

ENGINEERING CONSIDERATIONS

DESIGN AND CONSTRUCTION

SAN JUAN HARBOR NAVIGATION PROJECT

ARMY CORPS OF ENGINEERS | JACKSONVILLE DISTRICT



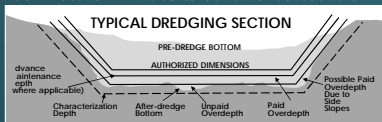
DREDGING

Dredging equipment used to deepen or widen a channel is determined by many considerations, such as site characteristics including the type and location of sediments along a channel bottom. Dredging is simply the removal and disposal of materials necessary to provide the authorized depths and widths within a project footprint. Geotechnical surveys, additional field measurements such as bathymetric surveys, and modeling are critical components of the project design and analysis.

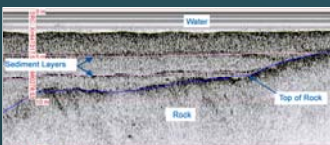
GEOTECHNICAL CONSIDERATIONS & DATA GATHERING

- 1) **HYDROGRAPHIC SURVEYS** provide information about the characteristics of the channel bottom and offer insight into how much material will need to be removed based on existing conditions.

BATHYMETRIC AND VOLUMETRIC SURVEYS define the location of the channel bottom and the volume of material to be removed to meet project depths.



- 2) **SUB BOTTOM PROFILING** uses powerful low frequency echo-sounders to map the subsurface layers of the ocean floor, river beds, or channel. The diagrams below illustrate sub-bottom data collection, as well as an example of a sub-bottom profile, identifying the top of rock.



- 3) **CORE BORINGS** provide information about the character of sediments and rocks underneath the ocean floor, river bed, or channel. Only limited information is currently available for San Juan Harbor and shows predominately soft sediments such as clay in the interior of the harbor and rock in the Bar Channel. Testing of two rock samples showed rock strength of 1,580 and 24,000 psi in the Bar Channel (see table below). Rock strength greater than 5,000 psi may require pretreatment and blasting, as was performed for the previous deepening event.

Location	Boring	Sample Elevation (feet MLW)	Unconfined Compressive Strength (psi)	Tensile Strength (psi)	Unit Weight (lb/cu ³)
Bar Channel	CB-SJHBC-8	-39	24,000	500	167
	CB-SJHBC-8	-50	1,580	125	119

- 4) **SHIP SIMULATORS** are used to:

- Evaluate proposed modifications for improvements to navigation such as deepening and widening
- Portray currents, wind and wave conditions, shallow water effects, bank forces, ship handling, ship-to-ship interaction and use of tug assistance
- Optimize the channel design for purposes of providing the safest and most efficient channel to construct and maintain

Bridge controls and display mirror actual ship controls and the visual scene of the harbor being tested. Models are first tested, adjusted, and validated with the assistance of local licensed pilots. The output is in the form of Track Plots that reflect the outline of the ship and its location during inbound and outbound transit of the channel under various combinations of environmental conditions for the existing and proposed channel plans.

DREDGING METHODOLOGIES

Various dredging methodologies can be employed to remove material based on its particular characteristics. Ultimately, the contractor will determine the combination of plant and equipment that will be used to accomplish the construction in the most efficient manner, and in accordance with environmental guidance.

HYDRAULIC DREDGING



CUTTER-HEAD SUCTION DREDGE



HOPPER DREDGE

MECHANICAL DREDGING



CLAMSHELL DREDGE

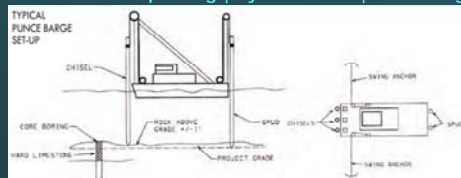


BACKHOE MARINE EXCAVATOR

PRETREATMENT OF ROCK

Rock pretreatment is necessary in order to remove rock with unconfined compressive strength greater than 5000 psi. Methodologies include:

MECHANICAL: Spudding | Hydrohammer | Punch Barging | Rigging | Dredging



- Typically used in isolated locations of limited rock extent
- Generally creates more sound and for a longer duration than confined blasting

CONFINED BLASTING

The borehole (the hole in which the explosive material is placed) is capped with inert material, such as crushed rock (stemming). Studies have shown that stemmed blasts have a greater than 90% decrease in the strength of the pressure wave released compared to unconfined blasts of the same charge weight.



SAFETY MEASURES: A confined blasting plan includes a complex array of safety measures including operations limited to a time of year when protected species are least likely to be in the project area; aerial and vessel-based observers to monitor marine species; fish scares; as well as regulated safety radii (pictured to the right) to protect marine species during blasting activity.



POTENTIAL DISPOSAL OPTIONS

- Offshore Disposal
- Beneficial Use of Dredged Material



EXISTING PROJECT (Authorized Project Depths/Widths)

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