

Operations Manual

The Dredger

The Dredge is in the form of a catamaran pontoon, rigidly and permanently connected across the rear by a pontoon section. A Electric prime mover drives a clean water pump. The water pump drives a ladder-mounted jet pump that performs the functions of disintegration, excavation and discharge to a distance. The dredge may be located into the deposit by means of capstans, usually operating between bridle lines. All machinery is safely above water level and all pontoon tanks are individually tested and sealed. The ability to access one is retained so that it may be used for ballast for trimming. The dredge weighs 7.7 tonnes and may be lifted into the water as a single load. Discharge is via floating pipeline comprising sections of HDPE pipe connected by flexible hose joints. Flotation is by any convenient means.



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Description

The dredge Jet Pump is powered by a single electric motor direct-driving a clean water motive pump set.

The motive pump set supplies pressurised water forward to the dredging ladder, down the ladder and into the jet pump situated at the forward end. The jet pump performs the dredging action. A second electric motor direct-driving a clean water disintegration pump. The jet pump incorporates a water jet disintegration array drawing water from the disintegration Pump

The ladder is supported in bearings and raised and lowered by an electric wire rope hoist.

The jet pump is capable of discharging the rated output of 60 tonnes of dry solids/ hour to a limited distance.

The maximum dredging depth as supplied is 6m.

The jet pump can pass material having a dimension up to 35mm. The dredge is maneuvered during dredging by a headline capstan,

Equipment supplied is protected to a high standard against corrosion and many key parts are of stainless steel.

The principal wearing parts are the motive nozzle and mixing chamber, for which spares are supplied. When a spare is fitted, a replacement should be ordered. Do NOT use local manufacture. Apart from being a breach of property rights it is almost impossible that material of equal quality will be obtained.

The dredge is pulled forwards into the deposit by means of the capstans operating along a headline. The capstan drum is mounted on the output shaft of an electric motor gearbox. Each motor is controlled via an inverter to obtain the best operating speed.

The jet pump is lowered as deeply as possible into the deposit, thus taking the largest possible cross-section and probably advancing at the lowest capstan speed. Maximum production rate in free-flowing material will be obtained by operating in hole-digger mode, ie stationary and dredging from maximum depth.

The highest speed is for recovering the dredge to the start position for the next forward cut. The headline usually attaches to bridle lines which may be winched transversely to the new position. Alternatively the attachment of the headline may be slid along the bridle lines.

The floating pipeline comprises sections of 8"/200mm NB HOPE pipe connected by flexible hose joints. Flotation is by any convenient means. The first hose joint will be attached to the rear of the dredge. For maximum manoeuvrability the shortest length of pipe should be attached to this joint. Then follows a second hose joint. The next length will be about twice the length of the first, then a third hose joint. The next length and all further lengths again may be longer than the preceding length.

Plastic pipeline is less strong than steel and is therefore preferred only for floating pipeline in sheltered locations or for land line. Note that the diameters of steel and plastic pipeline coincide neither internally nor externally.

What Will It Do?

The Dredge will disintegrate, mobilise, acquire, elevate and transport sedimentary solids from up to 6m below water surface at a nominal rate of 60 tonnes of solids per hour through 8"/200mm pipeline.

This rate will depend on the nature of the deposit and the length and terminal elevation of the pipeline.

If the material is very fine and easy to acquire and the pipeline short the maximum rate can be up to 80t/h.

The output obtainable at short distance can be sustained to a greater distance by conversion of the dredge to a Hybrid.

Delivered concentration is up to 14% by volume and total discharged flow rate 230m³/h. The assumptions of an induced concentration of 0.30. In practice, the finer material will lie at a lower in-situ concentration and it may not be possible to dredge at an induced concentration of 30%. Only 24% may be possible. Coarser, sandy material could be dredged at a greater concentration, perhaps 39% or 42%. 51% has been measured, but this would require perfect conditions and a specialised suction duct. Finer material than has been considered will pump easily but it may be possible to induce it only at a greatly reduced concentration, perhaps 12%. Then the production rate will be much lower, even though the pipefriction is reduced. Any pump can pump only what can be got into it.

