Metro Tunnel Project

Ventilation Design and Dust Collection
Metro Tunnel Project

Full Extract Ventilation System Design and Dust Collection Supply

Project Overview

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<th>Client</th>
<th>Cross Yarra Partnership</th>
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<td>John Holland Pty Ltd</td>
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<td>Lendlease Engineering Pty Ltd</td>
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<td>Bouygues Construction Pty Ltd</td>
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| Location       | Melbourne, Victoria, Australia |
| Application    | Ventilation and Dust Control for Tunnel Construction |

| Supply Summary | Full Extract Ventilation Design, Manufacture & Supply: |
|               | - 9 x JMS-60-MES |
|               | - 1 x JMS-40-MES |
|               | - 2 x JMS-10-MEC-XP |
|               | - 3 x JMS-10-MES (Rental) |
|               | - 3 x JMS-30-MDT (Rental) |

The Metro Tunnel is a key rail infrastructure project currently under construction in Melbourne, Australia that includes the construction of twin 9km rail tunnels between South Kensington station and South Yarra with five new underground stations. While TBMs are being used to build most of the Metro Tunnel, station box excavation and tunnelling between the two CBD stations is being undertaken by roadheaders.

Site geology comprises of interbedded Siltstone and Sandstone known as Melbourne Formation. The mineralogy in its unweathered state typically comprises a mineral assemblage principally of quartz (35% up to 59%).

![Metro Tunnel Route Map](image)
Our Solution

The Cross Yarra Partnership, a consortium comprising of, John Holland Pty Ltd, Lendlease Engineering Pty Ltd and Bouygues Construction Pty Ltd, initially contracted Grydale to provide a ventilation design system for the construction of the Metro Tunnel. Grydale was later contracted to supply all dust collection equipment required for the duration of construction works.

Initial engineering consultation converted the ventilation design from an Overlap or Cross-Over Extraction methodology to the now in-situ, proven Extract methodology. Within full extract ventilation systems, air is drawn through the tunnel using negative pressure from the outside and is exhausted via ducting to a dust collector to deliver clean air to the atmosphere. This system removes all contaminants from the tunnel at the face and supplies fresh clean air for Civil, Mechanical and Engineering Works.

The Metro Tunnel provided some unique challenges for the ventilation design, including space and noise constraints plus the location on excavation works within the CBD.

The design was created using Ventsim Design 5 to simulate ventilation, airflows, pressures, heat, gases, radon, fire and other key ventilation data to be considered, along with managing the financial constraints of the project.

The ventilation design was separated into 13 stages, representing the tunnel area changes, and was designed around the last dig sequence, where maximum air flow is required. The ventilation design utilises dust collectors for each stage, with additional axial fans to boost airflow in the latter stages of construction.

The Melbourne Metro Stations will be built as trinocular caverns, where three overlapping tunnels will be mined by roadheaders to total platform width that will be around 19m – one of the widest metro platforms in the world.

Two temporary acoustic sheds up to 20m high enclose construction sites within the CBD to minimise the impact on residents, businesses and the local community, from the construction of the stations. A system of louvres on the outside of the acoustic sheds help to control clean air flow into the tunnel. The ventilation system was also designed for environmental noise limits while balancing required air flow into the tunnel.

Since construction began, Grydale has designed, manufactured and supplied the following dust collection systems, in line with the ventilation design:

- **CBD North** – 4 x JMS-60-MES (60m³/s, mobile, electric, drag skid units).
- **CBD South** – 5 x JMS-60-MES (60m³/s, mobile, electric, drag skid units). CBD South had further space constraints, so these units were customised to have four roof-mounted fans to provide a reduced footprint so dust collectors can be located within the acoustic shed.
- **Parkville** – 1 x JMS-30-MDT (30m³/s, mobile, diesel, track unit) and 3 x JMS-10-MES (10m³/s, mobile, electric, drag skid unit) were rented to provide short-term dust extraction at source.
- **Tunnel Cross Passages** - 2 x JMS-10-MEC-XP (10m³/s, mobile, electric, castor wheel units). These units were designed for the tight space constraints of tunnel cross passages. The castor wheels allow units to slide onto the platforms in the cross passages for the duration of construction.
- **Rental Units** - 3 x JMS-30-MDT (30m³/s, mobile, diesel, track units) have been utilised for dust extraction within backend works at various project work sites.
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Accoustic sheds house dust collectors above the surface

The JMS-60-MES dust collection units run 415kW fan motors with Variable Speed Drives (VSD) which has allowed up to 40% in power savings. The excavation sequence has been programmed into the dust collectors via the Programmable Logic Computer (PLC) so as excavation advances, power progressively increases.

