Equipment and Methodology

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Most *LakeLine* readers have seen first-hand the process of sediment filling in a lake or reservoir. The challenge is to keep clear, deep water and to maintain a healthy aquatic environment for nature and humans alike. A variety of dredging equipment and methodologies are available for keeping aquatic areas clean. Both mechanical and hydraulic dredging have advantages and disadvantages. The more lake managers know about all the methods available, the better able they are to decide what method is right for their lake. Lakes and ponds provide aesthetic, recreational, and irrigation benefits to the entire community. When sediment builds up in these lakes, it can cause problems in a variety of ways.

Time to Dredge

The process of sediments filling the lake contributes to eutrophication. It is a natural process that may occur over hundreds or thousands of years. Accelerated eutrophication evolves when ground cover vegetation is disturbed within the lake's or reservoir's drainage basin. This disturbance occurs during construction projects, farming operations, or any incidents when ground cover is disturbed. What might occur naturally over a hundred years or more can occur in a matter of months during a construction project in which no effective erosion control measures are implemented. Too often, silt fences and other erosion control measures are not properly installed or maintained after installation. All of this leads to topsoil runoff into the lake and over time this causes the lake to disappear.

The most effective long-term solution is to remove the sediment and restore the lake to its originally designed depths. At this point, dredging is usually what is required to restore the lake to its previous condition prior to development of the drainage basin.

With dredging, there is not a one-size-fits-all solution. Each project needs to be assessed and engineered for the best method of dredging. Like with any job, a successful project depends on using the right tool for the job. Let's look at the tools of the trade and where each tool may be applicable.

Mechanical Dredging

Mechanical dredging involves machinery equipped with a bucket of some kind that reaches underwater and scoops material from the bottom of the water body. Some of these machines date back to the Renaissance period where Leonardo daVinci designed a machine with buckets on a large wheel to dredge the Roman aqueducts. Mechanical dredging uses one of three methods to remove sediment: clamshell, dragline or excavator. Any of these methods can be used either from the shore or based on a barge on the water. In many cases, the lake is drained prior to undergoing a mechanical dredging project. This method will usually require building a haul road to provide access for heavy trucks to haul the sediment offsite. Mechanical dredging is susceptible to weather issues; even a small rain may affect the schedule for an extended period. In addition, it may take weeks or months for the material to dry enough to excavate and haul it offsite and then refill the lake to original water levels.

Clamshell dredging. Clamshell dredging uses a clamshell bucket attached to a crane. The operator swings the crane into position and lowers the bucket in place with the clamshell open. After reaching the bottom, the clamshell is closed, filling the bucket with sediment. The clamshell bucket is used more often when digging deep areas and is more commonly done from a barge. The operator deposits the wet sediment mix into a dump truck or onto a barge that is then offloaded to another location.

Dragline dredging. The dragline is a machine that looks more like a crane with a perforated bucket. The operator casts the bucket into the water and drags the bucket back. As the bucket is dragged back, it digs in and fills with sediment. After the bucket is full, the operator casts it behind him or into a truck for disposal. Some draglines are so large you could fit an average size house in the bucket. The large machines have been used for years in mining operations. Some of the more common draglines used for lake dredging can generally reach about 50-60 feet from

shore.

Excavator Dredging. Another mechanical dredging method is the backhoe or excavator. These machines have replaced draglines in most lake dredging applications. They are much more versatile and easier to operate than a dragline. The disadvantage of the standard excavator is the reach is limited to around 20-25 feet from the shoreline for most common-sized machines. For this reason, long-reach excavators are often used for lake dredging. These machines can reach up to around 50-60 feet from shore. The disadvantage over a dragline is that the bucket is smaller and thus it takes longer to perform the dredging in most cases.

Hydraulic Dredging

A hydraulic dredge floats on the water and excavates material by pumping it through a temporary pipeline to an offsite location, often several thousand feet away. This dredge acts like a giant floating vacuum cleaner that can remove sediment very precisely. The sediment slurry is then pumped through a pipeline to a disposal area and dewatered. There are three main types of hydraulic dredges suited for lake maintenance.

Auger dredge. This small dredge uses an auger extended into the water to vacuum soft material from the hard bottom. Because this dredge runs on a cable system, it is ideally suited for industrial ponds that have straight-line access to shore anchors. It is economical because it requires a small crew and can pump a high percentage of solids, provided the material is soft.