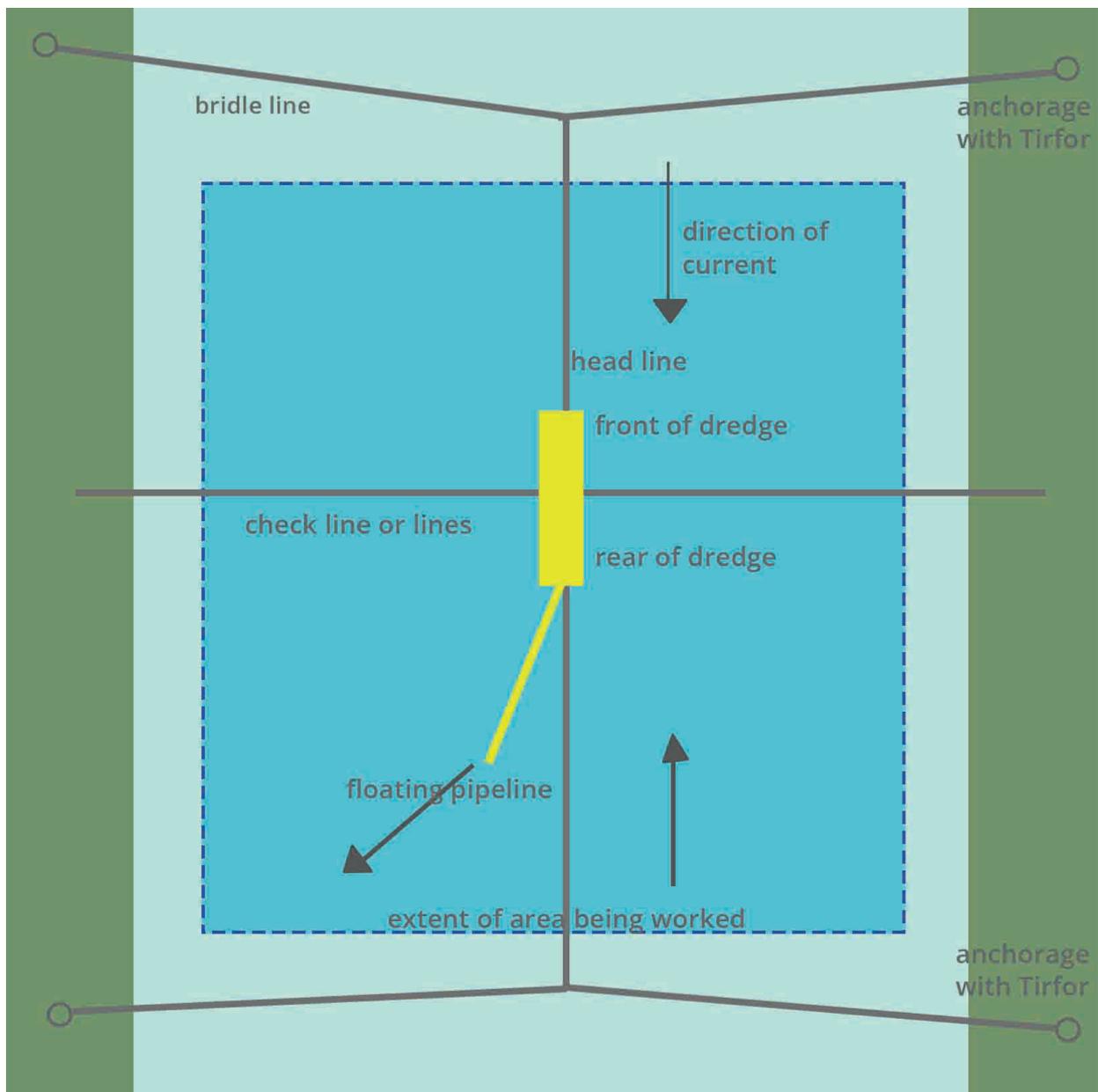
The terminal elevation assumed for this exercise was 1m. Output is sensitive to terminal elevation, far more so than dredging depth.

How to Operate the Dredge

The diagram shows the dredge operating on a headline by means of a capstan.

Normally one winch and rope is used as a check line to hold the dredge on line against wind and current. Alternatively a second capstan and rope may be used for swing operation. Whatever other mode is specified any Jet Pump dredge may be operated as a hole-digger.





Larger dredges may be equipped with load sensing fairleads. A programmable logic controller (plc) can then operate the dredge in a rectangular pattern that is more efficient than the traditional swinging mode. This facility is not fitted to the present dredge.

Operator - Management

The system relieves the operator of the task of dredging as such and allows him to concentrate on management of the operation, attending to the ropes securing the pipeline, and so on. Any attempt by the operator to drive the dredge in the traditional way will result in reduced output because the system automatically optimises itself. Continuous adjustment of the dredging depth will reduce average production. For this reason it is often better to appoint an operator who has no experience of dredging. However, the operator must have the capacity to imagine what is going on beneath him and an experienced dredge operator may have proven ability in this respect. In such a case the difference between a Jet Pump and other systems must be clearly explained.

The operator Will be ensuring that the pipeline will not become taut during the full

extent of the fore and aft travel of the dredge.

The machinery will be monitored by the operator according to good practice. All machinery will be operated in accordance with the manufacturers' data supplied.

