project buy-in by key participants, enhancing communication throughout all levels of survey and construction, training survey and construction personnel about ways to recognise survey inaccuracies in the field and an appreciation during the design stage for incongruities between restrictions and required performance standards will result in enhanced project success.

CLAIMS AVOIDANCE MADE SIMPLE

Employing the adage that history is the greatest teacher, examples of prior disputes are shared below to assist industry participants in avoiding common project pitfalls. Further guidance is offered so that claims can be avoided through the implementation of certain key dispute avoidance techniques.

Have Contractors Made Early and Thorough Requests for Contract Clarification and Do All Parties Concur on the Means and Methods for Gauging Project Success?

Ask:

- Do all project participants have a clear understanding of *what* work the contract requires and *how* the work will be measured?
- Has the contractor performed a careful review of the project requirements to ensure compliance?
- On public projects, have the means and methods of before after-dredge survey measurement been clearly and expressly stated in the bid documents?
- If possible, have all parties to the agreement come to consensus regarding the particular technology and methodology to be used on the project?

The basis for any project is the signed contract between the owner and the contractor. Any disputes that arise between contractors and owners will ultimately be resolved in light of the contract, and the language of the contract will control. Thus, it is axiomatic that contractors *must* have a complete understanding of their duties, rights, and obligations under the agreement that outlines the project. This includes a clear comprehension of exactly *what* the contract requires of each party, and *how* the work to be performed under the contract will be measured. The latter point is especially important in dredging disputes where miscommunication and ambiguities in terms can lead to costly problems.

When bidding on or entering into a project, parties should be mindful of even the most

Figure 1. A high-end survey vessel. With a wide range of survey methodologies and ever-changing technologies, contractors and owners must be sure to familiarise themselves with the chosen protocol.

innocuous contract provisions. In one project example, the contract was clear about the required dredge depth but was ambiguous with respect to precisely *how* and under what processing methodology the owner would measure and verify the contractor's work. It became clear during the performance of the after-dredge surveys that the contractual term used to describe the survey methodology to be employed (simply: "acoustic sweep survey") was inherently ambiguous. It could have referred to one of four common processing methods, each of which may have yielded different results. The contractor, assuming that the Owner intended to use average sounding analysis method, itself used the average method when performing its pre-acceptance surveys. In contrast, however, the owner used the minimum depth processing method for acoustic sweep surveys.

While such information should have been made clear at the outset of the project, it was not. As a result, there were discrepancies between the contractor's surveys and the owner's after-dredge surveys resulting in a claim for excess shoaling.

Contract language

Given the immense importance of contract language as it relates to the rights and obligations of the parties, contractors must take certain proactive steps to ensure that they understand precisely what they are signing up for *before* they actually do so and before their contractual duties take effect. For example, contractors should be practiced at proactively issuing a Request for Information (RFI) in the pre-contractual stage to clarify any ambiguities in the contract language.

Even where the contract language appears to be clear on its face, as above, contractors would be well served to review the documents with an eye toward practical implementation of the requirements listed, to determine whether there are actually any terms or conditions that might cause confusion when the time comes for performance. This is especially important because often contractors and owners rely on standard form contracts with "boiler-plate" language, and as a result may not analyse the contract terms as carefully as is necessary.

Early, thorough analyses of contract language with an eye toward real-world implications of the terms used, aided by substantive requests for clarification from contractor to owner, will help ensure that the types of misunderstandings illustrated above are avoided.

Consensus on technology and methodology

Relatedly, it is critical that owners and contractors understand and, if possible, come to a consensus regarding the particular technology and methodology to be used. Because of the wide range of survey methodologies available, as well as the ever-changing technology in the field, contractors and owners must be sure to familiarise themselves with the chosen protocol. Failure to reach understanding or consensus regarding survey methodologies can and does lead to costly delay when problems occur.

Achieving project participant buy-in prior to the start of a project ensures that each party is fully aware of the risks and benefits inherent in the chosen survey methodology, and helps to foster a sense of mutual collaboration on the project as well as ownership of the methods chosen. This ensures that parties begin projects as partners rather than adversaries (Figure 1).

In another illustrative case, the problem of repeated rejection of acceptance requests was determined to be the result, in part, of improper tide readings. The owner, using a manual tide gauge as opposed to an electronic tide gauge, had been measuring the contractor's work in oftentimes imperfect conditions. Although the use of an electronic tide gauge was, at the time, the widely preferred method for making tide readings and was, in fact, what the contractor expected was being used to measure its work, the owner's reading were negatively impacted by choppy water, excess boat traffic and poor weather.

