

natm

November 1999

**The UK's Leading Specialist
Civil Engineering Journal**

incorporating Tunnelling, Directional Drilling
Sewer Renovation and Geotechnics



B&W TUNNEL FORWARD to beat the 'GREAT WHITE FINGER DEBATE'

Scheme Title: Howdon STW Tunnel Works
Client: Northumbrian Water
Engineer: Entec
Main Contractor: Alfred McAlpine Ltd
Specialist Contractor: B&W Tunnelling Ltd
Form of Contract: ECC Option B
Contract Value: £220,000 (estimated)
Contract Duration: 15 weeks

Introduction

As part of Northumbrian Water’s £300 million “Second Wave” of improvements to the River Tyne and the North East Coast, work has started on a £70 million project at Howdon Sewage Treatment Works, near the mouth of the River Tyne. The project will provide secondary treatment to a population of approximately 1 million people and the first of up to 14 No. contracts was awarded to Alfred McAlpine.

The Alfred McAlpine contract is valued at in the region of £15 million and was awarded under the ECC Option B form of contract and their works briefly comprise the provision of secondary treatment units, aeration tanks which are being constructed as large circular RC structures, final settling tanks, the construction of pipelines including some 1.5 and 1.8m in dia. tunnelling and some complex mechanical and electrical works.

Tunnel Works

The tunnelling works were let as an estimated £200,000 package to specialist contractor B&W Tunnelling and comprised the construction of 2 no. tunnel drives via. pipejack from different locations at either end of a proposed 20m long flume chamber. B & W’s work would enable the transfer of waste water from the secondary treatment process which is under construction by the main contractor through to the existing system and out into the River Tyne.

There is a 300m length of 1.8m in dia. going into the chamber and 100m of 1.5m in dia. tunnel going out of the other end. The flume chamber will be constructed once B&W have wrapped up the tunnelling works.



Photograph Above. Lowering the 2.5m long Hepworth jacking pipes down into the sheet and framed drive pit