Maintenance

All machinery should be maintained in accordance with manufacturers' data. The inspection hatch on the side of the jet pump should be opened once a week. The condition of the motive nozzle and the mixing chamber should be monitored. The maximum bore of the mixing chamber will occur with wear at about 40% of the way in. This bore should not exceed 10% of the nominal bore. For a 75mm mixer the maximum bore should be 82mm. When this is reached the mixer should be changed. The motive nozzle, will also wear. Usually it should be replaced at about the same time as the mixing chamber. If the nozzle is worn it can be exchanged via the inspection hatch. If the threads were not perfectly clean at previous assembly the nozzle could be tight. Use a strap wrench. If it refuses all such attempts at removal then it can be burned out using a torch. This process takes about one hour. When fitting the new nozzle first clean both male and female threads thoroughly, grease and install by hand. No wrench is required.

Water jet disintegration nozzles should be fitted as required to work the deposit. Solids can be pumped only at the rate at which they can be cut. More nozzles mean more cutting.

Blockages

Blockages of a jet pump are relatively uncommon because the inlet velocity is much lower than the velocity into the eye of the impeller of a centrifugal dredge pump or its associated suction pipe. Blockages, when they occur, are external to the inlet grille and can usually be cleared, without raising the ladder, by back-flushing. The motive pump is turned off, whereupon the flow in the pipeline will reverse and a flow will occur out of the suction inlet of the jet pump, usually washing the oversized material off the inlet grille. Nevertheless the ladder hoist is fast to reduce further time lost to the clearance of blockages.

The MuckDuck™ is a production tool and the unit cost of delivered material is inversely proportional to the average production rate. The meaning of the word average is important in the selection of a dredge and is discussed in a later section. The system ensures that blockages DO NOT OCCUR in the pipeline, even if the engine is stopped when the pipe is full. Similarly, air ingestion will not cause the line to settle harmfully. If the pipeline length and the material grading coarsen such that the system stalls, simply lift the dredge head into water. The system will re-start.

When it has settled down, lower the jet pump but not as deeply as before, or reduce the rate of advance.

Nothing is quite impossible and pipeline blockages can occur from the following combination of circumstances. A welding rod that is longer than the pipe diameter catches on the gasket of a pipe joint and swings across so that it lodges against the opposite side of the pipe. Then rags or kelp come down and drape over the wire. At this stage the pressure difference will usually bend the wire out of position and everything clears. However, a high proportion of silt at the same time can concentrate at the incipient blockage and form an arch or dome that is consolidated by the pressure that develops across it.

A high concentration of irregular stones of a size more than about one-fifth of the pipeline diameter can concentrate in a sort of dam. If this dam reaches the top of the pipe a purely mechanical blockage can occur. This does not happen with rounded stones.

Blockage of water inlets must be avoided. The motive pump carries a vacuum gauge tapping and this should be monitored. A rise in vacuum indicates weed on the inlet to the footvalve.

Foreign matter can thread its way through the screen of the foot valves serving the motive/disintegration pumps. It will then prevent closure of the flap and the pump will not prime next time. The interior of the valve can be accessed through the inclined branch. When re-fitting the flange, ensure that the gasket is forming an airtight seal.

Starting

Prime the motive/disintegration pumps through the funnel and valve.

With the ladder in the water start the motive pump. The reason for immersion of the jet pump is that if a lot of air is induced the pipeline will surge. Otherwise there is no detriment. Lower the ladder to the working depth. Start forward movement of the dredge. Check gauges.

Syphon

WHEN PUMPING over a bund it will usually be beneficial and often be feasible to 'syphon.' That is, hang the discharge line over the side to a maximum useful drop of 30 feet (9 metres). Syphoning is more worthwhile for the pure jet pump version than for the Hybrid. Hoses used for this purpose must be suction hoses capable of taking a vacuum of up to one atmosphere without collapsing.

Fault Finding

FAULT: Water Splashing back excessively from the Suction Inlet while operating

CAUSE: Low water pressure (check with pressure gauge)

ACTION: Increase supply pressure, within permissible limits or use syphon

CAUSE: Wrong size of Motive Nozzle

ACTION: Check this item: it might be too small

CAUSE: Excessive length of discharge line

ACTION: Shorten or convert to HYBRID system

CAUSE: Partly blocked mixing chamber

ACTION: Turn off pump and clear blockage

CAUSE: Party blocked Motive Nozzle

ACTION: Turn off pump and clear blockage - ensure no one can turn it on again during this time

FAULT: Low or zero production

CAUSE: Partly blocked Mixing Chamber

ACTION: Turn off pump and clear blockage

CAUSE: Worn or damaged Mixing Chamber

ACTION: Turn off pump and check wear with internal callipers; if excessive(112mm or more at the worst point) replace.