While there was no contract requirement that the owner use an electronic tide gauge on the project, in light of the inherent risk in operating a manual tide gauge, the contractor should have been made aware that the owner was not using the most accurate, up-to-date technology. As such, the owner's failure to educate or gain consensus regarding the tide gauge to be used eventually subjected it to claims from the contractor when the manual method gave inaccurate results that in turn tainted the survey readings. If the owner had identified its methodology prior to the project start date, then both parties could have evaluated the efficacy of said methodology or at least entered into the project with full knowledge of the attendant risks of utilising a manual measurement system.

How, then, can contractors and owners best act to prevent issues like those illustrated above from adversely impacting their projects?

- First, contractors should note whether owners are using commonly accepted, "tried and true" survey methodology, or whether they are pushing the limits of these standards. This may require that contractors actually bring in outside "peer reviewers" who are familiar with the latest technology to evaluate the efficacy and reliability of the proposed methods.

- Second, contractors should be watchful for obsolete procedures and specifications that may hamper progress. Although some might argue that determining what is an "appropriate" survey protocol is an inherently subjective decision, external standards that all owners and contractors can use to measure the acceptability of a chosen protocol are available.

Has the Interplay Between Error Budgets and Dredge Limits Been Fully Explored and, if Necessary, Reconciled?

Ask:

- Does the contract include a dredge depth limitation beyond which the contractor may be sanctioned for over-dredging?
- Are there any specific site challenges that will inhibit the accuracy of survey systems (i.e., rough bottom, ship traffic, fast or erratic currents, floating debris from outfalls).
- Are such over-dredge design restrictions compatible with standard error budgets or does the interplay between these two factors create an impossible situation for the contractor?

For all of the aforementioned reasons, it is essential that contractors familiarise themselves with a project's chosen survey methodology prior to entering into an agreement with a project owner. In addition to the above examples, contractors should also be sure that they comprehend the survey technology to be used – especially in those cases where the project owner has prescribed a dredge limit – so that any irreconcilable differences in the interplay between the equipment capability and the dredge depth precision can be easily identified, addressed and fixed early.

Case study over-dredging

One recent project provides an excellent example of how irreconcilable differences between dredge limits and survey technology can lead to disputes. On that project, the contract restricted the contractor to a 0.61 metre (2 foot) over-dredge envelope (e.g., the required dredge depth was -10.7 m (-35 ft) MLW with an allowable over-dredge limit of -11.3 m (-37 ft) MLW). Key there was not the tightness of the 0.61 m (2 ft) range, but rather that over-dredging beyond the 0.61 m (2 ft) pay limit actually carried adverse legal consequences and severe financial penalties according to applicable environmental laws.

This was a significant restriction given that a number of environmental conditions of the subject site commonly created error budgets within the owner's surveys that actually ranged from 0.18 m (0.6 ft) to *over 0.61 m (2.0 ft)*. Thus, the contractor was prohibited from over-dredging more than 0.61 m (2 ft) beyond the contract depth, but the surveys used to evaluate the contractor's work measured to a standard of accuracy incompatible with the contract design.

It is noteworthy that based on the version of the Engineering Manual in effect at the time, the projections were that most survey product variations could be expected to be less than 0.27 m (0.9 ft). Thus, even if the owner's survey accuracy met the commonly accepted 0.27 m (0.9 ft) standard variation, the contractor was in reality held to an envelope much smaller than 0.61 m (2 ft). Moreover, because of the inaccuracy of the owner's surveys that led to variations of over 0.61 m (2 ft), in some cases the contractor's margin of allowable error was actually *below zero*. As such, even if the contractor was successful in keeping within the 0.61 m (2 ft) envelope, when that same dredged area was surveyed by the owner, the final survey plots would have randomly shown shoals of up to 0.15 m (0.5 ft) or more.

Performance of the project within such incompatible extremes thus becomes the equivalent of either a defective design or a tacit agreement by the owner that the measure of the finished work product can and will be done to a compatible tolerance. As all contractors should, the contractor in the above example had the right to expect consistent, uniform and accurate deployment and operation of whatever survey system the owner used. The contractor also had a right to expect a degree of survey accuracy that was compatible with the environmental restrictions inherent in the contract. As is clear from the case study, neither of these conditions were met, and delays and disagreements ensued.

While this may sound like an extreme example, situations such as this are, unfortunately, more common that one might expect. This points out a very common survey problem within the industry: Field conditions and the behaviour of a waterway can be very unfriendly towards even the most sophisticated survey system. To make matters even more difficult, conditions within certain waterways can change dramatically by something as common as the change of tide or a major rain event. Such conditions dramatically affect the sound velocity in water and can introduce survey errors of over a foot as the survey vessel traverses from bank to bank.

