

Technical Memorandum Summary E1 Alternative Initial Screening Profile Options at the South Mountains' Ridges

INTRODUCTION

E1 Alternative Description

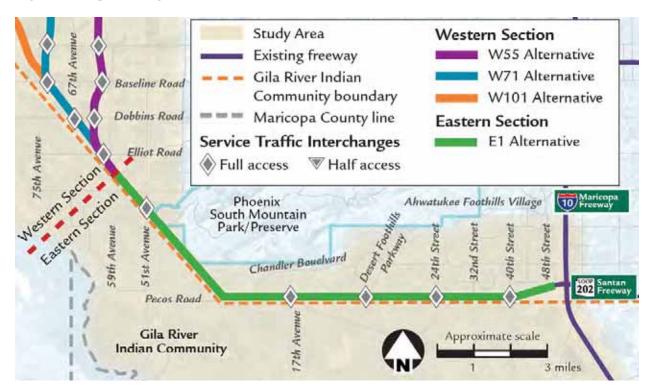
The E1 Alternative, shown in Figure 1, is currently the only action alternative being considered in the Eastern Section (see the *E1 Alternative Initial Screening Technical Memorandum Summary* for details regarding other alternatives considered but eliminated from further study). In general, it would:

- connect the existing I-10/Loop 202/Pecos Road system traffic interchange in the east to the action alternatives in the Western Section.
- proceed west, replacing Pecos Road (through the southern edge of Ahwatukee Foothills Village), then diagonally through Phoenix South Mountain Park/Preserve (adjacent to the Gila River Indian Community).

Memorandum Purpose

The E1 Alternative would result in direct use of resources associated with the South Mountains. The protected resources include the public parkland associated with the Phoenix South Mountain Park/Preserve, the historic nature of the mountains and parkland, and the cultural significance of the mountains. This memorandum presents the impacts associated with the proposed alternative as well as the design options considered but eliminated from further study.

Figure 1. Proposed Alignment



1



Technical Memorandum Summary E1 Alternative Initial Screening Profile Options at the South Mountains' Ridges

PROPOSED E1 ALTERNATIVE

Description

The current proposed profile through the South Mountains, shown in Figure 2, would follow existing ground except where cuts to the hillsides would be needed to pass through the ridgelines. Figure 3 presents two simulations of what the cuts might look like through the ridgelines

Design Elements

Cut Sections

The width of the cut sections has been minimized to reduce the right-of-way needed. As shown in Figure 4, the typical section through the mountain ridges includes a rockfall containment ditch and assumes that cut slopes of up to $\frac{3}{4}$:1 could be attained. The actual constructed slopes would depend on the geotechnical constraints encountered during construction.

Potential Impacts

Landscape alteration

The proposed action would cut into three mountain ridges (two of which are located in Phoenix South Mountain Park/Preserve). The cuts could create substantial visual scars by replacing a natural setting with unweathered subsurface rock exposure. Mitigation measures would be used by ADOT to minimize the impacts of the cuts.

Intrusion

The proposed E1 Alternative would introduce an intensive man-made use into an otherwise passive, natural setting as evidenced by the remainder of Phoenix South Mountain Park/Preserve to the north and Community land to the south.

Access

The proposed E1 Alternative could alter access to Phoenix South Mountain Park/Preserve. While there are no formal trailheads or staging areas for access into the park where the proposed action would pass through the park, hikers, equestrian users, and Community members would have uncontrolled, casual access to the park in the affected area.

Habitat connectivity

While the Study Area is urbanizing and no documented major wildlife dispersal/migration routes exist, there is a continued interest from the commenting public, park/preserve stakeholders, and state and federal agencies to address habitat connectivity. Unmitigated, the possibility remains that the proposed action could create a physical impediment for the movement of wildlife to and from the Sierra Estrella, the Gila River lowlands, and the South Mountains.

Safety

Rockfall containment facilities would be provided through the ridges of the South Mountains.



