FACTS ABOUT

Site Investigations

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Why do Site Investigations matter?

Dredging is often described as an industry where you are working in the dark, at depths usually only accessible to fish. The dredging crew cannot see what they are doing, and neither can the client or the public. Yet the risks of encountering "unforeseen" material are not only inconvenient, but also time-consuming and invariably costly. Accurate preparation to limit as much as possible the unforeseen is the foundation for a job well done, on time and within budgeted costs.

With today's technologies, this is a feasible goal. As much light as possible should be shed on the "ground" prior to the start of a dredging project. A well-designed site investigation informs both the contractor and the client. It reduces risks and uncertainties and enables all involved in the project to prepare properly. Site investigations are the first step toward a successful project and satisfaction on all sides and that is why they matter.

When is a Site Investigation necessary?

The simple answer is "Always". In some dredging and maritime construction projects information will already be available and the contractor and client can depend on previous investigations. In most cases, however, thorough inspection of the entire area should be a high priority as previous investigations may not be wholly representative of the conditions which may be encountered. One of the most frequent causes of delay and additional unexpected, unbudgeted investigation costs is an inadequate site.

Since the costs of the dredging work are directly related to the risks encountered on site, site investigation is an important tool in risk management. The basic questions a site investigation should answer are:

- What types of material are present?
- Are they dredgeable?
- What type of equipment and plant will be needed?
- What will the wear and tear on plant be?
- Is the available financial budget feasible for the work to be carried out?

Who is responsible for the Site Investigation?

Since the results of a site investigation directly influence the choice of plant, method of operation, and the contractual costs, it might seem that the dredging contractor would bear the responsibility of the site investigation. In reality that is not usually the case. The client is best placed to investigate the potential site given that the client is most familiar with the specific area and has the time to hire an independent site investigator, whilst the contractor has limited time to tender and usually can only summarily inspect the location before pricing the tender. For instance, a port authority seeking to implement expansion plans, will choose an independent investigative contractor to conduct the site investigation. The contractors then submit their tenders based on this third-party information. If this investigation is not actually representative of the ground conditions which are later encountered, then the question of who bears the costs of these unforeseen conditions may arise. According to the FIDIC contract, the risk of adverse ground conditions, that is, the proper cost of removing physical obstructions or conditions that are not reasonably foreseeable by an experienced contractor, lies with the client.

However, both the dredging contractor and the client must realise that in the long term that their best interests are linked and both are best served by a reliable site investigation. Reasonable estimates from the contractor based on the best possible data, plus financial relief for the contractor from the client for unforeseen predicaments will ultimately lead to more harmonious working arrangements and successful execution of the project. An investment in a top-notch site investigator can help mitigate potential conflict and unexpected surprises for both parties and go a long way to reducing the number of unforeseen events during the course of the project. The least expensive solution may look good at the start, but it is not always the least expensive at the end of the day: It does not pay to be "penny wise and pound foolish".

What is required for a thorough Site Investigation?

The dredging and maritime construction industry has invested heavily in developing scientific means for determining the conditions of the sea- and riverbeds. This reflects an industry-wide commitment to innovation and it enables clients to take advantage of these capabilities. Generally speaking three investigative types of ground examination are recommended:

- geological and geotechnical evaluations;
- bathymetric surveys; and
- environmental assessments.

What are geotechnical and geological evaluations?

Geotechnical and geological investigations help determine the type, quantities and locations of material to be dredged. Since the volumes to be dredged are used to calculate the costs of the project, the highest accuracy is of benefit to all parties. Geotechnical and geological investigations are also essential in analysing the physical and mechanical properties to determine if the subseabed consists of cohesive and non-cohesive soils or rock, including grain size (gravel, sand, silt or clay). Important geotechnical data include: particle size distribution, strength, plasticity, in-situ density, mineralogy, particle specific gravity, permeability, calcium carbonate content and organic content.