More often than not, designers and specifiers may be totally unaware of such conditions and the survey crew, who deal with such problems on a routine basis, may not understand the importance of communicating their difficult experiences to the design teams while a particular project is in the design or permitting stages.

Contractors who are considering entering into an agreement that specifies over-dredge penalties cannot take for granted that the contractually mandated over-dredge limits will actually square with the survey technology as employed and operated. What does this mean for contractors evaluating new project opportunities?

First, contractors should pay close attention to any restrictions on over-dredging, particularly where legal or financial penalties are involved, as this turns an already imprecise process into a risky endeavour that carries the weight of potential liability. As environmental awareness grows and project owners place more and more conservative measures on their projects, this issue will likely occur with more frequency.

Figure 2. A modern multibeam sounding system.

Compounding the problem is the fact that owners (or their representatives who are tasked with writing the terms of the contract and overseeing the design process) sometimes do not have a thorough understanding of the ramifications of these restrictions and the interplay between their survey methods and project realities. Thus, contractors themselves should ensure that they have a clear understanding of the survey methodology/ technology to be used by the owner to evaluate their work, so that both parties can identify, at the outset, any inconsistencies or incompatibilities between the error budgets and dredge limits. If necessary, contractors should seek out the advice of industry experts to identify potential conflicts and determine how best to handle their resolution.

Have Both Parties Engaged in Expert, In-the-Field Review of Raw Survey Data to Determine Shoal Validity?

Ask:

- To the greatest extent possible, are all after-dredge surveys being performed using best practices so that operational, environmental and equipment-based survey error is minimised?
- Has the contractor requested the owner's raw data files to make such determinations on its own?
- Is the contractor aware of the signs it should look for in the data to determine that best practices are being followed?

One of the most important ways that parties can protect themselves from unnecessary and costly disputes is by learning how to identify potential errors and anomalies in the raw survey data. Particularly, contractors should ask owners not only for the after-dredge survey results, but also for the data that underlies those results. In so doing, contractors will place themselves in a stronger position in the face of owner requests for costly shoaling that might not actually be necessary or appropriate.

By way of background, a multibeam sounding system is a device that marries a series of single acoustic measuring beams into an "inverted fan" arrangement (Figure 2). Simply put, the soundings produced in modern sweep surveys are little more than a complex array of signals generated in rapid succession, from which the sounding system measures the quality of the signal return over time. That time interval increases as water depth increases, and thus the time duration of the signal can be used to calculate the water depth with relatively consistent accuracy. In order for an electronic signal to be accurate in this measurement process, the variables that affect the speed of sound in water must be accounted for. In "tank test" conditions the water temperature and salinity are usually uniform and consistent, thus the calibration adjustments for these figures can be manually entered into the system computer and the computer will adjust the output accordingly.

These same variables in a navigable waterway must be accounted for by calibration methods known as sound velocity probe casts, as well as physical measurements to check the electronic sound velocity data. These are known as "bar checks", "ball checks" and "blunder checks" and are performed using equipment and measuring devices designed specifically for that purpose. Failing to diligently carry out these tests will radically reduce the quality and accuracy of the survey results.

A sampling of the various problems with survey accuracy that may occur as a result of a party's failure to properly administer the appropriate quality checks required by the multibeam sounding technology are described below.

Identifying problems with sound velocity casts

Looking back over the past century of dredging, multibeam survey represents a relatively new technology that is continually undergoing rapid advancements. A typical modern multibeam system represents the cutting edge of hydrographic technology, and most of the components represent highly sophisticated electronic systems and components. Nevertheless, the unfortunate fact remains that this sophisticated equipment is also subject to an abundance of potential problems that can quickly and dramatically degrade overall system accuracy, only some of which include equipment malfunctions. As such, it has become extremely important that a level of constant and diligent interrogating of system quality take place during the performance of survey work. Without such diligence, erroneous data will be introduced and may go unnoticed or, worse yet, be ignored or manipulated in post-processing.

Field interrogations of the system consist of a series of prescribed testing and calibration procedures that measure the output of the system against known standards. In theory, if a survey party follows these prescribed procedures, the end result will be a reasonably accurate work product. That, at least, is the theory. And it holds reasonably true as long as the survey crew remains diligent in their duties and applies a level of common sense with respect to the overall site conditions, which also includes voiding obviously bad survey passes and re-scheduling and/or cancelling the conduct of surveys when environmental conditions (such as satellite availability, weather and vessel traffic) are outside of reasonable parameters.