Figure 2. E1 Alternative Profile

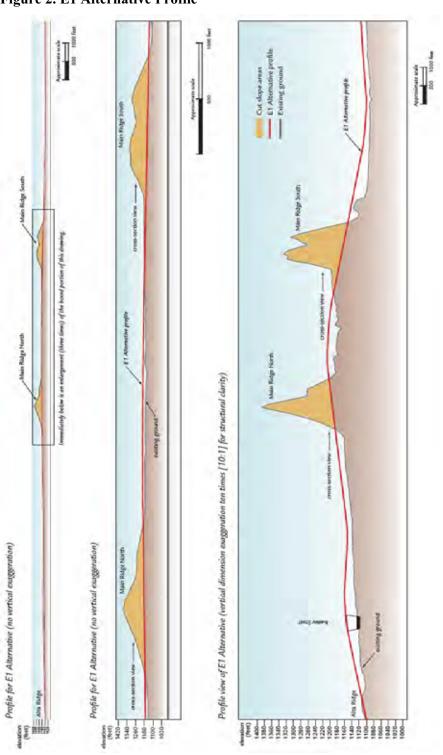




Figure 3. Photo simulation of cuts through South Mountains' Ridges

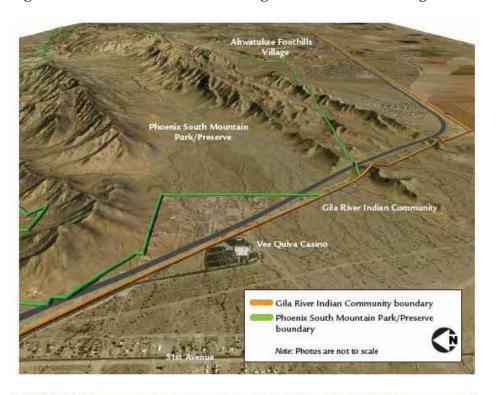
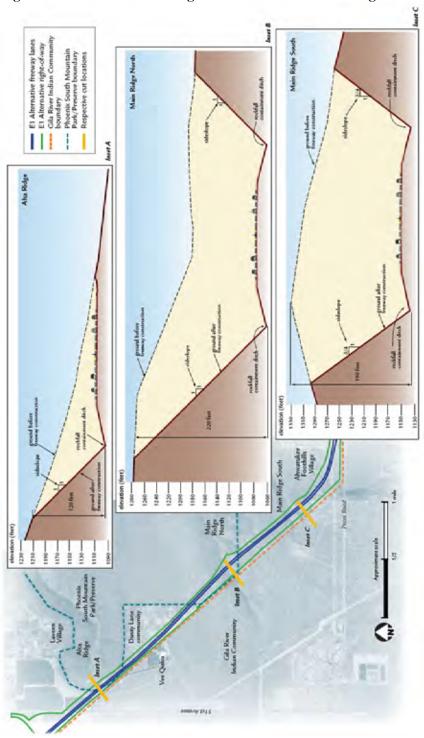






Figure 4. Cross sections through the South Mountains' Ridges





Technical Memorandum Summary E1 Alternative Initial Screening Profile Options at the South Mountains' Ridges

Homeland security

There is no known abnormally high risk to homeland security from the proposed profile and cut sections through the South Mountains.

Hazardous material transport

It is anticipated that there would be no restrictions on the transport of hazardous materials along the E1 Alternative. Consideration would be given to transport of hazardous materials given that topography of the area would tend to cause any spills to flow immediately onto the Gila River Indian Community, unless a drainage containment system were used.

Cost

The E1 Alternative (entire length, not just through the South Mountains) is estimated to cost \$810 million. The construction cost would be \$478 million, while the right-of-way cost would be \$332 million.

Potential Mitigation

Wildlife crossings

While there are no known migration corridors, ADOT believes it is an important issue. As such, ADOT has proposed to construct multipurpose bridge structures in lieu of concrete box culverts at strategic locations along the E1 Alternative to improve habitat connectivity and provide equestrian, public, and other access points.

Cut slope treatments

ADOT would blend the appearance of the cuts through mountain ridgelines with the surrounding natural environment as would be feasible. The degree of slope treatment would depend on the interaction of the following factors:

- the angle of the cut slope and geological conditions
- the receptivity of the cut rock would to sculpting and rounding to mimic existing contours and allow for staining, revegetation, and other related measures



Technical Memorandum Summary E1 Alternative Initial Screening Profile Options at the South Mountains' Ridges

BRIDGE ALTERNATIVES CONSIDERED BUT ELIMINATED

Description

To avoid or minimize impacts to the South Mountains, alternatives that would bridge either over the ridges or above the majority of the ridges were evaluated.

Design Elements

Profile

Two profile options, shown in Figures 5 and 6, through the South Mountains' ridges were developed for the bridge alternative. They include a high profile that goes over both ridge lines, approximately 200 feet above existing ground, and a medium profile that goes half-way up the ridge lines, approximately 100 feet above existing ground.

The maximum permissible grade based on ADOT *Roadway Design Guidelines* for a freeway facility is 3 percent. This constraint determined the linear extent of an inclined freeway needed to ascend or descend from the ridges.

Depth of Embankment

In coordination with ADOT Valley Project Management and ADOT District Maintenance, it was determined that 40 feet was the highest that the freeway could remain on dirt embankment. At heights greater than 40 feet, the freeway would need to be on a bridge structure. This constraint determined where the bridge piers would begin and end.