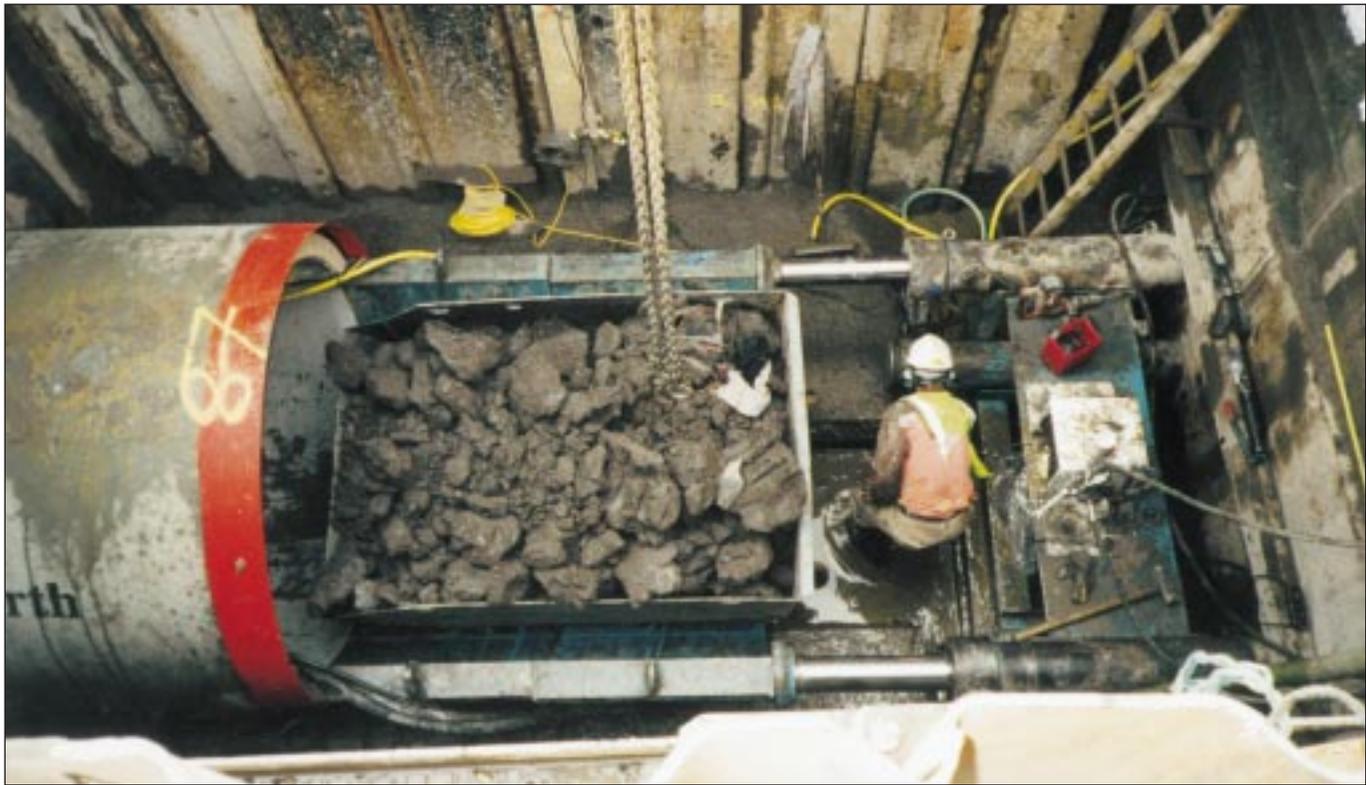
Ground Conditions

The overall geology on site comprises very stiff boulder clay, which is littered with cobbles averaging between 300-350mm dia.

with the occasional large boulder 2 no. of which have been encountered to date. These possess strengths of anything up to 150Mpa and to break them out B&W have had to use ‘plug and feathers’.

Although the works are situated close to the River Tyne they are on an elevated level, therefore there is no evidence of groundwater ingress within the tunnel.

“The ground has been consistent with the borehole report.”



Photograph Above. Mucking out in the pit bottom. Director for B&W Tunnelling Steve Williams explained: "If this type of job was done by hand we would probably have to go 24 hour working producing a maximum drive of 4 no. pipes (2.5m long) in 24 hours. By going mechanical from start to finish we are averaging 5 no. pipes on a 12 hour shift basis."

Mechanised Tunnelling

In the past B&W were renowned for their vast experience on hand excavated pipejacks. Although this is the case, current HAVS guidelines which are being implemented by the HSE has made the specialist re-think their strategy. They have just recently procured 2 no. Custom-built backhoe units from Tunnel Engineering Services UK of Manchester.

This comes soon after their successful flirtation with a mechanised pipejack on a contract in Derby for Severn Trent Water.

Although it appears relatively straightforward or even simplistic, it is a totally mechanised backhoe system. It has a hydraulic excavator mounted within the shield, which feeds directly onto a swan-neck conveyor system, which runs through the centre of the shield. It is driven by an electric power pack, which is sited, at the surface with hydraulic pipes feeding all operations within the shield.

"It is slightly different from the Decon machine. The Decon had the electric motors and pumps and the entire reservoir built into the machine and restricts the operations by providing limited space. We decided to put all of this set up on the surface to give us maximum working space within the shield. This is a big plus on this contract, especially bearing in mind the large boulders we have encountered."

Configuration of the Backhoe

The telescopic arm is mounted from within a roof-mounted bearing, which operates off of a slew-ram within the centre of the shield and provides a 40-inch (1.01m) stroke.

The bucket is attached at the end of the telescopic arm giving a claw-like grab and possesses 5 no. teeth. 2 no. side cutters and 3 no. main cutters in the centre of the bucket.



Photograph Above. The machine driver. Space is not that limited at the front

The whole system is driven by a 100kV generator, which drives the hydraulic power pack. The power pack has a maximum working pressure of 3000psi.

Comparing Mechanised - Hand Mining

Prior to this job we did 70m long by 1.20m dia.-mechanised pipejack for Amey Construction at Medlock in very simi-

lar ground to what we have got here. The machine is ideally suited to stiff clays, weak mudstones, weak sandstones and small sandy ballasts. Split faces would be a big disadvantage, i.e. half a face of clay and half a face of rock,

although it is possible to adapt a small pecker for any excavations of soft rock.