Swinging ladder cutterhead. This dredge is anchored by three spuds that drop directly into the hard bottom. The hull of the dredge stays in a fixed position while the cutterhead is moved via hydraulics to excavate the sediment. Because the dredge has no swing wires or anchors, it is more maneuverable and therefore a good fit for tight spaces like marinas or small coves.

Conventional cutterhead. This dredge is similar to the swinging ladder dredge, but it has a wider swing. The dredge pivots off spuds. The dredge swings off swing cables that are anchored to the shoreline or large anchors set on the bottom of the lake. This added width to the swing increases production by allowing the dredge to remove more sediment between steps.

Advantages and Limitations of Dredging Methods

Dredging Type	*Advantages*	*Limitations*
Mechanical Dredging	This type of dredging does not require the building of a spoil basin, so it is best suited for areas that have little or no open land nearby. In some cases, the cost to remove material can be lower than hydraulic dredging. Minimal mobilization requirements allow for smaller projects	Mechanical dredging is highly invasive to surrounding environments due to the need for heavy truck traffic and clear access to shoreline. In most cases, you are handling the material at least twice so additional budget dollars are required for hauling and disposal. Generally, mechanical dredging is slower than hydraulic dredging because of the limited capacity of barges and dump trucks. Weather plays an important role in the success of mechanical dredging projects. Because of the constant movement of the bucket, more turbidity is created in the water.
Hydraulic Dredging	Hydraulic dredging is a minimally invasive method that does not require disturbing the shoreline. Material can be placed several thousand feet or even several miles away. Material is handled only once when it is pumped through a pipeline to a settling area. In addition, because no additional handling is required, hydraulic dredging tends to be faster than mechanical. Hydraulic dredges can surgically remove sediment for a much more precise excavation. Since the material is simultaneously excavated and suctioned, there is minimal turbidity.	For very small projects, the cost of removing sediment is more than mechanical. An open area is needed to build a settling basin, stage geotextile tubes or set up mechanical equipment for dewatering of material. Mobilization costs lend hydraulic dredging to projects with a larger scope.

Sediment Storage and Dewatering

Regardless of the dredging method chosen, a project manager will have to decide on the method for dewatering sediment. The dewatered sediments are easier to handle and can be used for a variety of purposes, including fill and soil amendment. The excess water is usually returned to the dredged lake but it must be of sufficient quality to meet state and Federal water quality standards. This dewatering can be accomplished in a variety of ways.

Settling basin. The least expensive is to construct a temporary settling basin. This basin allows the sediments to settle while the clear water flows over a weir to return to the lake or continue downstream. When the dredging is complete and ample time is given for this material to dry, the area can then be leveled and seeded. The material can also be loaded out and beneficially deposited at other various sites to fill in low areas, utilized for topsoil, etc.

Geotextile tubes. Another creative dewatering method is the utilization of geotextile tubes. With this method, the slurry is pumped into large geotubes, which might be 6 to 8 feet tall when filled and may be 100 to 300 feet in length, depending on the area available. The sediments stay in the tubes and the water filters out through the geotextile membrane. Depending on the type of sediment, a chemical polymer may be used to enhance the dewatering of the material.

Geotubes are most suited to projects that have only a limited area available for dewatering and sediment placement. In some cases, for smaller quantities, parking lots are used as geotube lay down areas prior to the material being hauled offsite.

Depending on the area available for the deposit of sediments, and the long-term plans for the area, the tube can be buried in place, cut open and leveled or hauled to another site, or used as a structure. The design as a permanent structure depends on the type of sediment available. One option is for shoreline stabilization and shoreline erosion control. They can also be used to create new islands. The geotubes can form a circle somewhere in the body of the lake. Additional sediment can then be pumped inside this circle and an island can then be created that can be landscaped.

Mechanical dewatering. A third dewatering method is with mechanical dewatering equipment. This option often allows the most rapid dewatering process, but is also the most expensive. Utilizing mechanical dewatering equipment allows the material to be dewatered and hauled off as it is being dredged. Trucking costs and fees for dumping, if applicable, are budget considerations for this method.

Sedimentation issues will not disappear. The option of dredging becomes a necessity as development and erosion issues increase over time. Lake managers armed with the best available information can pursue the dredging option that will have the most long-term benefit with the least short-term inconveniences. A healthy aquatic environment is the ultimate vision for every lake manager.

*(**Dan McDougal**, president of Dredge America, Inc, has more than 25 years experience in the marine construction industry and he is president-elect of Dredging Contractors of America. Dredge America is the leading provider of portable dredging services throughout the United States.)*