Innovation in the mining industry
Derisking access to underground mines using Tunnel Boring Machines

GHD Energy & Resources
Brendan Henry
Manager, Tunnels and Underground Spaces
Safety Commitment

Safety is a strategic driver and core business value at GHD. We believe that the best solution for the management of GHD’s safety – as part of our internationally certified Health, Safety and Environment (HSE) system – is also the best solution for our clients.

Providing workplaces free from harm supported by a culture that promotes the safety of people and the protection of the environment is an absolute priority.

GHD remains committed to measurable and continual improvements to safety.
Addressing risk!

Risk to personnel:
• Placing workers in a dangerous situation during construction and operation

Financial risk (or opportunity):
• Loss of revenue
• Cost of recovery (collapse)
• Improved Net Present Value (time to first ore/coal)
What does the **Civil Tunnelling Industry** bring to the underground mining industry?

- Fast access to the underground workings by tunnel boring machines
- Safe tunnel boring machine construction
- Ability to excavate and support soils and weak strata with groundwater
- Long term ground support (100 year life cycles)
- Ability to produce completed product during linear production
- High speed tunnel fit out

It also brings:

- Competitive tunnel construction
Time for change?

Traditional use of roadheaders and drill and blast for mine access

– Methods offer flexibility
– Fast Lead Times
– Production rates
  • Roadheader – 9 to 25 meters per week
  • Drill and Blast – 21 to 63 meters per week
  • Mining industry recognising the higher rates achieved in civil tunnelling
  • Mine access often lacks the detailed planning and investigation
  • Requires procurement ahead of other mine infrastructure

Quality Issues

– Drift collapse halting production
Any **Ground Condition**

- Mining industry typically employs drill and blast or roadheaders
- Range of ground conditions is limited
- Potentially for gassy grounds restricts drill and blast
- Groundwater causes issues with roadheader and tunnel excavator
- Tunnel excavator and roadheader in weak strata have extremely low advance rates
- Mixed ground tunnel boring machine cover the majority of conditions
Grosvenor Coal Mine

Anglo American Metallurgical Coal

- High quality coking coal
- A$1.95 billion project (growth of Moranbah North)
- Longwall underground mine
- 5 Million Tonne per annum
- 14,000T/day
- Conveyor Drift access (top) 1:6
- Transport (M&M) Drift (below) 1:8
- GHD Detailed design and owners engineer role with construction surveillance.
Permian (Conveyor Drift) Sandstone/siltstone with carbonaceous material/coal
Transport Drift (Critical Section)

- Weathered Permian
- 50 meter hydrostatic head
- Coal Seam with Gas
Grosvenor EPB Tunnel Boring Machine
Grosvenor EPB Tunnel Boring Machine – control of gas

Tunnel Boring Machine GA showing ERZ/NERZ boundary and extended screw conveyor

Muck paste in cutter chamber under pressure

Screw conveyor

Snuffing box

TBM

ERZ1

NERZ
Tunnel lining design and refuge bays
Tunnel Boring Machine assembly - Conveyor drift during Armco
Tunnel Boring Machine main drive extracted, shield left in place
Tunnel Boring Machine after extraction


**Grosvenor Production**

**M&M Drift production time**
- 994 meters in 90 days
- 11 m/day average
- Significant delays in P Seam
- Last 30 days of tunnelling over 13 m/day
- When including 30 days for tunnel boring machine extraction, production rate was 58 m/week
- Even achieved 6.5 meters per day through gas seem

**If roadheader could have been used**
- Approx. 18 to 24 months
- Issues with gas
**Springsure Creek**

**Bandanna Energy**
- Thermal coal - 40 year life of mine
- Longwall underground mine production 4 MTPa
- Peak production up to 11 Million Tonne per annum
- Single drift short term solution for mine development
- M&M drift reaches coal after 2,200 meters (linear drivage at 1:8) and then the tunnel boring machine continues 1,350 meters in coal at 1:13
- Tunnel boring machine extracted
- Conveyor drift which will be developed to 250 meters depth
- 8.7 meters Gripper tunnel boring machine (Herrenknecht preferred supplier)
- Geology - Tertiary basalt 40 meters deep, over 100 meters depth of Triassic age inter-bedded sequence of mudstone, siltstone and sandstone
- The Aries 2 coal seam is 2.5 to 3.5 meters thick and has an average gas content in the range 2 m3/t to 3 m3/t
- GHD – Owners Engineer during ECI process
Mine Plan

Conceptual Mine Plan and TBM Drivage
Recent roadheader declines

Eagle Downs

- Twin declines, 2 km
- 7 m wide, ~ 5 m high
- S300
- Bolting and shotcrete rigs installed on Roadheader
- Progress very slow

Kestrel South

Conveyor Drift

- 1430 metres long at a Gradient of 1:6
- Arch profile 6.5 m wide x 4.75 m high
- Concrete segment floor

Transport Drift

- 1670 metres long at a Gradient of 1:8
- Arch profile 6.0 m wide x 4.5 m high
- Concrete segment floor

- 7 day period Project record - 36.3 m
- 24 hours period project record – 10.4 m
- Weekly meters (stone) – 25 to 32 m
- Weekly meters (coal seams) – 18 to 23 m
**Mine development** from single heading

Springsure Creek
- Applying the Kestrel advance rates
- 3465 m of decline at 30 m per week – 28 months
- Time to first coal – 18 months
- At 20 m per week – decline takes over 41 months

Main Beam tunnel boring machine with bolts and mesh for support
- 135 m per week average
- Time for 3465 m – 6 months
- Tunnel boring machine extraction 2 months
- Time to first coal (at 2200 m continuous miners start) – <4 months
**Airport Link – Brisbane** Road deck installed as tunnel boring machine progresses
M30 Madrid Road deck installed as tunnel boring machine progresses
**Drift Layout** – intermediate road deck installed with TBM advance

**Above Deck:**
- MSV
- TBM Conveyor
- NERZ

**Below Deck:**
- Return airway
- ERZ
- Possible mains conveyor
- Deck installed by TBM
- Deck loading very high in operation (chock and shearer carriers)
- Layout allows development of mine from single heading due to return airway
Bolting requirements

Lower Section of tunnel boring machine 1 Drive in-seam

Weak sandstone above coal

Forward (fixed) bolting rigs important for Strata Control (about 2.2 m from face)

Multiple drill rig assembly behind main drive with ability to bolt and mesh

Pattern bolting, cables in some locations

Example layout of Gripper TBM with forward fixed bolting rig assembly
Legacy Way  Fast tunnel fit out - 124,000T of tunnel spoil used for roadway - placed by reversing the tunnel conveyor.
Other tunnel fit out solutions placed during tunnel boring machine production – CLEM 7
Recent Study - mine development from single heading
**Speed Study** – deep mine with fault zones and squeezing potential. 3000 meter decline access
Extended overcut on tunnel boring machine with squeezing ground. Increased overcut by 150 mm on radius.
GHD innovations - Quiet Truck

The (quiet) truck

Acoustic Attenuation Project
Summary

The civil tunnelling industry can provide innovative tunnel boring machine tunnelling solutions to the underground mining industry:

• High speed mine access and development
• Ability to handle most ground conditions providing increased flexibility to mine planning
• Tunnel can be fit out for use during tunnelling
• Fit out solutions predominantly from road tunnels
• Highly mechanised and safe solutions
Questions