Big Walker Mountain Tunnel – General Information

Big Walker Mountain Tunnel (BWMT) is a twin rock bore tunnel that was constructed on I-77 and opened to traffic in 1972. BWMT is located approximately eight miles north of the town of Wytheville.

The tunnel was constructed by sequential excavation and drilling/blasting through rock. There are two parallel horseshoe-shaped tunnel bores that carry two lanes in the northbound direction and two lanes in the southbound direction. The tunnel has 26'-0" of horizontal clearance measured from curb to curb, and 16'-6" of vertical clearance. BWMT has a cast-in-place reinforced concrete tunnel liner, and a concrete slab on grade with an asphalt wearing surface. The tunnel walls along the roadway are covered in a tile finish. There is a concrete sidewalk with steel railing running along the full length of each tunnel bore, with two concrete cross passageways that connect sidewalks between the two tunnel bores. A concrete ceiling slab is suspended above the tunnel roadway by an interior center wall, which forms the bottom of the exhaust and supply ventilation ducts.

BWMT has a full transverse ventilation system, with 12 exhaust fans and 12 supply fans located in buildings at each end of the tunnel. Exhaust air is withdrawn from the tunnel through vents in the ceiling slab, while fresh air is injected through flues that run through the walls and have openings at the curb level. Air quality monitors are located throughout the tunnel.

BWMT has numerous other functional systems, including drainage, lighting, electrical distribution, emergency power distribution, emergency generators, fire detection, fire protection (extinguishers, on-site fire brigade), emergency communications, and signs. All systems are operated from a control room located in the south building, which is manned 24 hours a day. The original Programmable Logic Controller (PLC) system connected to a manual control board with push buttons and indicator lights is used to operate all equipment.

The Big Walker and the East River Mountain Tunnels do not have any restrictions that apply to the transport of hazardous materials, so long as transporters and shippers are in compliance with 49 CFR 100 through 180.
## Tunnels - Major Projects in 30-Year Plan

<table>
<thead>
<tr>
<th>Project Number</th>
<th>Project Description</th>
<th>Start Year in 30-Year Plan</th>
<th>Cost (2018 Dollars)</th>
<th>Reason for Importance/Potential Consequences of Inaction</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Fire Suppression, Emergency Ventilation</td>
<td>5</td>
<td>$38M</td>
<td>• No fire suppression systems exist at this tunnel. Uncontrolled fire and inability to keep people in a smoke free or survivable environment for the duration of evacuation and rescue.</td>
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<tr>
<td></td>
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<td></td>
<td>• Original ventilation configuration was not designed to control smoke from large fires.</td>
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<td>• Tunnel closure for prolonged period of time.</td>
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<td>• Potential for large fires from heavy goods vehicles and trucks carrying hazardous materials.</td>
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<tr>
<td>2</td>
<td>Structural Rehabilitation, Lighting, Traffic Control, Emergency Ventilation, SCADA, Control Systems</td>
<td>7</td>
<td>$39M</td>
<td>• Original control system has reached the end of its useful life. Does not have a modern Personal-Computer-based control system.</td>
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<td></td>
<td>• Structural deterioration of tunnels continues to spread, which could eventually lead to sacrifice of structural integrity.</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>• No emergency lighting exists at this tunnel.</td>
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<td></td>
<td>• Risk of accidents increase.</td>
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<td>• Ability to communicate during emergency situations suffers.</td>
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<tr>
<td>3</td>
<td>Ventilation and Structural Rehabilitation, Fire Apparatus, Electrical System Rehabilitation</td>
<td>11</td>
<td>$65M</td>
<td>• Inability to exhaust fumes produced by motor vehicles.</td>
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<td>• Outdated systems become unreliable and obsolete.</td>
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<tr>
<td>4</td>
<td>Fire Protection Rehabilitation, SCADA Upgrades, Lighting Replacement, Structural Rehabilitation</td>
<td>21</td>
<td>$60M</td>
<td>• Risk of accidents increase and ability to timely communicate emergency situations decrease.</td>
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<td>• Structural deterioration of tunnels continues to spread, which could eventually lead to sacrifice of structural integrity.</td>
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<td>• Outdated systems become unreliable and obsolete.</td>
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</tbody>
</table>