Potential Impacts

Landscape alteration

Vegetation would be maintained in the areas under the bridges. Vegetation would be lost in the areas where permanent improvements are made, such as freeway embankment and bridge piers. The medium profile option would also result in the removal of the ridges in open cut.

Visual

The bridge alternatives would increase visual impacts for views from the South Mountains to adjacent land and from adjacent land to the South Mountains.

As the medium profile option would pass out of the ridges in both the northwest and southeast, the freeway would be elevated approximately 50 feet above existing ground, fully visible to the residences in the Dusty Lane community, Ahwatukee Foothills Village, Laveen Village, and Gila River Indian Community. Cut slopes through the ridges could have slope treatment applied to better blend with the surrounding area. Vegetation would be used on all exposed ground surfaces. However, the open cut sections would disrupt the natural appearance of the existing ridges.

As the high profile option would pass over the ridges in both the northwest and southeast, the freeway would be elevated approximately 150 feet above existing ground, fully visible to the residences in the Dusty Lane community, Ahwatukee Foothills Village, and Gila River Indian Community. The freeway would be elevated above existing ground from approximately 51st Avenue to 25th Avenue. The high profile option would not result in cut slopes.



Figure 5. Bridge Alternative – High Profile Option

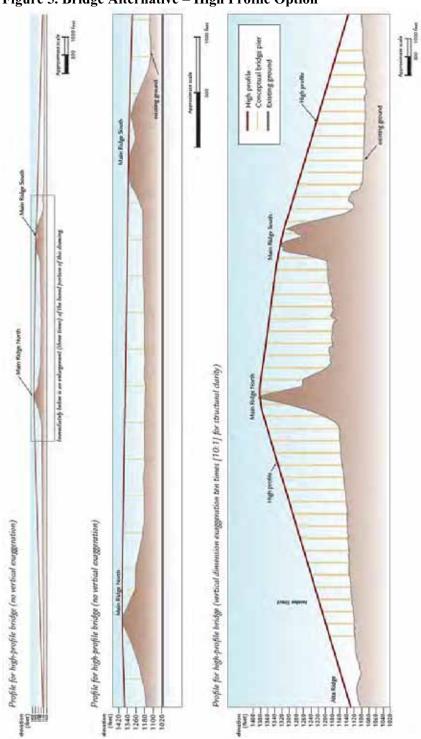
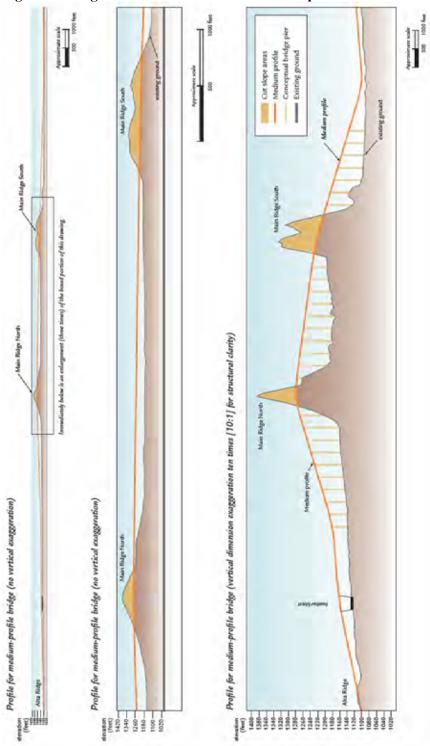




Figure 6. Bridge Alternative – Medium Profile Option





Technical Memorandum Summary E1 Alternative Initial Screening Profile Options at the South Mountains' Ridges

Intrusion

Construction of the bridge alternatives would require drilling and blasting for the numerous pier foundations, which would result in permanent scarring and excavation of the ridges.

Access

Access to the South Mountains would be maintained in the areas where bridge structures would be used to approach the ridge crossings.

Habitat connectivity

Wildlife connectivity would be maintained in the areas where bridge structures would be used to approach the ridge crossings.

Safety

The medium-profile option would require rockfall containment facilities in the roadway cross section through the cut sections

Incident management would be constrained on the bridge alternatives because of the height above existing ground, lack of a graded side-slope, and the distance between freeway access points.

Continuous maximum grades of this length would be unique to an urban freeway in the Phoenix area.

Homeland security

Based on previous threats around the nation, the potential exists that a bridge of this length and height on a regional freeway system could become a terrorist target.

