TUNNEL CROSS SECTION

CONCEPT TUNNEL GEOMETRY
ONE DIRECTION OF TRAFFIC

CLEARANCE ENVELOPE
(36’ W x 16.5’ H)

ALTERNATIVE CENTRAL TRAFFIC BARRIER FOR SOME CONCEPTS

TUNNEL SHOWN FOR TRAVEL DIRECTION INTO PAGE.
COMPLIMENTARY TUNNEL TO LEFT FOR OPPOSITE TRAVEL DIRECTION.
Long Tunnel Alternative
Two 2 lane tunnels separated by structural wall

Sketch concept above depicts a cross section view of a tunnel portal area. This long tunnel alternative would be about 2500 ft in length extending from south of Iowa Street to north of Washington Avenue. The tunnel is constructed by ‘cutting and covering’ technique. The alignment should be fairly close to the existing although it would probably be several feet lower in places. This view is looking north, note existing residential neighborhood to the left or west on the hillside slope.

Native landscape would extend down the slope over the tunnel to the commercial area to the east. Bike trail and informal crossings can be made throughout most of the tunnel length. Fences will required near portal areas shown above.

A longer tunnel like this would require an active ventilation system.
Long Tunnel with lateral openings: Open Interior.
Single 4-lane tunnel with central barriers.

This cross-section sketch view is looking north just south of Iowa Street. Note the Iowa Street bridge in the middle ground, and the residential neighborhood to the left. This alternative is also a continuous 3300 ft long tunnel with generous openings on the east side for ventilation. A native landscape of grasses and wildflowers extend from the natural uphill slope across the top of the structure.

Because of the access required at road edges, these alternatives would have a more limited emergency pedestrian access at a few locations.

Tree and shrub planting can be used at edges to soften view of structure for surrounding neighborhoods.

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Muller Engineering Company, Inc. Consulting Engineers
LYMAN BENN INC. RANGE ENGINEERING
FRANK MILLER-BERGER LANDSCAPE ARCHITECT
Long Tunnel with lateral openings: Split Interior
Single 4-lane tunnel with a structural wall

This cross section sketch view is looking north just south of Iowa Street. This alternative is another variation of the tunnel with lateral openings idea. It differs from the other similar alternative in that there are opening on both east and west sides and has a solid structural wall separating north and southbound lanes. This is also a continuous 2500 ft long tunnel. The roof or top also has a native landscape of grasses and wildflowers and fences at edges.

Tree and shrub planting can be used at edges to soften view of structure for surrounding neighborhoods. Sound emanating from the west side may make this alternative less desirable.

FIGURE ________
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FRANK MILTENBERGER  LANDSCAPE ARCHITECT

FIGURE _________
This sketch view, looking southeast from the edge above the roadway, shows a conceptual design utilizing an architectural roof to cover the roadway. The example at right utilizes a stepped roof with openings for ventilation. This particular roof material might be translucent to aid in lighting the roadway below. An architectural roof would likely be less expensive than an earthen roof because of the lighter structural requirements.

The architectural treatment of the roof becomes a community architectural issue. This structure would be a prominent feature and would require some investigation into the appropriate materials and configurations for maximum acceptance.

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LANDSCAPE ARCHITECT
Two short tunnels alternative
Two tunnels connected with an open section

This bird's eye view is looking north at the two short tunnels concept. A tunnel is more than 2000 feet in length does not require an active mechanical ventilation system as do longer tunnels. This concept has two 2000 ft tunnels with an 800 ft long opening between. Depicted here is the opening starting on the north side of Iowa Street and extending toward the Washington Avenue area. The tunnel portion is similar to the four long tunnel concept and is covered with soil and native type landscape. The opening is a sort of a roadway canyon with tall retaining walls on both sides. Sound barriers may also be needed along the top of the west side to augment the sound attenuation.

Contrasting light changes and changing roadway surface conditions are a disadvantage to this alternative.
# EVALUATION OF TUNNEL CONCEPTS

## TABLE 1: OPERATIONAL AND USER SAFETY ISSUES AND COSTS

<table>
<thead>
<tr>
<th>Concept</th>
<th>Description</th>
<th>Concept Variations</th>
<th>Interior Dimensions (W x H in feet)</th>
<th>Operational and User Safety Issues</th>
<th>Relative Costs</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Ventilation</td>
<td>Capital</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Emergency</td>
<td>Operation and</td>
</tr>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>Egress</td>
<td>Maintenance</td>
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<td></td>
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<td></td>
<td></td>
<td>Lighting</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Road Surface Safety</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Long Tunnel with Active Ventilation</td>
<td></td>
<td>85’ x 24’ Total</td>
<td>Assumed several cross-passages</td>
<td>High - ventilation and lighting</td>
</tr>
<tr>
<td>2</td>
<td>Long Tunnel with Lateral Openings</td>
<td>Open Interior</td>
<td>85’ x 21’ Total</td>
<td>Designed to avoid</td>
<td>Medium - primarily for lighting</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Split Interior</td>
<td>85’ x 21’ Total</td>
<td>Assumed several cross-passages</td>
<td>High - de-icing at portals plus moderate rain and snow at openings</td>
</tr>
<tr>
<td>3</td>
<td>Long Tunnel(s) with Top Openings</td>
<td>Low Profile</td>
<td>85’ x 21’ Total</td>
<td>Designed to avoid</td>
<td>High - de-icing at portals plus minor rain and snow at openings</td>
</tr>
<tr>
<td></td>
<td></td>
<td>High Profile</td>
<td>42’ x 21’ Per Direction</td>
<td>Assumed several exits to the outside</td>
<td>Medium - de-icing at portals plus snow at openings</td>
</tr>
<tr>
<td>4</td>
<td>Two Short Tunnels</td>
<td></td>
<td>85’ x 21’ Total</td>
<td>Assumed not required</td>
<td>Lowest - short tunnel sections</td>
</tr>
</tbody>
</table>