### Big Walker Tunnel 30-Year Plan Total in 2018 Dollars

$202M
**Project #1 - Fire Suppression, Emergency Ventilation - Start Year 5 in 30-Year Plan**

**Fire Suppression**

This proposed project expands on the standpipe system from the previous phase and provides a fire suppression system throughout each tunnel bore. Similar to a sprinkler system in a building, a tunnel fire suppression system provides zones of sprinklers or nozzles over the roadway, which can be activated upon detection of a fire. The purpose of this system is to immediately begin suppressing the fire growth rate, preventing small fires from spreading and limiting the amount of heat and smoke produced in the tunnel. The fire suppression system works in conjunction with emergency ventilation to provide a safe environment for motorists to evacuate the tunnel. The design of each system is dependent on the configuration of the other. A functional fire suppression system is a vital safety feature for all tunnels.

No fire suppression systems currently exist at the tunnels. Both tunnels have heavy truck traffic and permit the conveyance of hazardous materials, capable of producing large fires. Fire suppression systems would be required to meet design fire sizes per current National Fire Protection Association (NFPA) Standard 502. Some components/benefits of a fire suppression system:

- Deluge or foam system with zones of nozzles/sprinklers located above the roadway
- Immediately suppresses growth rate of fire upon detection
- Reduces necessary ventilation capacity by limiting heat and smoke produced
- Can be combined with standpipe system project

**Emergency Ventilation Phase 1 – Saccardo Nozzle**

The tunnel ventilation system works in conjunction with other proposed improvements, including fire suppression systems. With the long-term goal of meeting current fire safety standards, improvements are proposed in phases due to the high costs and significant engineering and construction durations for these systems.

The first phase to improve emergency ventilation at the tunnels is to install Saccardo Nozzles in both tunnel bores. This project includes reconfiguring the ventilation ducts to create longitudinal airflow in the tunnel and improve emergency ventilation capacity using the existing fans.

As part of a phased approach, the Saccardo Nozzle is the critical first step, because the longitudinal ventilation provides for future installation of a fixed fire suppression system. A saccardo nozzle introduces an air jet into a tunnel, at a high velocity. This air jet imparts most of its momentum to the tunnel air, and hence helps to drive the tunnel air in the desired direction. Half of the existing fans will no longer be needed after this project, significantly reducing long-term maintenance costs.

**Existing Conditions**

- Original (and current) ventilation configuration is a full transverse system, which was not designed to control smoke from large fires
- Existing fans need significant maintenance and repair to remain operational
- Potential for large fires from heavy goods vehicles and trucks carrying hazardous materials
- Large gap between current fire safety standards and existing conditions
- Problem is most severe in the southbound lanes due to the downhill grade and the natural “chimney effect.” With traffic stopped behind the fire, heat and smoke will naturally flow uphill and must be counteracted by the tunnel ventilation system.
The field inspection of the BWMT recently completed by a consultant resulted in a detailed list of numerous locations where the deterioration has advanced to include delamination, spalling, and exposed reinforcing steel with section loss evident.

The slab rehabilitation details for both tunnels will be developed for the general case of slab deterioration and will be adaptable to the particular extent of deterioration encountered at each location. These details are anticipated to generally include concrete removal and reconstruction of the joint areas.

Rehabilitation plans will be developed to minimize disruption to traffic in the tunnels. It is anticipated that limited lane closures and rolling tunnel closures at night will be required to complete the repairs.

This project includes installation of LED luminaries in the tunnel on a separate circuit using 2-hour fire rated cable with a new emergency panel. These LED fixtures would replace the existing night level luminaries which are always illuminated.

The proposed system will meet the requirements of the current NFPA 502 standard for an emergency lighting system.

- Provides code-compliant emergency lighting system
- Reduces energy consumption and maintenance costs
- Minimizes risk of lighting outage during a tunnel fire

The project scope also includes the installation of large reflective signs and exit lighting at the cross passageways between the tunnel bores and reflective exit signs spaced throughout the tunnel to indicate the distance to the exits.