In field deployment an abundance of potential issues with multibeam systems remain, especially with respect to the accuracy of the outermost beams of the array, their propensity to "bend", and the ability of these very small beams to identify and properly record the variability of bottom materials. The true accuracy of the outer beams of the system array can be seriously affected by common variations in water temperature and salinity within the water column. This is generally corrected to more acceptable levels of accuracy by the use of the SV-Probe data, which records samples at regular intervals from the surface to the bottom and then uses this data to correct the beam deflection. Aside from the "bending" issue, the importance of the proper application of the sound velocity data itself can also not be emphasised enough.

By way of example, the variation in sound velocity from the water surface shown in Figure 3 ranged from 1482 m/s (4860 ft/s) at the water surface to 1489 m/s (4885 ft/s) at the bottom. Failure to account for, or a significant change in, this variation alone would introduce up to 0.15 m (0.5 ft) of depth error into a survey at the center beams and a minimum of 0.21 m (0.7 ft) at the outer (45°) beams.

Figure 4 is an example of what can happen to the outer beams of a multibeam array when sound velocity is not properly tuned. This section view shows multiple passes of the same area (yellow, blue, red, etc.) using inadequate velocity probe data. Note how the ends of each pass (denoted by extreme end of color band) are turned up – resembling "smiley faces". This is erroneous data that can be seen as a disparity of up to 0.46 m (1.5 ft) in depth. This illustration clearly demonstrates that the conduct of several velocity probe casts per survey day becomes critically important to survey accuracy.

Identifying problems with wave disturbances

The introduction of errors attributable to wave and wake disturbances while a survey is in progress is an issue of serious concern with respect to the conduct of surveys that are expected to be precise. Areas with heavy weather exposure and vessel traffic may make a survey area subject to considerable potential wave action.

Devices known as HPR compensators are the industry standard for electronically adjusting a vessel's position in the computer when its "steady state" is disrupted by waves or wakes. Modern HPR sensors are very efficient, but they still have corrections problems, especially when the survey vessel's "steady state" is thrown off rapidly, such as regularly occurs with large regular waves or wakes that hit the bow of the boat at an angle.

Most manufacturers' specification data indicate that, in theory, the HPR can handle almost any sea state. In practice this is not the case, which clearly shows the effects that wave action can have on the accuracy of survey data.

The graphics in Figure 5 illustrate what happens to a multibeam survey performed with a state-of-the-art multibeam system in choppy seas. The colour legend bar is the disparity between high and low soundings in the same bin, with blue being near zero and the difference increasing to yellow at 0.46 m (1.5 feet) as the colours proceed down the column. The vertical thin strips represent "swath" groups from the multibeam fan. Where the vertical strips are blue, there is good agreement within the "bins"; however, where there are typical non-blue streaks, the agreement is poor and show over 0.46 m (1.5 ft) difference in places.

Figures 5 and 6 show how steep, head-on seas produce an irregular bottom that resembles the sea surface (less some buffering from the HPR sensor). The typical false wave height in the bottom in these figures is about 0.24 m (0.8 ft) in the areas indicated by the arrows.

When steep waves or wake hit the bow or stern of a survey vessel at an angle and throw it off course, triangular patterns of irregular soundings occur. As shown using the arrows in the 3-D image, Figure 7 demonstrates in a survey area footprint how "quartering" waves and wakes produce the typical triangular "hatched" areas, which indicate that the survey vessel was subjected to rapid course change from the waves hitting it at an angle.

Identifying scatter

Scatter refers to a general disagreement of data points within a cell. Figure 8 shows an example of scatter and demonstrates that in a 0.91 m x 0.91 m (3 ft x 3 ft) area data points are scattered over a depth of 0.73 m (2.4 ft). This is typical of problems caused by the "gain" and "power" settings of the system, and can be the result of floating or bottom debris.

While one could argue that the spread of points within the cell merely represents a rough bottom condition, as shown in Figure 9, extreme bottom roughness only appears when multiple survey passes are overlaid. Here red, yellow, blue, green and white represent multiple passes by a survey vessel over the same location. Note that the average extremes of data within one pass are from 0.061 to 0.122 m (0.2 to 0.4 ft). However, when overlaying the data from multiple passes over the same location, the data disparity expands to 0.3 to 0.46 m (1.0 to 1.5 ft) –

