

## Water Injection Dredging



### Introducing Water Injection Dredging

Undertaking dredging work can be complex and costly to both plan and execute. Dredging requires in-depth knowledge of the material to be dredged and the environmental circumstances of the site. In the appropriate situation, Water Injection Dredging provides a hydrodynamic dredging technique that is both cost-effective and environmentally sound.

Water Injection Dredging was developed by engineer R.N. Van Weezenbeek nearly 30 years ago and now offers a popular method for maintenance dredging. Siltation is an on-going problem for harbours and access channels, which require regular maintenance dredging to ensure safe navigation depths. Consequently, dredging works can quickly account for a large proportion of port authorities' budgets and the pressure to reduce these ongoing costs is increasing. Water Injection Dredging can be an effective, economical and environmentally sound solution.

### The theory

Water injection dredging is one of a number of hydrodynamic dredging techniques, where the basic principle is to remobilise the sediments, using the action of natural currents. Water Injection Dredging allows sediments to flow horizontally out of a port taking advantage of natural processes and forces, while the fluidised sediment layer remains close to the water bed. A low pressure water jet is directed into the sediment layer to create a gravity-driven density current. The sediments are then picked up by this current and taken to a 'lower' point situated downstream of the current. A density current is best described as 'a fluidised soil layer, on the move'. What makes Water Injection Dredging so effective, is that the horizontal transport takes place in the water column, by the combined forces of a pressure difference in the water and gravitational forces. This in turn removes the need for the costly traditional dredging methods of excavating and then transporting dredged material.

### The process

A Water Injection Dredger is used to inject large volumes of water at low pressure into the sediment, using pumps with a series of nozzles on a horizontal jetbar. This process fluidises the sediment, which then remains close to the river or channel bed, flowing down to deeper areas. Staying close to the bed creates a density current that then, either by the force of gravity or through a natural or artificially created slope, flows downwards to deeper water. Therefore, instead of mechanical transportation, nature takes care of the sediment transport, making Water Injection Dredging a cost-efficient dredging technique with less impact on the environment.

Water Injection Dredging is often combined with other dredging technologies which can then often operate with increased efficiency. The process can therefore provide either a stand-alone dredging solution or complement traditional dredging methods.

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### Environmental considerations

For Water Injection Dredging to be effective it is essential that the environmental and ground conditions on-site are clearly understood. The process allows for nature to take care of the horizontal transport of the sediment by the dredger creating a density current. For this to occur, soil conditions for both the fluidisation of the soil and the horizontal transport by nature must be favourable. Therefore, the undrained shear strength of the build up must not be too high or the jetting water will not be able to disintegrate the sediment into individual particles. The soil will not fluidise and flow, but lumps of clay will form and quickly settle on the bed. In addition, if the average grain size in a granular soil is too high, sediment may settle too quickly and the flow will only continue over short distances. Coarser-grained materials such as sands, have a higher settling rate than finer-grained material such as silt and clays. Due to these factors, Water Injection Dredging performance in fine-grained sediments is reduced as cohesion and consolidation increase and the process is also not effective for highly plastic clays or rock. Water Injection Dredging can only be used where in-water dredged material placement is permitted. The process is not suitable if the generated density current will create negative environmental impacts, for example, if this causes resuspension of contaminants or an unacceptable level of suspended solids.

Site-specific bathymetry and geometry also plays an important part in the effectiveness of Water Injection Dredging. Factors including the water depth, the dredge template and the bathymetric features and site geometry of the sediment deposition areas, as well as characteristics of the transport path of the density current, influence the dredging production rates.

### Environmental impact

The process of Water Injection Dredging transporting dredged material horizontally along the water bed, compared to traditional dredging techniques, results in the following specific circumstances which reduces the impact of the process on the environment:

- An increased quantity of sediment goes into the lower layers of the water column
- The rate of sediment input in the natural system at the dredging area is increased
- The sediment is transported by natural phenomena to the final destination through the density current
- The rate of sedimentation in the deposition areas may vary if the natural conditions vary
- Dredged sediments remain within the ecosystem

Special attention should always be given to areas nearby the dredging location to determine if there are sensitive habitats, such as shellfish beds, spawning habitats, sandy gravelly habitats, clear water estuaries or coral reefs. In addition, in most cases, if the soil is contaminated, Water Injection Dredging is probably not a suitable method.

### Applications

Water Injection Dredging is a popular and effective method for maintenance dredging as it involves variable quantities of material, from thin to thicker layers. With maintenance dredging in navigation channels and harbours, the sediments to be dredged are the most recent layers which have formed. This process is a regular activity, within a dynamic environment, where sedimentation and erosion are on-going occurrences even as dredging is taking place.

As the process does not dig into or excavate sediment as traditional dredgers do, Water Injection Dredgers can operate in places where other types of equipment cannot reach. Therefore, this process works well in locations such as underneath jetties and moored vessels, alongside quay walls, and in locks. The system can also be used for levelling the water bed for pipelines, tunnel sections or for increasing the depth of pipelines and cables.

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