- Current NFPA 502 standard requires emergency lighting and egress signs at 25-meter intervals indicating the distance to the nearest exit
- No other exit signs existed in the tunnel
- Provides clear direction to exits for motorists during tunnel evacuation

The purpose of this project is to provide an automated traffic management system to quickly stop interstate traffic if there is an incident in the tunnel. The proposed upgrades include installation of additional overhead sign structures, Dynamic Message Signs (DMS), signals, and gates outside each portal that can be operated from the tunnel control room.

- Provides the ability to stop traffic safely and reliably
- Eliminates the need for tunnel staff to leave the control room and enter the roadway
- Provides advance warning to motorists during incidents or delays
Project #2 cont. - Structural Rehabilitation, Lighting, Traffic Control, Emergency Ventilation, SCADA and Control Systems - Start Year 7 in 30-Year Plan

Emergency Ventilation Phase 2 - Upgrade Southbound Supply Fans at BWMT

Phase 2 of the emergency ventilation upgrades can be implemented at BWMT after the fixed fire suppression system has been installed. This project includes upgrading the existing supply fans in the northwest and southeast quadrants of the tunnel to increase capacity. This combination of the Saccardo Nozzle, upgraded fans, and fixed fire suppression systems will allow the tunnels to control a large fuel tanker fire with a potential fire heat release rate of 300 megawatts.

Supervisory Control and Data Acquisition (SCADA) and Control Systems

The SCADA system operates using signals over communication channels that provide control of remote equipment. The control systems are combined with a data acquisition system that can be programmed to operate the tunnel facility at optimum levels. The SCADA system plays a major role in the detection of fires, accidents, security and communications.

The I-77 mountain tunnels are the only major tunnel facilities in Virginia that do not currently have a modern control system. This project will replace the original PLC and manual control system, reconfigure the tunnel control rooms, and implement a new SCADA system at both tunnels. Connectivity and redundancy will be provided between both tunnels and the Salem Traffic Operations Center. The purpose of this project is to provide a long term solution that will improve reliability, reduce risk or operator error, and can accommodate future improvement projects.

Project #3 - Ventilation and Structural Rehabilitation, Fire Apparatus, Electrical System Rehabilitation - Start Year 11 in 30-Year Plan

Ventilation Rehabilitation

Repair one exhaust fan at BWMT with severe corrosion and holes in the wheels to bring it to operational condition.

For all remaining supply and exhaust fans at BWMT, clean and recoat all surfaces with missing paint and corrosion on the wheels, casings, and other components. For the fans exhibiting more significant corrosion with pitting, clean and sandblast the surface before recoating.

Investigate all bearings (supports) exhibiting vibration that exceed acceptable limits and repair or replace as necessary.

Change oil, repair all leaking seals, inspect and adjust alignment and drive chain tension for all fans at BWMT. Modify chain drive covers to make them more accessible for regular inspections.

Structural Rehabilitation

These projects are cyclical in nature, as the repairs have a limited life span. See Project #2.

Fire Apparatus

During the Fire Protection and Emergency Response study in 2014, VDOT met with all fire departments that respond to the mountain tunnels to discuss potential improvements and project prioritization. The unanimous recommendation of the fire departments was to install a standpipe system in the tunnels to reduce delay times when responding to a fire.
Project #3 cont. - Ventilation and Structural Rehabilitation, Fire Apparatus, Electrical System Rehabilitation

- Start Year 11 in 30-Year Plan

**Fire Apparatus**

The proposed standpipe system will be designed per current NFPA standards and include hose connections spaced throughout the tunnel. This system will be carefully designed to accommodate the addition of a fixed fire suppression system (deluge or foam) in the future with a shared main pipe.

- Faster firefighting: eliminates the need to lay long lengths of hose to reach the fire
- Unanimous recommendation of all responding fire departments

**Electrical System Rehabilitation**

The electrical systems are incidental to each of the individual items above and will be addressed as each of those systems are upgraded.

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**Project #4 Fire Protection Rehabilitation, SCADA Upgrades, Lighting Replacement, Structural Rehabilitation - Start Year 21 in 30-Year Plan**

These projects are cyclical in nature, as the upgrades have a limited life span. Project #4 entails upgrades of elements installed or improved as part of Projects #1 through #3. See previous project descriptions for explanations of the scope and purpose of these work elements.