CAUSE: Partially blocked motive suction inlet

ACTION: Close down pump and re-start

CAUSE: Partially blocked pipeline

ACTION: Close down pump and re-start

CAUSE: Excessive length of discharge pipe

ACTION: Shorten or convert to HYBRID system

FAULT: Low motive pressure

CAUSE: Partially blocked suction motive inlet

ACTION: Close pump down and clear

CAUSE: Motive nozzle blown out due to stripped thread

ACTION: Close pump down and clear

CAUSE: Motive nozzle blown out due to stripped thread

ACTION: Close pump down and open inspection hatch - fit new nozzle

CAUSE: Loss of prime

ACTION: Tighten up all suction-side connections; smear grease round sealing edges

FAULT: High motive vacuum pressure

CAUSE: Partially blocked suction inlet

ACTION: Shut down and clear

FAULT: High engine temperature

CAUSE: Partially blocked cooling suction inlet

ACTION: Shut down and clear

CAUSE: Partially clogged heat exchanger

ACTION: Shut down and clear

How not to use the Dredge

DON'T Lose this manual. It must always be available for operators. Ask for or make many additional copies as you need.

NEVER stand anywhere near in line with the discharge. Surging due to air ingestion can spray grit at high speed to a considerable distance.

NEVER put any part of the body inside the pump or close to the suction inlet while the pump is running.

NEVER use hose without first checking the pressure rating relative to the

pressure being used. Hire hose are frequently in imperfect condition. Preferably avoid flat fire-type (layflat) hose.

DON'T attempt to remove, repair or replace any of the pump whilst it is running.

TURN OFF THE PUMP before connecting or disconnecting pipeline.

ALWAYS WEAR EYE PROTECTORS when doing any sort of maintenance.

DON'T drop casting! Hard metals are always brittle.

DON'T put replacement nozzles in place where they will bang about against hard items. Exit edges must be preserved clean and sharp. Also screw threads.

DON'T run the motive pump if it is not primed

DO look after your spares.

DON'T pressure the pipeline if there are any crimps in discharge hoses. MAKE SURE the hose is supported over coamings, sheet piling or the edge of quays.

DON'T use the hose if you can use rigid pipe, you will get more production from rigid pipe, plastic being best, e.g. abs or HDPE, use steel where strength is required.

DON'T use the MuckDuck Dredge before reading the section on Fault-Finiding. Make sure you have pressure and vacuum gauges handy or fitted.

Commissioning

While the following items are being checked the pipeline will be in the final stages of assembly and the mooring points are bridle lines established.

Check all fastening and security of all items. Secure the dredge against movement, Hydraulic reactions can be considerable and any hydraulic equipment can be dangerous unless secured, particularly during start-up.

Ensure that lifebuoys are fitted both sides.

Make sure that a comprehensive first aid kit is on board.

Check that the fire extinguishers are to hands.

There is no need to initially to connect the pipeline.

As the dredge sits on the water, without ballast it will not initially be level. Fore and aft trim does not matter because it will change according to ladder position. Also, additional buoyancy has been provided at the front to provide for some increase in ladder length should be required. However, lateral trim should be correct.

Reference to the next two pages will illustrate the trim and conditions to be aimed at. The tank indicated may be filled with a mixture of fresh water and emulsifying oil to the level necessary to achieve correct trim. Note that the emulsifying oil should be specified as being for the purpose of corrosion inhibition.

Usually 10% of this oil will be sufficient in the mixture, but with some oils 5% may suffice.

Prime the motive pump by the funnel and valve provided.

Start the motor.

Check that the pump is rotating and pressure indicating on the gauges.

Lower the ladder in to the water

Observe water leaving the discharge pipe.

Check the speeds of the capstan, forward and reverse.

When all is in order the pipeline may be connected, the dredge driven to the working area under its own power, towing the pipeline if that is preferred.

Run out the headline, twice round the capstan drum, through the fair lead rings. Note that the rope is at low level for safety reasons, Ensure that the rope passes through all the guides and guide rings. This is important for the safety since it is possible for a damaged rope to break.

Run out the check lines. Use extensions if necessary.

Make a provisional assessment of the depth of cut, dredging depth and speed of advance. Select a (slow) forward speed.

Make a trial dredging run. The pipeline need not be connected for this. At the end of the forward cut, select the fastest reverse speed and return to the start. If all has gone well the dredge is ready to go to work.

Disclaimer

The information presented herein is to the best of our knowledge true and accurate. No warranty or guarantee expressed or implied is made regarding the capacity, performance or suitability of any Product. We reserve the right to modify the dimensions, weights, materials or performance of the Product without notice. You are advised to ensure that information given has not been superseded. All our products or materials are sold subject to our Conditions of Sale available on request. Reference date for this manual is July 15 2008.