

## Waterview's Tunnel Boring Machine

### Moving the earth

When Alice, Waterview's Tunnel Boring Machine (TBM) has finished her job, she will have extracted enough earth to fill 320 Olympic sized pools, around 800,000 cubic meters.

It will take two years to complete this feat: one year for Alice to bore a 2.4km three-lane tunnel one way and one year to complete the tunnel in the opposite direction. The total distance the machine will have travelled is 4.8 kilometres.

Alice began her underground journey in November 2013 at Owairaka, first heading north to construct the southbound tunnel. She is expected to reach the northern (Waterview) end of this tunnel in September/October 2014. She will then be turned around to bore the northbound tunnel from north to south, reaching Owairaka in late 2015.

### How big is it?

Waterview's TBM has been specifically designed for the Waterview geology by German company Herrenknecht and manufactured in China.

The TBM is the 10th largest machine of its type in the world and the largest ever built for use in the Southern Hemisphere. The cutting head and shield are as high as a four-storey building.

The machine is the length of a rugby field. It comprises a 14.4 diameter rotating cutting head attached to the front of a 12-metre long shield, followed by three back-up cars, or gantries that house all the equipment needed to run it, place the precast concrete rings that will line the tunnels and to remove the material extracted from the ground.

### TBM Facts

- Cutting head diameter                      14.4m
- Total length                                      87m
- Total weight                                      2200 tonnes or 3200 when the gantries are included
- Crew    15
- Top speed                                         80mm a minute or 0.0005km/h
- Expected daily progress                      up to 20m (10 lining rings)
- Cutting head power                            8400 kW
- Cutting head speed                            1.9 rpm maximum (1RPM for normal operations)
- Nominal torque                                 68,220 kN



## How does the TBM work?

Tunnelling occurs when the cutting head rotates as a cutting wheel against the solid earth and rock face, boring out the underground material and drawing it into an excavation chamber behind the wheel. The material is excavated as a “mush”, having been prepared for cutting by a mixture of polymer, water and compressed air via nozzles in the cutting head.

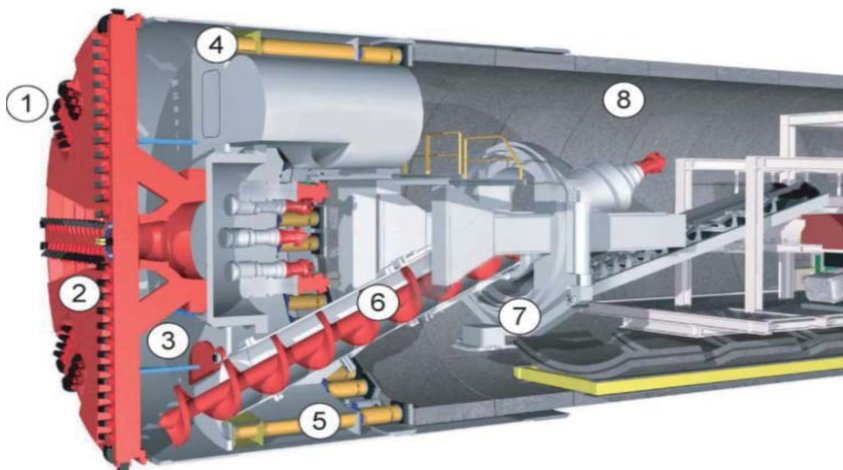
The “mush” is transported from the excavation chamber by a screw conveyor, to conveyor belts and then carried back through the trailing rig on a conveyor belt. At the third gantry it is dropped onto the tunnel conveyor belt and taken out to a spoil handling building. There, it sits for up to 24 hours while most of the water drains from it. It is then trucked to Wiri where it is being used to clean-fill the dis-used Wiri Quarry.

Every time the TBM moves two metres it stops and erects precast concrete liners (known as segments) that become the finished wall of the tunnel. As the TBM advances, grout is pumped into the space between the segments and the excavated “wall” to fill any voids or gaps.