Hazardous material transport

Consideration would be given to transport of hazardous materials across the medium-profile and high-profile bridges, given that topography of the area would tend to cause any spills to flow immediately onto the Gila River Indian Community, unless a drainage containment system were used.

Cost

The bridge alternatives would cost approximately \$212 million and \$265 million more than the proposed E1 Alternative for the medium-profile and high-profile options, respectively. The increased cost would be entirely attributable to construction cost.

Conclusion

Based on costs of extraordinary magnitude and the inability to avoid direct use (and direct use-related impacts) of the resources associated with the South Mountains, the bridge alternatives would not be prudent and feasible and were, therefore, eliminated from further consideration.



Technical Memorandum Summary E1 Alternative Initial Screening Profile Options at the South Mountains' Ridges

TUNNEL ALTERNATIVES CONSIDERED BUT ELIMINATED

Description

In response to concerns regarding the impacts of the Proposed E1 Alternative, design options to tunnel through the South Mountains were examined.

Design Elements

Profile

Three profile options through the ridges of South Mountains were developed for the tunnel alternative. They included an underground profile that goes approximately 60 feet below existing ground for approximately 1.6 mile; a low profile which generally follows the same elevation as the proposed E1 Alternative, resulting in two 1,000-foot-long tunnels; and a medium profile that is the same as the medium profile for the bridge alternative but instead of an open cut through the ridges would result in two 500-foot-long tunnels through the ridges. Figure 7 presents each option.

The same constraints as employed with the bridge alternatives with regard to maximum grades and maximum embankment heights were applied to this alternative.

Tunnel Engineering

As background information, the appearance of a freeway tunnel system is generally controlled by technical considerations:

- A tunnel's dimensions and its distance below ground are determined by existing geological conditions and available construction technology. When coupled with appropriate safety considerations, these factors basically determine a single tunnel's size or tunnel conditions.
- Once geologic and construction capabilities are determined, operational needs are considered, including the number of lanes, safe sight distances and other safety features, ventilation features, maintenance features, and security issues. These considerations are used to determine whether the operational needs can be met with the tunnel conditions outlined or if more than one tunnel (located adjacent to each other) would be needed.
- Finally, it is necessary to determine whether the tunnel(s) would be sufficiently deep and long to avoid or reduce impacts on the surrounding environment. When considered together, these factors help determine the minimum acceptable tunnel dimensions (height and width), distance below ground, number of adjacent tunnels to accommodate all of the freeway lanes, tunnel length and location, and possible construction techniques.

Tunneling options were assessed to determine the feasibility of their construction and maintenance, to determine their effectiveness in avoiding or reducing impacts to the South Mountains, and to assess whether tunneling through the mountain range would generate other desirable or undesirable outcomes.

Constructibility

The tunnel evaluation included investigation of current methods for constructing the tunnel. The two potential methods were 1) use of the traditional boring method or 2) use of the sequential excavation method (SEM; also known as the New Austrian Tunneling Method [NATM]). The boring method uses a boring machine built to the size of the desired tunnel to drill through the mountain. The SEM uses



Technical Memorandum Summary E1 Alternative Initial Screening Profile Options at the South Mountains' Ridges

traditional machinery to excavate rock in 2- to 3-foot increments. The SEM is more cost-effective and is able to produce wider tunnel sections than the boring method.

The proposed freeway would ultimately need to be ten lanes to accommodate design year (2030) traffic. In an ideal situation, all lanes of traffic moving in one direction would be in one tunnel. This would result in two tunnels, each approximately 104 feet wide (width would entail five 12-foot lanes, two 12-foot shoulders, and two 10-foot emergency walkways). The next most appropriate option—minimally acceptable—would have high-occupancy-vehicle (HOV) traffic for both directions using a separate, approximately 92-foot-wide tunnel (the HOV tunnel would have two 12-foot lanes, four 12-foot shoulders, and two 10-foot emergency walkways) and two similarly sized tunnels for general purpose traffic (the general purpose tunnels would have four 12-foot lanes, two 12-foot shoulders, and two 10-foot emergency walkways). Neither of these options would be possible to construct with current technology. To date, the widest tunnel excavations in the United States have been 70 feet, about 22 feet narrower than would be necessary for the minimally acceptable option.

The only option that appears constructible using current technology would be to use four tunnels, splitting traffic going in the same direction. Two of the four tunnels would require an 80-foot width, 10 feet wider than the currently constructed tunnels noted above. The ideal, minimally acceptable, and constructible tunnel configurations are presented in Figure 8. Because of the variable nature of the site-specific geology (including dangers that could arise from encountering fractured rock), it is not possible at this time to determine specific dimensions of a maximum feasible tunnel width.

