Confederation Line Tunnel Fact Sheet

An integral part of the Rideau Transit Group (RTG) proposal for the Confederation Line was the approach to the construction of the tunnel under Ottawa's downtown core. The tunnel will span 2.5 kilometres, be on average 15 metres below the surface and will feature three of the stations in the Confederation Line project — Lyon, Parliament and Rideau.

Since the beginning of the bid process in 2012, our experts from around the world have worked to carefully determine the tunneling method and equipment required. Proximity to the Rideau Canal, a UNESCO World Heritage Site, the specific soil conditions of the downtown core, and the properties of the materials (geotechnical properties) that will be excavated were all evaluated. It was also important that the tunneling method minimize disruptions for the general public and daily life in the city.

Three accesses are bringing in equipment, crews and materials, as well as removing debris during tunnel construction:

- West Portal, located on the west side of Commissioner Street.
- East Portal, located next to the University of Ottawa's campus at Waller Street and south of Laurier Avenue East.
- Central shaft, located at Kent and Queen streets.

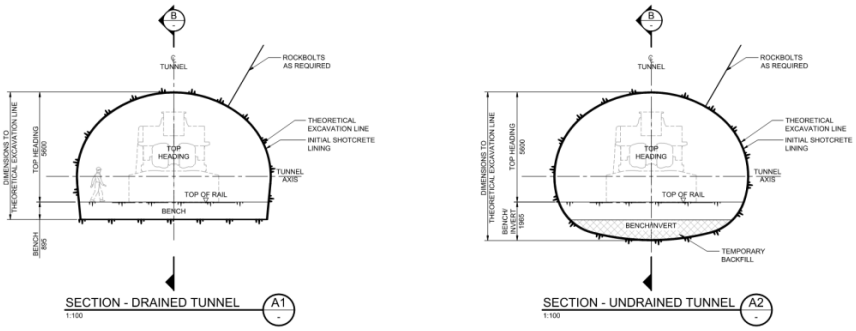
Construction Sequencing

Sequential Excavation Method (SEM) is being used to mine the tunnel. Tunneling began in late fall 2013 using three roadheaders and other supporting equipment. West Portal tunneling is moving east toward Lyon Station. Central shaft tunneling is moving east toward Parliament Station. The East Portal excavation is moving west toward Rideau Station, linking underground to the central shaft and West Portal tunneling.

SEM consists of advancing in increments (headings and rounds), which are supported with shotcrete (projected concrete), followed by the installation of reinforced shotcrete and steel support elements. The concrete lining has a defined stiffness and allows rock and soil settling to increase its self-supporting capacity until a safe and stable opening is created. SEM provides a high degree of flexibility to adjust the excavation approach and support measures for soil and rock conditions encountered; it also reduces risks of tunneling construction.

This method also minimizes longer term disruptions at surface. Excavation of the station caverns is being done within the tunnel; only entrance and ventilation structures are being constructed from the surface. Since excavation is being done underground, noise and vibration impacts can be kept to a minimum.

After the initial support, a concrete lining will be built to form the tunnel shape and the three underground stations. Rebar installation, poured concrete and projected concrete will be used to form the tunnel walls. Architectural finishes and systems of the underground stations, tracks and systems will be completed in the final phases of construction prior to Testing and Commissioning.



Mucking equipment at the West and East portals includes underground loaders inside the tunnel, with trucks on the surface. At the central shaft, muck is being removed using underground loaders inside the tunnel, a gantry crane and containers at surface level at the shaft. Trucks then take the muck to disposal sites.

Tunnel Portals — Portal is a term that is used to describe a tunnel entrance where the guideway and light rail vehicles will go from above-ground to underground. The Confederation Line has two – the West Portal and the East Portal. The central shaft will be restored.