This information determines what type of plant is needed for construction. It may also determine the suitability for reuse of the materials, as well as whether materials with contamination will require special treatment or disposal arrangements.

Are there other sources of geological information besides field investigations?

Some information can be gathered from existing sources such as previously published geological surveys, computerised databanks, universities and research institutes, and records of previous dredging projects. Even satellite imagery and aerial photography can occasionally provide some pertinent geophysical information during planning stages. These indirect methods should support the field investigations and only be used in conjunction with other more direct investigative means on the potential site itself.

What do bathymetric surveys tell the contractor and the client?

Bathymetric surveys establish the water depths and level of the sea/riverbeds including tidal levels at a number of points. This will result in the creation of "isobath curves" or depth contours, cross sections and/or digitised grids of the investigated site. Echo sounders are the most commonly used method for assessing water depths, and today's state-of-the-art ultrasonic echo sounders can be used in waters up to 5000 metres deep. They usually work at sound frequencies from 33 to 210 kHz which can reflect low-density fluid muds as well as the more solid layers below them. Calm seas improve the reliability of sounding data, but some movement of the survey vessel is unavoidable. This is a difficult and time-consuming process and the skill needed to achieve reliable results should not be underestimated, nor should the value of accurate data. Automated computerised systems have greatly expedited the collection of sounding data but not eliminated the need for double-checking by manual measurements.

Bathymetric surveys will also identify any operational or access restraints. However, more detailed surveys, for instance, by side-scan or magnetometer, are needed to identify obstructions such as underwater pipelines or debris.

Difficult weather conditions, such as snow and ice, can have significant consequences for choosing work methods and equipment, time estimates and safety measures.

Why are environmental assessments essential?

Environmental assessments provide meteorological, hydraulic, and sediment transport information. These data include wave action and current velocity, the degree of sedimentation, siltation and erosion, and the effects of wind, waves and weather. In the last few decades, environmental impact assessments (EIAs) have also become an essential part of site investigations. Careful study of the flora and fauna of a region and the

repercussions of disturbing these by maritime construction have become a crucial element in project planning.

What are gravity waves?

Gravity waves are divided into "sea" waves, which are located in a wave-generating area of the sea, and "swell" which occurs when the waves are no longer in the wave-generating area nor influenced by significant winds. Sea waves are steeper than swells and shorter in time length. Collecting wave data is complex and the most often recommended method is using devices that measure pressure, acoustics and acceleration, although estimations from ships as well as radar and satellites are sometimes used.

Do water levels and current velocities vary according to the type of water body?

There are differences between water level fluctuations at sea, on tidal and non-tidal rivers, and in lakes and canals. Tide-generated astronomical forces that cause changes at sea are well documented and routinely predicted. Current velocity in coastal waters is influenced by the tide, wind and waves. In rivers, as well, predictions of water level are more readily available because rainfall estimates are known for longer periods and current velocity results from discharge and tidal forces. Lakes and canals require more analysis and may need closer scrutiny regarding water level, but usually they have rather low current velocities.

How are current velocities measured?

Current velocities are measured by mechanical meters with horizontal axis rotor and vane; elecronmagnetic flow meters; acoustic Doppler current profilers and float-tracking or moving-boat methods. Generally speaking a reasonable overview of maximum and minimum current velocities will suffice for dredging operations.

Should weather be part of a Site Investigation?

Temperatures, especially extreme heat or freezing conditions, precipitation be it rainfall or snow, and high winds and waves can influence the choice of equipment, the work method, cost and time estimates for delays, and the implementation of necessary safety measures. Severe storms such as hurricanes and tsunamis or at the other extreme, snowstorms and the formation of ice, may hinder operations. Another hindrance can be reduced visibility caused by fog. Difficult weather conditions may mean that seasonal restrictions for operations are necessary and should be incorporated into contractual agreements. This may protect the contractor from being asked to solely bear the risks of climatic conditions. Therefore, the climatic data provided must be a reasonable representation of what may be expected.