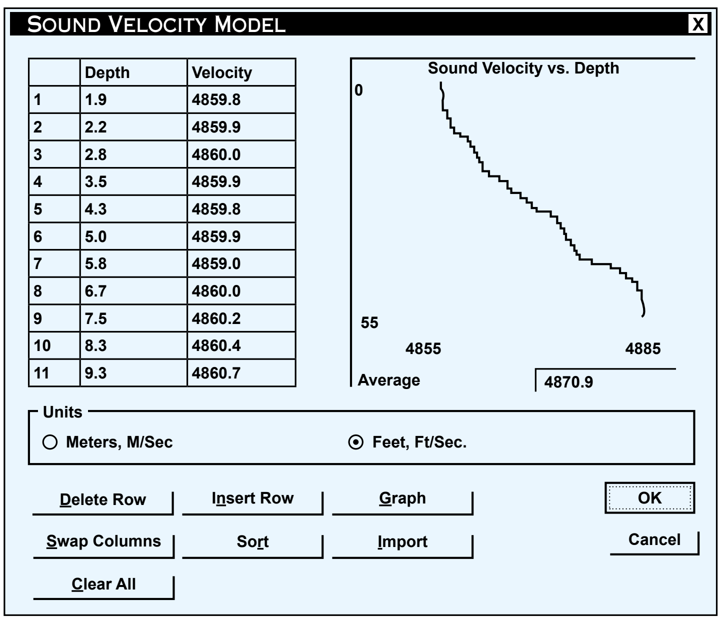


Figure 3. Screen shot of a sound velocity profile showing the variations in sound on the water surface and at the bottom.

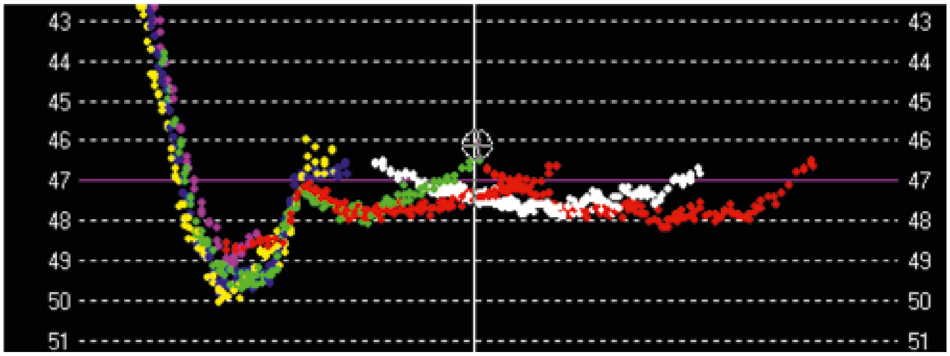


Figure 4. Multiple sound velocity traces.

reaching 0.61 m (2 ft) in places. Figure 10 is a visual overview of what happens to the quality of data in the finished work product based on conditions such as the ones shown in Figure 9. Note how the smooth surface becomes rippled (representing erroneous data) as successive survey passes are overlaid on the original data display (lines and notations added). To further expound on this point, by way of comparison, in the isometric view in Figure 11, unfiltered "sounds" show up as rake-like ridges (or as rough panicles in the extreme case).

Compare the survey results in Figure 11 with the survey results in Figure 12, which came from a different, but similar, project. A dramatic difference in the two work products is clearly visible. This also speaks to the attained level of operator skill that must be required in "fine tuning" the multibeam settings to produce a dramatically better and more consistent, as well as precise, finished work product.

Proactive remedies

These illustrations are not meant to be exhaustive, but rather to show some of the problems evidenced by reviewing survey data instead of merely accepting survey results. They are intended to give some impression of the type of information with respect to survey quality that can be gleaned merely by examining the raw data as it comes in.

While the actual survey methodology used will differ across projects, contractors can still use these guidelines as a starting point towards better educating themselves about the indicia of reliability that should be present in the data.

Additional proactive steps that contractors can take to prevent unnecessary disputes include establishing, in conjunction with the project owner, a clear protocol by which contractors may review an owner's survey results once they are available and verify that said results are acceptable prior to engaging in costly shoaling.

Are Internal Controls in Place for Communication between Engineering, Survey and Construction Personnel?

Ask:

- Does the contract require internal reporting between engineering, survey and construction so that all project participants are communicating effectively?
- Is the contractor aware of what questions to ask in order to illicit helpful answers from the owner?

Beyond recognising the need for frequent and clear communication, discussed above, owners, contractors and other project participants should ensure that actual policies and programmes are in place to facilitate such communication. By ensuring that formal avenues exist by which project participants can either prevent misunderstandings from occurring or address misunderstandings once they occur, owners and contractors will place themselves in the best position possible to avoid costly delays and litigation.