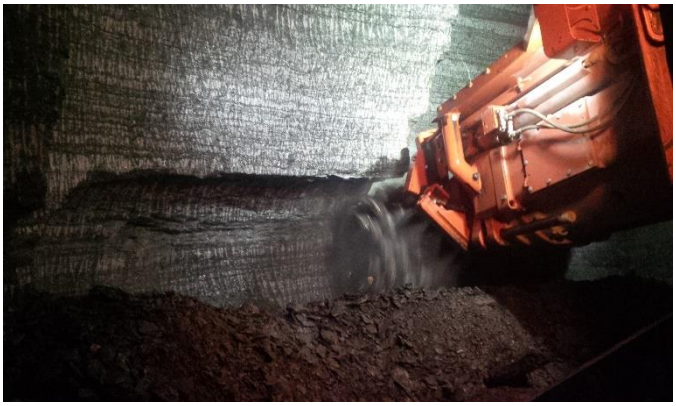
Soil Conditions — Crews are mining through limestone, the prevailing material found in the excavation area, as well as some soft materials such as clay and sands. On average, each roadheader is mining up to three linear metres per day.

Mitigation Measures — A watering system (mister) and a ventilation system are being used to filter and minimize dust and control debris (excavated material particles) from the roadheader as it grinds and rips the excavated face. Dust is propelled into the filter as rock and debris get deposited onto the conveyor belt, subsequently removed from the tunnel by loaders and taken away from site by trucks to a designated area. The majority of the noise generated by tunneling is contained underground and within the limits of the general construction site. Measures, such as adding silencer units to external fans, are being taken to attenuate noise at surface level.

Roadheaders — The 135-tonne roadheader is, at approximately 20 metre long, the industry's giant. It is comprised of a cross-cutting head (cutterhead) which includes tools called pics and a loading device that loads and transfers debris to a belt conveyor. It operates using electricity and moves on diesel fuel. Different pics will be used depending on the hardness and diameter of the tunnel. It is anticipated that approximately 50,000 pics will be required throughout the tunnel.

The pics on the roadheader grind and rip the material at the excavated face into particles, normally not exceeding 10 to 15 centimetres in diameter, depending on the underground material type encountered.

Occasionally, if the soil has deteriorated or due to joints in the rock, a larger piece can detach from the tunnel face. The larger piece would be crushed into smaller particles for easier removal.



The three roadheaders, one for each access point, are excavating up to 70 to 80 MPa rocks (UCS). These highly specialized machines were shipped preassembled in small to mid-size pieces from New York by trailers and from Austria by ship, and assembled onsite. Experts have trained local operators, mechanics and electricians on using the equipment.

Roadheader repairs and day-to-day maintenance activities are being performed by crews inside the tunnel, as spare parts are stored onsite.

Additional equipment is being used in the construction of the tunnel, such as jumbos for the installation of the temporary support, robots for shotcrete, and loaders for mucking.

Tunnel Navigation: How will the different sections connect?
Crews operating in each section of the tunnel and around the roadheaders are navigating inside the tunnel using a computerized surveillance system, equipped with fixed references and electronic devices.

Monumentation - making all essential measurements to determine the relative position of points beneath the surface of the Earth – is being built based on the best accuracy systems such as GPS and surveying observations. From this monumentation, frequent traverses are being generated to create the survey underground networks just behind the excavation. These traverses are being observed by various instrumentation. In addition, the roadheader guidance system is monitoring the excavation in real time using robotic total stations, placed by the survey underground networks.

World-Class Expertise
Up to 100 experts in design, construction, equipment and facilities were consulted during the tunnel construction planning.

A crew of highly skilled tunneling and underground environment miners has been assigned to each excavation area. Work commenced late fall 2013 and is scheduled to be ongoing 24 hours a day, five days a week (Monday to Friday), divided into two shifts. Maintenance work occurs on Saturdays.

Tunnel excavation, support and final lining installation works are anticipated to be completed in 2016. Once constructed, the 2.5 kilometre underground tunnel and the three stations, each measuring 16 metres by 13 metres in range and 120 metres in length, will be an essential part of the Confederation Line.