What methods are used for Site Investigations?

Investigations may involve direct, physical searches – samplings – or more indirect such as geophysical means and remote sensing. Amongst direct methods are: cable-toll percussion, wash boring, rotary core drilling, vibrocoring, probing and test pits. Indirect methods include geophysical investigations and seismic reflection, refraction surveys and restivity surveys as well as remote sensing which are used more infrequently. They should not be used on their own because the data they provide is too generalised.

Direct methods yield more accurate samples that can then be laboratory tested and are thus far more useful. Keep in mind that the quality of the laboratory is extremely important for accurate and reliable test results. Ideally, laboratory testing and analyses of soil and rock samples should occur simultaneously with in-situ field investigations so that a continuous flow of information is available. In some cases, for a particularly complex situation, a trial dredging area may be advisable.

How many samples should be collected?

Enough samples should be collected to ensure that the site to be dredged is adequately covered and that it accurately reflects the composition of the ground. Although because of the variety of factors, there is no standard plan, the collection of field samples should be carefully planned including mapping, statistical designs, types of gear and techniques to be used, and the estimated scheduling and costs. The more samples taken, the higher the costs will be, but, on the other hand, the client should feel confident with the degree of information acquired. There are objective systems for determining how many samples should be enough.

Are there other aspects to a Site Investigation?

Broader "above water" types of investigation should also be mentioned. Knowledge of the frequency of marine traffic, obstructions such as debris, the location of outfalls, navigational markers or buoys, regulations specific to the particular harbour, as well as applicable national,

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international and local laws, and support and safety facilities such as air-sea rescue services, tugs, safe havens, and fuel and electricity supplies are also part of "investigating" the site.

Other pre-dredging investigations could be evaluation of noise and air quality, the presence of cultural or archaeological objects of value, and the impact of dredging on area activities, for instance, recreation. The more knowledge the contractor, client and for that matter the public, has the better chances of a cost-effective operation in which risks are minimised and the likelihood for satisfaction are enhanced.

How does a client find a reliable investigative contractor?

Experience and qualifications count. The investigative contractors should be properly qualified by the appropriate governmental authorities and be working in accordance with national standards and/or codes, as well as knowledge of the requirements of dredging and maritime construction contractors. The data assembled by the investigative team of engineers and geologists must be clear and fulfill the needs of these potential dredging tenderers. To achieve this, communication channels between the designers of the project and the investigators must be established early on and maintained throughout the investigation, allowing for adjustments as data becomes available. Reliable data is the basis for a smooth operation.

What are the risks if a Site Investigation is not thorough?

The costs of sub-sea site investigations are not insignificant and so the temptation to take short cuts or limit the investigations can be great, but in the long term this is unwise. Soil investigations on land are more accessible and readily implemented and thus less costly, which makes underwater investigations appear expensive by comparison. Unjustly so. Underwater investigations are more complicated and time-consuming. What may seem expensive or even extravagant upfront may reduce risks and prevent far greater additional costs as the job proceeds. Ultimately you get what you pay for. Unfortunately, too often insufficient time is allocated to perform an adequate site investigation and "short cuts" are taken. A better solution is to request an extension of the tender date.

What are the advantages of a reliable Site Investigation?

At a project site that is thoroughly and reliably investigated, the "dredgeability" of the site will be clear. The type of material – rock, sand, clay or stone – will be known, whether it is homogenous or not, the hardness, thickness, depth and number of layers. This will help determine the proper excavation methods, as well as the methods for transporting the excavated material, through pipelines or by hoppers or barges. It will also help determine the final use, re-use or disposal possibilities of the dredged material. The element of unpleasant surprise will be reduced, and so will the risk factors. And reduced risk factors result in more accurate cost estimates, which in turn result in less disappointment and more satisfaction, a "win-win" result for both client and contractor.

For further reading and information

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