The project discussed in the first section of this article provides a helpful illustration of the ways in which a lack of internal controls can exacerbate miscommunications between project owners and contractors. As set forth above, the issue between the owner and contractor centered on the acceptability of the method used by the contractor to perform its pre-final acceptance surveys:

- The contractor used the average sounding method, believing that to be the best way to determine actual bottom surface conditions owing to inherent inaccuracies

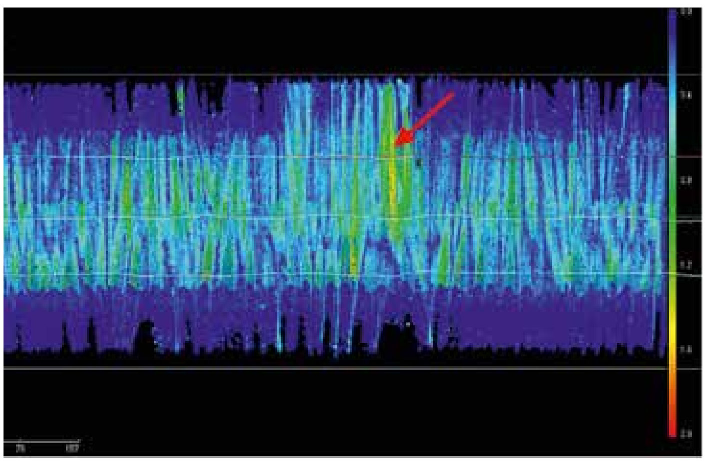


Figure 5. Multibeam survey in choppy seas.

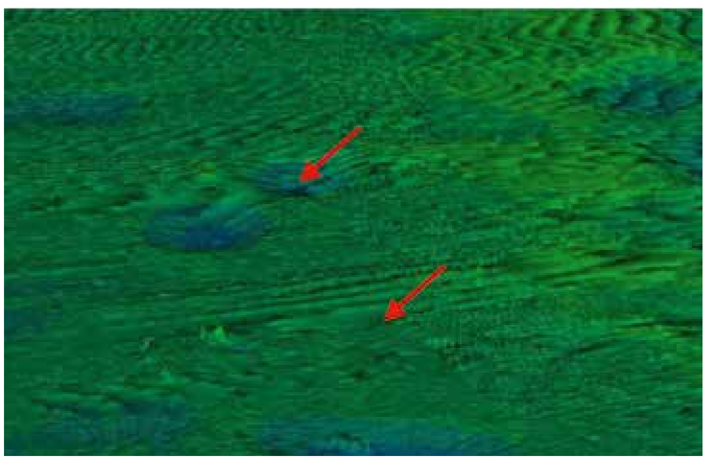


Figure 6. Effect of head seas on bottom irregularity.

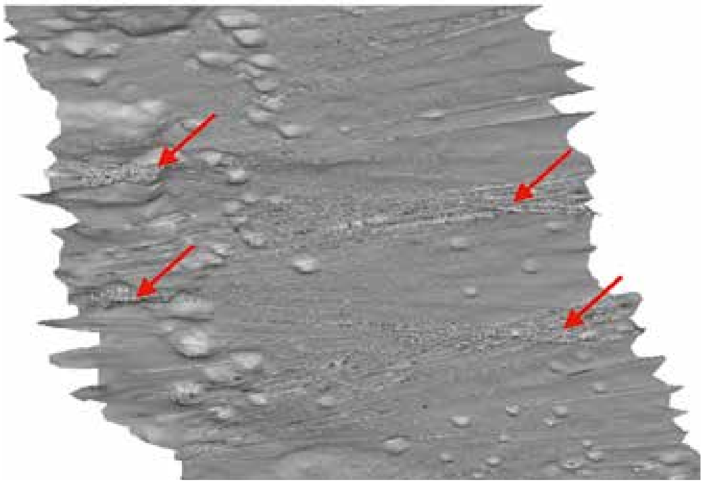


Figure 7. Survey area footprint showing effect of quartering waves.

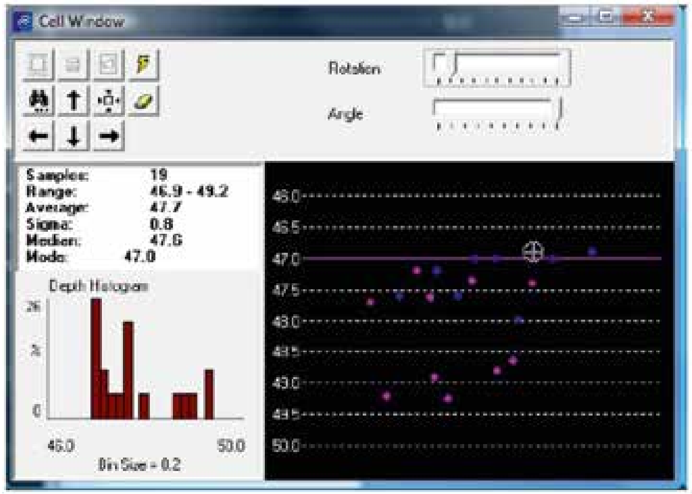


Figure 8. Example of scatter.

present in the equipment that devalued the reliability of the "highest" and "lowest" promulgated points.