The ventilation design for the CBD underground stations utilises a mix of negative and positive pressure systems while design for Parkville and Anzac stations and the portals, use positive pressure ventilation. The latter back-end works are supported with mobile source extraction units for shotcrete and other works where dust or fibre controls extract dust at source, in addition to the supplied air ventilation.

In each acoustic shed, twin JMS-60-MES large volume dust collection units move up to 120m³/s (>250,000 CFM) via 350m of underground duct. Each unit features 84 high efficiency filter cartridges that are cleaned by reverse pulse using the onboard air compressor. Product is discharged via a hydraulic reversible auger and collected into bulker bags.

The Result
The use of Grydale ventilation and dust control systems have resulted in a clean and safe working environment during construction works, which has been monitored and approved by regulators to meet unionised working orders.

Grydale has conducted independent air flow performance and filtration testing on all units both above and below ground as part of rigorous performance verification and certification processes. Testing undertaken has been certified by the National Association of Testing Authorities (NATA) and units have shown a collection efficiency of 99.99% at 0.067 micron.

After Market Service and Support
Grydale continues to provide ongoing product technical support and engineering services to meet the changing requirements of the project.
# Other Tunnel Experience

Proven track record within tunnel construction

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| **Metro Tunnel** | Twin 9km, 6.1m Ø railway tunnels in Melbourne, Victoria. Project includes five new underground stations. Tunnel construction using four TBMs plus mined caverns which are the two major stations in the CBD, three station boxes with diaphragm walls and deep bored piles. | - 9 x JMS-60-MES (60m³/s) - housed in acoustic sheds to provide general ventilation during station excavation.  
- 2 x JMS-10-MEC (10m³/s) for cross passages.  
- 1 x JMS-40-MES (40m³/s)  
- 3 x JMS-10-MES (10m³/s)  
Plus rental units for source extraction:  
- 1 x JMS-40-MES (40m³/s)  
- 3 x JMS-30-MDT (30m³/s) |
| **WestConnex** | WestConnex is Australia’s largest road infrastructure project and is a critical part of a broader Sydney, NSW infrastructure plan. When complete in 2023, WestConnex will provide motorists with a continuous, 33km traffic-light free motorway.  
Stage 3A: Twin mainline tunnels between the M4 East and the New M5 in Sydney. Each tunnel is 7.5km long and sized to accommodate up to four lanes of traffic in each direction. Construction using roadheaders. | - 16 x JMS-50-MHT (50m³/s) – for source extraction alongside roadheaders.  
- 25 x JMS-50-MHS (50m³/s) – for general ventilation and source extraction at face alongside roadheaders. |
| **Rozelle Interchange** | Stage 3B: A group of underground tunnels connecting the M4-M5 Link with adjacent roads in Sydney. This project includes stubs to eventually connect with the Western Harbour Tunnel. Construction using roadheaders. | - 26 x JMS-40-MHSS (40m³/s) – for general ventilation and dust extraction at source during construction.  
Plus rental units for source extraction:  
- 1 x JMS-50-MDT (50m³/s)  
- 1 x JMS-50-MHS (50m³/s)  
- 2 x JMS-30-MDT (30m³/s)  
- 4 x JMS-20-MDT (20m³/s)  
- 1 x JMS-10-MDT (10m³/s) |
| **Sydney Metro** | Sydney Metro is Australia’s largest public transport project. In 2024, Sydney will have 31 metro stations and more than 66 kilometres of new metro rail, revolutionising the way Australia’s biggest city travels. By the end of the decade, the network will be expanded to include 48 stations and more than 113 kilometres of world-class metro for Sydney. | - 1 x JMS-50-MES (50m³/s)  
- 1 x JMS-20-MDT (20m³/s)  
- 1 x JMS-10-MES (10m³/s)  
- 1 x JMS-30-MDT (30m³/s) |
| **Central Station** | Central Station is one of the most important elements of the project. It is a highly complex brownfield project situated in an operational live environment. | - 1 x JMS-60-MES (60m³/s)  
- 1 x JMS-10-MES (10m³/s) |
| **City Rail Link** | The City Rail Link (CRL) is a 3.45km twin-tunnel underground rail link up to 42 metres below the Auckland city centre. Construction using 4 x TBM and 2 x Roadheaders. | - 1 x JMS-60-MES (60m³/s)  
- 1 x JMS-10-MES (10m³/s)  
- 1 x Axial Fan (50m³/s) |