- Indicates a preferred concept
- Indicates a highly adverse characteristic of the concept

**Notes:**
1a Single 4-lane tunnel with low central traffic barrier, and with openings and egress exits only on one side.
1b Single 4-lane tunnel with central wall, openings on both sides, and egress through central wall.
2a Road elevation significantly below existing ground surface with concrete roof and landscaping above.
2b Road elevation near existing ground surface with architectural roof raised above ground surface.
3 Total indicates width of structure in both directions including 4 lanes and center divider.
4 Based on assessment of need for active ventilation.
5 Based on method of egress or refuge during life threatening emergencies.
6 Lighting needed for all concepts. Evaluation based primarily on overall level of lighting and secondarily on variation in lighting level.
7 Based on the impact of weather and meteorological conditions on the condition and safety of the road surface.
8 Based on the relative cost of the initial capital investment for tunnel concepts, and not necessarily relative to an open road.
9 Based on the relative annual cost of operation and maintenance, especially power for ventilation and lighting.
# EVALUATION OF TUNNEL CONCEPTS

## TABLE 2: COMMUNITY ISSUES

<table>
<thead>
<tr>
<th>Concept</th>
<th>Description</th>
<th>Concept Variations</th>
<th>Exterior Aesthetics</th>
<th>Community Connectivity</th>
<th>Access Restrictions</th>
<th>Roadway</th>
<th>Noise Abatement</th>
<th>Mechanical Ventilation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Long Tunnel with Active Ventilation</td>
<td>- 1 -</td>
<td>Most desirable</td>
<td>Best - unlimited</td>
<td>Best - no restrictions except at portals</td>
<td>Best - high noise reduction for many homes</td>
<td>Moderate to poor</td>
<td>Not applicable</td>
</tr>
<tr>
<td>2</td>
<td>Long Tunnel with Lateral Openings</td>
<td>Open Interior</td>
<td>Moderate to high - restrictions on east side only</td>
<td>Moderate to high - restrictions on both sides</td>
<td>Moderate to high - restrictions at portals and both sides</td>
<td>Moderate to good - noise from ventilation openings can be directed away from noise sensitive areas</td>
<td>Not applicable</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Split Interior</td>
<td>Moderate to some restrictions on both sides</td>
<td>Moderate to restrictions at portals and both sides</td>
<td>Moderate to bad - noise emanates from both sides</td>
<td>Not applicable</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Long Tunnel(s) with Top Openings</td>
<td>Low Profile</td>
<td>High - some restrictions above tunnel at vents</td>
<td>Slight to moderate - restrictions at portals and vents</td>
<td>Moderate - less open area for ventilation because openings located at tunnel crown</td>
<td>Not applicable</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>High Profile</td>
<td>Worst - access is limited with significant restrictions</td>
<td>Worst - highly restricted</td>
<td>Moderate to poor - less open area, but may provide limited noise reduction if architectural roof is lightweight material</td>
<td>Not applicable</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Two Short Tunnels</td>
<td>- 3 -</td>
<td>Combination of desirable and undesirable</td>
<td>Overall medium - combination of unlimited and restricted</td>
<td>Overall moderate to poor - restrictions at portals and open section</td>
<td>Not applicable</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- Indicates a preferred concept
- Indicates a highly adverse characteristic of the concept

**Notes:**
1. Single 4-lane tunnel with low central traffic barrier, and with openings and egress exits only on one side.
2. Single 4-lane tunnel with central wall, openings on both sides, and egress through central wall.
3. Road elevation near existing ground surface with architectural roof raised above ground surface.
4. Relative ranking for tunnel concepts according to degree of visible absorption into landscape, with lowest number (highest rank) corresponding to greatest visual absorption. All concepts are significantly better than open roadway.
5. Based on the freedom for people to move across the highway thereby connecting the community, and ability to use the land over and in the vicinity of the highway.
6. Based on degree of restrictions to access in the vicinity of the highway such as fencing at the portals.
7. Based first on the level of noise generated from traffic on the roadway and second on the difficulty of mitigation.
8. Based first on the level of frequency of the noise generated from ventilation and second on the difficulty of mitigation.
9. Roof is prominent architectural feature and the aesthetics depend on community acceptance.