- The contractor notified the owner of the survey method it planned to use and identified the use of the average sounding method on several of its submissions to the owner.
- In addition, over a two-month period, the contractor sent multiple letters to the owner identifying its method of data processing and seeking guidance or direction when its surveys were repeatedly not being accepted. Likely because such communication was being directed to the owner's construction personnel, the owner's survey department neither commented on, objected to nor corrected the contractor's activities; nor did the owner voice any type of concern with regard to the use of the contractor's chosen survey method.

How could the use of internal controls have prevented these problems from occurring? One way that the owner and contractor could have pre-empted the communication issues that led to such a massive misunderstanding is by setting up a protocol under which parties would be contractually required to respond to RFIs in a timelier manner.

Contracts should be written to ensure that policies, procedures, timing, and acceptance protocols are clearly spelled out and strictly enforced. For example, the parties could have included a stipulation in the contract that, prior to submitting its first pre-final acceptance survey, the contractor would be required to obtain the owner's written approval for the method to be used and to confirm that it would use the same method so as to promote consistency in after-dredge surveys.

By writing into the contract policies designed to foster communication between owners and contractors, project participants protect themselves against the danger of miscommunication down the line when the project reaches a more critical juncture. While disagreements with respect to chosen project methodologies may still exist, disputes will be minimised by the requirement that contractors and owners timely and accurately, based on good information, communicate their views to identify and address major points of contention contemporaneously with the work being performed. Owners and contractors must also ensure that

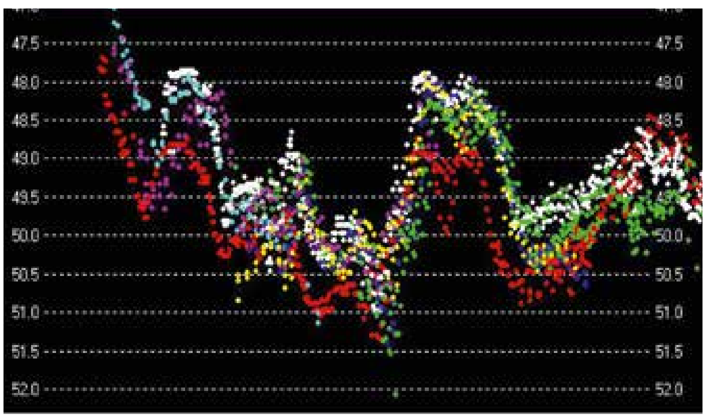


Figure 9. Example of multiple passes of a survey vessel.

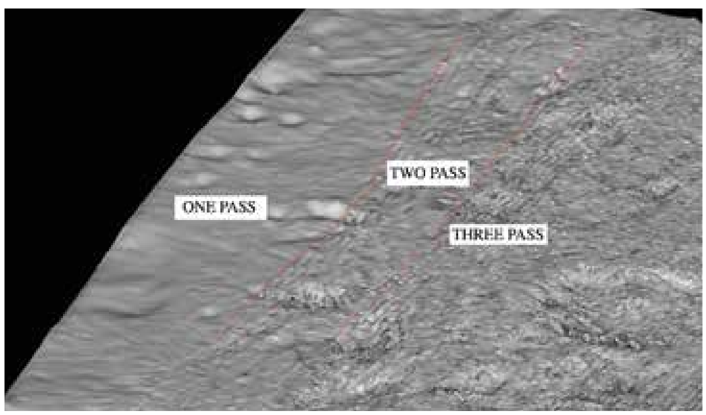


Figure 10. A visual overview of the quality of the data.

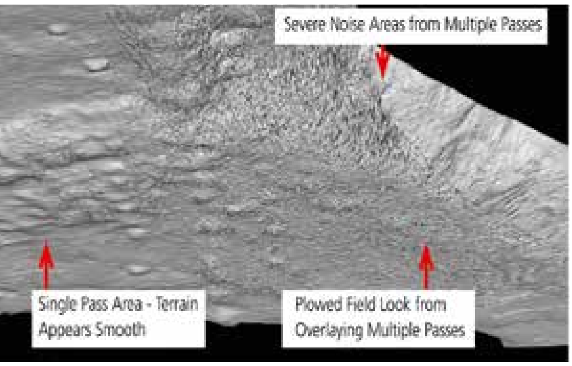


Figure 11. Isometric view of survey results.

controls exist to facilitate communication between engineers and other project participants. For example, the above-referenced project would have benefited from a policy requiring construction field personnel to connect the owner's surveyors, and possibly with the initial project designers, and with the contractor when design and survey methodology was questioned.