"If this type of job was done by hand we would probably have to go 24 hour working producing a maximum drive of 4 no. pipes (2.5m long) in 24 hours.

"By going mechanical from start to finish we are averaging 5 no. pipes on a 12 hour shift basis, 5 days a week."

Pressures

The drive pit is a 6.3m long x 4.2m wide by 5m deep structure and was constructed using Mabey M12 trench sheets and Hydraulic frames.

"We have always found that Mabey always give us a good service."

The backwall has been designed to take a jacking force of 300t and there is a 200mm thick concrete base with the jacking rails cast in 300mm of concrete.

The set up in the pit bottom comprises 4 no. 200t 1m stroke by 200mm dia. rams.

There are remarkably low pressures on the drive at present, with pushing capabilities of 4000psi pressure, which equates to 260t.

"The jacking system is more than adequate for this set up."

Interjacks

There is one interjack station in after 35 no. pipes and a 2nd interjack after 60 no. pipes. Each interjack station has 12 no. 50t rams installed, which have not been used to date.

“We will probably use one of the interjacks before the end of the drive, although we don’t expect to use any of the other two.

The tunnel will be driven into a 5m x 5m by 4.5m deep sheet and framed reception pit.

Lubrication

Mud mixing, slurry, lubrication etc., is becoming extremely popular with pipejacking contractors. The time and the overall cost it can save a contractor easily outweighs the risk of ‘not lubricating’ the pipes properly, and on this contract, bearing in mind the size of the pipes, the distance involved and the size of the machine up front, good lubrication was essential.

“The lubrication system we used is a mixture of bentonite and clay cap. The bentonite is mixed on the surface and pumped into the system and inserted every 4th pipe within the drive. We are finding that this is working exceptionally well and that the pressures are extremely low.”

B & W are using a Wilden 2” air pump from Pump Supplies for pumping the bentonite lubrication into the line.

Mucking out

At present B&W are in 75% into the 300m long drive.

The backacter fills out into a 3t muck skip via the swan-neck mini conveyor. The conveyor system takes the spoil from the bottom of the shield at approximately 45° and there is a swan-neck on it, which enables the maximum filling of the skip without much spillage. It is then hauled out of the tunnel via an endless rope haulage system, which is operated from within the pit bottom. The pit bottom is in constant contact with the machine driver via a 2-way telecommunication.

“The swan-neck conveyor is something that we and Tunnelling Engineering Services have designed ourselves.”

B & W are handling the 2.5m long Hepworth pipes and removing the spoil from within the tunnel via a 30t track mounted Hitachi F125 which is on hire from AGD Equipment.

Settlement

B&W were driving on a relatively flat gradient with a cover of approximately 11m. At the time of NATM’s site visit there was zero settlement and the

The 1.50m dia. tunnel drive.

“We intend using our new 1.50m dia. backhoe for this drive, which is exactly the same set up as the 1.80m dia. and have got 2 no. ma-



Photograph Above. The telescopic arm of the backacter is mounted from within a roof-mounted bearing, which operates off of a slew-ram within the centre of the shield and provides a 40-inch (1.01m) stroke.

line and level was within 25mm.

As for the tunnel drive: “They don’t come much better. We are very pleased with it and the standard

chines, which can cater for drives of anything between 1.20m to 2.10m in dia.

“With the hand arm vibration (HAVS), I think that it is the only way to go.”

The 1.50m dia. tunnel will be driven on a +1:50 gradient from within a 6.3m long x 4.2m wide by 5m deep sheet and framed thrust pit.

On completion of B&W’s tunnelling works, the drive and reception pit for both drives will get stripped out and then the excavation will be battered back ready for the main contractor to put down their excavation for the flume chamber.

Summary

“We have been on site for 6 weeks and the relationship with the main contractor is fine.”

The future?

“As a company we have been brought using hand work and whilst not writing off hand work altogether we are just looking for contracts with a substantial amount of work for the machines.”



Photograph Above. B & W are handling the 2.5m long Hepworth pipes and removing the spoil from within the tunnel via a 30t track mounted Hitachi F125

workmanship and the performance of the machine has been excellent. The machine has exceeded all our expectations.”