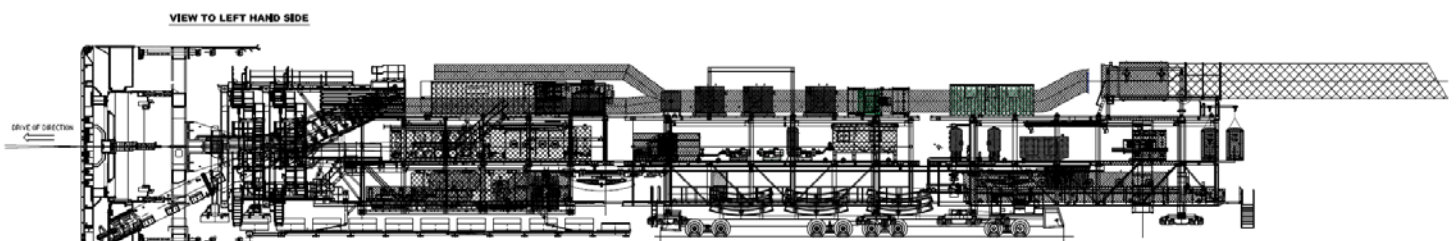
The TBM then pushes off from the finished lining ring to move forward, and the process begins again. All these activities are monitored from the TBM’s control cabin at the rear of the head shield.

## Tunnel lining segments

The tunnel lining comprises 2m wide, 450mm-thick concrete rings, each made up 10 pre-cast segments which together weigh 100 tonne. A precast facility operated in East Tamaki by sub-alliance partner Wilson Tunnelling will manufacture 24,040 segments, which are being delivered to site three at a time.



- [1] Tunnel face
- [2] Cutting wheel
- [3] Excavation chamber
- [4] Pressure bulkhead
- [5] Thrust cylinder
- [6] Screw conveyor
- [7] Erector for lining
- [8] Concrete lining

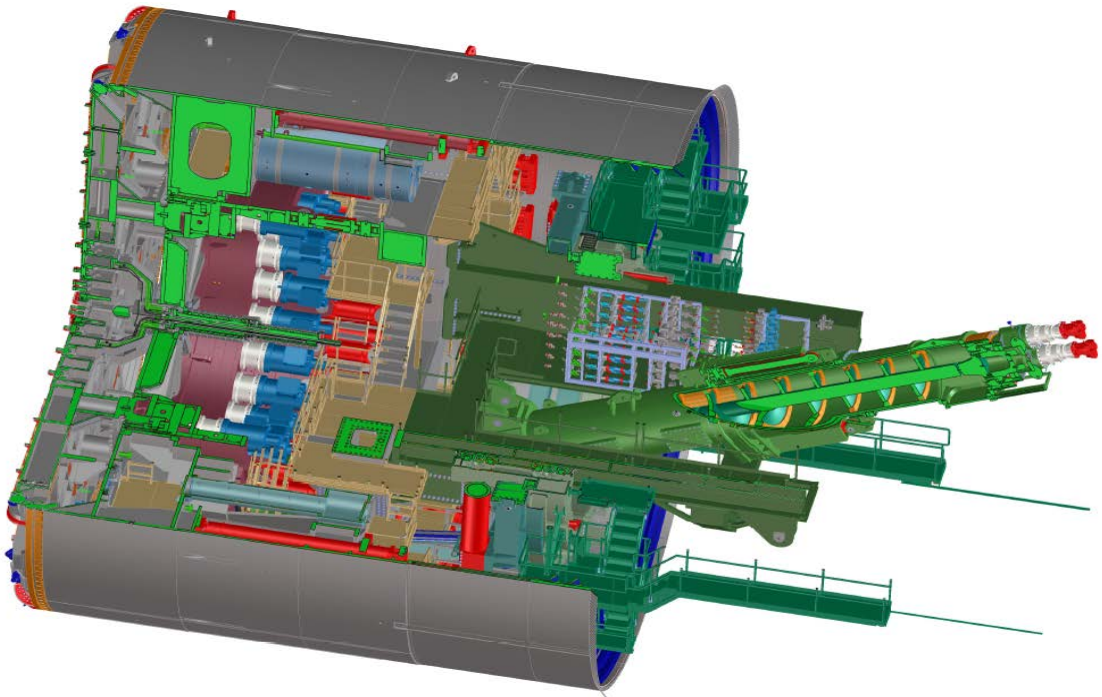


## How will we prevent ground movement?

Waterview's TBM is an earth pressure balancing machine which means the pressure in the cutting head is kept the same as the pressure of the ground it is boring through. Under this system the spoil is liquefied with foam, polymer and water as it enters the cutting chamber. The chamber is then kept full at all times to balance ground pressure while surplus spoil is transported via the screw conveyor to enclosed conveyor belts for removal.

## What geological conditions will the TBM encounter?

The Waterview tunnels will be bored through ground including alluvial deposits, residually weathered soil of the East Coast Bays Formation (ECBF), unweathered ECBF siltstone/sandstone and unweathered volcanoclastic sandstone (Parnell Grit -EUg).



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