If such a protocol had existed, an informed dialogue could have occurred. As evidenced, project participants should place clear communication at the forefront of their project goals, and should fashion their contracts to reflect this priority.

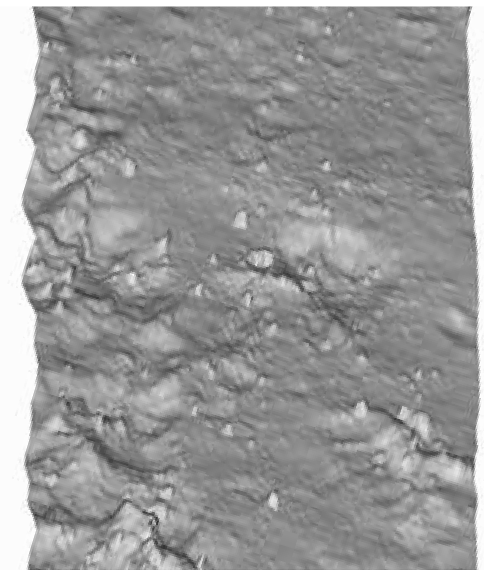


Figure 12. Survey results for rocky bottom: This is a sample of data from a project with a rocky bottom. Note that multiple passes do not create the "sounds" or "plowed field" look shown in Figure 11.

CONCLUSIONS

The minimisation of disputes between contractors and owners will serve to benefit all parties, as unnecessary delay and increased costs effect everyone. In summary, the tips and techniques that all dredging contractors and project owners should observe are:

First, early proactive Request for Information (RFIs) by contractors on specification and contract ambiguities, coupled with proactive responses by owners, will result in a smoother project. These should be treated as indicators of project success, rather than nuisances. Ambiguities or conflicting issues should be aired in this way during the pre-bid process, as it is far better and less costly to deal with such issues before bid time than after – even if it causes delays and even if additional design budget must be allocated to do so.

Second, if long periods of time have elapsed between initial design and advancing for bids, the project requirements should be subject to careful review to be sure that they are up to date. The challenges of deeper and wider channels, increased cost of in-situ (or contaminated) material removal, coupled with increased environmental awareness, should never be underestimated. Projects often require the use of cutting edge technology, potentially well beyond the expertise of the designer, to create a successful project. This may require bringing in outside contractors or equipment manufacturers who are familiar with the latest technology. Such expense should be viewed as a "value added" and not an unnecessary expenditure. Contractors should be mindful of obsolete procedures and specifications, while owners should not try to handle new issues brought on by new challenges with outdated technology.

Third, all parties should be trained to recognise when a difficult demand has been placed on the initial design from the regulatory review process. Parties should be proactive in advancing approaches to recognise issues and seek advice on their resolution from industry experts. The entire protocol chain of design should be looked at and, to the extent necessary, outside peer review/value engineering (VE) review on difficult or challenging projects should be instituted. This peer/VE review may need to occur at various milestones, especially when – as discussed above – long periods of time have elapsed between initial design and advancing for bids.

Fourth, contractors would be well served to educate themselves on the different manuals and/or published guidelines that may exist in relation to a particular project, and to familiarise themselves with the standards contained therein. By ensuring that they have a complete understanding, not only of what is expected and/or recommended in terms of survey protocol and methodology, but also whether and how the owner actually plans to implement these protocols, contractors will be in a better position to consent to specific courses of action prior to commencing work on a project. The reverse is also true: Owners should be sure to understand the technology to be used by contractors in performing measurements of their own work and should be clear with contractors about what methods they, in turn, will be using.

Fifth, contractors should request raw survey data instead of merely accepting survey results. All parties should be well trained in reviewing raw survey data to identify indicia of error during survey and not after claims or litigation have arisen.

Finally, communication, communication, communication: Contractors must notify owners when issues arise, even if such issues seem insurmountable. It is better that all parties know when problems arise so that key participants can work on resolving them. If necessary, parties should also consider bringing in outside mediators and experts early on, as fresh eyes can often see things that are not as apparent on the project "battlefield".

The cost of outside help will be far less than ending up in a protracted dispute. Parties are encouraged to work toward resolving issues, rather than stonewalling and placing blame. Even if there are cost ramifications from early dispute resolution, at the end of the day resolving disputes in the field is a great deal less expensive than resolving them in court.