Detroit River INTERNATIONAL CROSSING STUDY

Tunnelling

The Detroit River International Crossing (DRIC) study team has assessed an end-to-end tunnel as one of five Practical Alternatives for the access road from Highway 401 to the E.C. Row Expressway. Plans, profiles and cross sections have been developed for this alternative and have been analyzed and compared with the other access road alternatives. All alternatives are being assessed according to the seven major evaluation factors for this project.

How the Analysis was Done

The analysis involved a review of tunnelling systems around the world to determine suitability for this project. The analysis included a review of geotechnical considerations, ability to provide a standard cross-section (six lanes with full width shoulders), timeframe for construction, portals, access and egress points, major utilities, watercourses and ventilation.

Findings to Date

Two basic types of tunnel construction have been considered, namely "bored" and "cut and cover".

Bored Tunnels

Bored tunnels are not being considered further because:

- A standard cross-section for a six-lane freeway would require a tunnel boring machine (TBM) with a diameter of over 18 m (59 ft). The largest TBM constructed to date in the world is just over 15 m (49 ft) in diameter. Developing and using a TBM with a diameter of over 18 m (59 ft) would entail considerable risk to the schedule and is not considered practical for this project.
- Soil conditions are not suitable for tunnel boring. A bored soft ground tunnel would result in a limited thickness of soil above the tunnel, which will result in unacceptable ground surface settlements that could impact structures (houses), utilities and roadways.

Cut and Cover Tunnels

Cut and cover tunnels are constructed using conventional excavation techniques and can include the initial construction of the side walls to minimize the overall width of the excavation.

Although there is a high water table and generally poor soils, an assessment by the study team's geotechnical experts has concluded that cut and cover tunnelling is a feasible construction method. Several cut and cover methods of construction would likely be employed at various locations along the alignment. These include:

1) *Conventional (2:1 slopes)*. This alternative requires extensive excavation and backfill, and is not generally being considered where it would result in severe property impacts. This alternative would be considered in areas where property is available.
2) *Caisson Wall, Cut and Cover-Bottom-up*. This alternative utilizes drilling (auger) rigs to install caissons down to bedrock, which will form part of the tunnel walls. This alternative is typically

constructed by the ‘Bottom-Up’ Method and has reduced property requirements relative to the Conventional Method. Once the caissons are in place, the soil between the walls is excavated to a depth below the tunnel floor. The tunnel floor slab is poured, followed by the side walls of the tunnel, which are constructed from the ‘bottom-up’. Once the tunnel walls have been completed, the roof of the tunnel is constructed, and the surface roadway on top of the tunnel is completed.

3) *Diaphragm Wall, Cover and Cut-Top-Down*. This method utilizes a trench cutter for installation of concrete walls down to bedrock using bentonite slurry to stabilize a trench. This method can achieve higher production rates than the caisson wall system, and also has reduced property requirements relative to the Conventional Method. Once the concrete walls of the tunnel have been built, the roof of the tunnel is constructed, and the surface roadway on top of the tunnel is completed. Excavation proceeds from the roof of the tunnel ‘top-down’ to below the tunnel floor. The tunnel floor slab is constructed last.

The cut and cover tunnel can be constructed in stages so that traffic can be maintained within the corridor throughout construction. An assessment made by the study team’s geotechnical experts has determined that there is a high water table and generally poor soil conditions for supporting deep excavations, particularly towards the north end of the access road corridor (Todd Lane/Cabana Road to Malden Road). The cut and cover tunnel would require complex construction techniques such as incorporating temporary ground improvement measures or other temporary wall and base stability enhancements during construction for the entire length from Malden Road to Highway 3. These methods include dewatering or depressurization of groundwater levels. The tunnel alternative is more complex and intensive than other alternatives due to the necessity to build the tunnel box, ventilation, electrical, communication systems and safety systems.

The construction of cut and cover tunnels through Environmentally Sensitive Areas (ESAs) requires the removal of surface vegetation within the tunnel right-of-way during construction. Impacts to adjacent ESAs can be avoided through the use of larger retaining wall structures constructed down to bedrock.

High groundwater conditions exist within the study limits. Strategies for groundwater control will be required for all methods of construction. Complex construction staging including stability enhancement measures and groundwater control will be required.

Highway Safety

Studies show that overall, operating speeds are generally lower in the tunnel, since drivers typically react to the different driving environment (enclosed by concrete walls) by slowing down. The potential consequences of catastrophic crashes within the contained area of a tunnel are greater than on an open road, although these types of incidents are infrequent. The occurrence of general traffic crashes is similar for these two types of facilities. Collected evidence suggests that placing an urban freeway in a tunnel should result in a safety performance that is no worse than using a surface freeway. However, there is no reference data that can be used to determine if mainline merge, diverge, and/or weaving areas caused by on and off ramps in the tunnel significantly affect safety performance.

The closed environment of the tunnel makes it more difficult for motorists to evacuate the area in the event of an accident. One-way traffic in each of the twin tunnels makes it more difficult for emergency response teams to gain access to an accident site.

Unique safety systems required for a tunnel include:

- Ventilation systems and buildings
- Emergency access between tunnels
- Emergency access and egress between the tunnel and the surface
- Smoke detector, carbon monoxide and dioxide monitoring system
- Emergency power supply
- Additional training for Emergency Services staff and education for motorists.

These safety systems increase costs to build, operate and maintain the tunnel.

Ventilation

Mechanical ventilation of long tunnels is required to control air quality and visibility in the tunnel and at the portals.

A mechanical ventilation system consisting of air flow ducts in the tunnel and one or more ventilation buildings with fans to force air in/out of the tunnel would be required. These ventilation systems would also be designed to control the direction of air flow and smoke in the case of an emergency. It is estimated that the ventilation building(s) would be about 18 m (59 ft) high (i.e. four to five storeys) plus the height of the stack. The total height including the stack could be up to 45 m (147 ft).

Although the technologies for tunnel air pollutant removal exist, there is no evidence to support that the use of such systems will result in an improvement to ambient air quality. Air dispersion modelling completed as part of the DRIC study indicates that the use of air pollution control systems would not significantly improve air quality in Windsor.