Both ADOT and FHWA believe that an 80-foot tunnel option would result in unacceptable safety concerns, because of diverging traffic and increased constructibility challenges.

Potential Impacts

Landscape alteration

The tunnel alternatives would maintain existing vegetation through the limits of the tunnel segments. Permanent scarring of existing vegetation would occur at the approaches to the portal openings for all three profile options (see Figure 9).

Visual

With the exception of the portals, tunnel alternatives would remove the freeway from view in the vicinity of the mountain ridges.

The construction of the portals for all of the tunnels would result in scarring to the ridges. These disturbed areas could have slope treatment applied as well as vegetation to better blend with the surrounding areas.

Ventilation locations, maintenance facilities, and access roads would be required and could adversely affect the visual setting of the ridges.

The bridge structures associated with the medium profile would increase the visual impacts. As the medium-profile option passes out of the ridges in both the northwest and southeast, the freeway would be elevated approximately 50 feet above existing ground, fully visible to the residences in the Dusty Lane community, Ahwatukee Foothills Village, and Gila River Indian Community.



Figure 7. Tunnel Profile Options

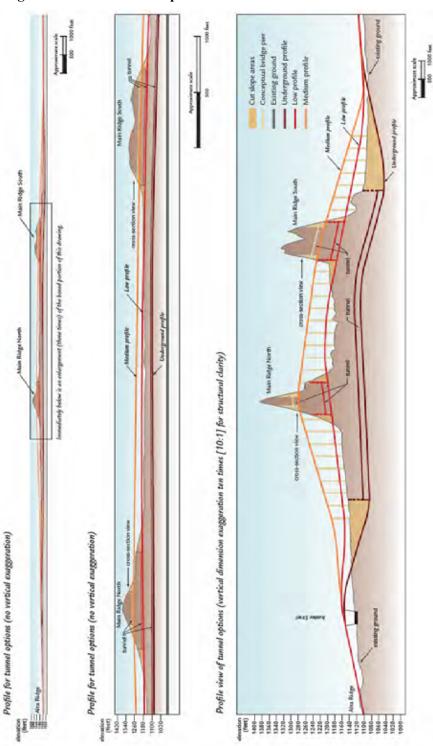
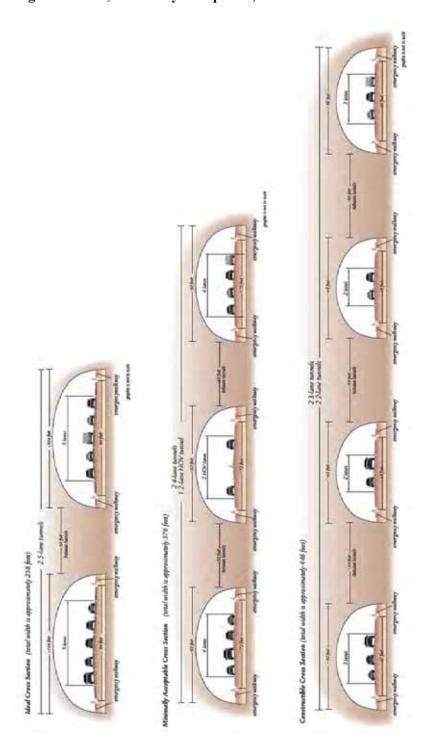




Figure 8. Ideal, Minimally Acceptable, and Constructible Tunnel Cross Sections





Technical Memorandum Summary E1 Alternative Initial Screening Profile Options at the South Mountains' Ridges

Figure 9. Photo Simulation of Tunnel – Low Profile Option



Intrusion

Construction of the tunnel alternatives would require drilling and blasting for tunnel portals, which would result in permanent scarring and excavation of the ridges. Ventilation locations, maintenance facilities, and access roads would also result in permanent scarring.

Construction of the bridge structures associated with the medium profile option would require drilling and blasting for numerous pier foundations, which would result in permanent scarring and excavation of the ridges.

Access

Access to the South Mountains would be maintained within the limits of the tunnel sections for any of the profile options. The bridge structures associated with the medium-profile option would provide additional access opportunities.



Technical Memorandum Summary E1 Alternative Initial Screening Profile Options at the South Mountains' Ridges

Habitat connectivity

Habitat connectivity would be maintained within the limits of the tunnel sections for any of the profile options. The bridge structures associated with the medium-profile option would provide additional access opportunities.

Safety

The tunnel options would create undesirable safety issues. Emergencies would result in complex response planning for traffic control, fire detection, ventilation and exhaust, and fire safety systems. Traffic operation would be affected by the splitting of lanes into different tunnels.

Homeland security

Tunnels on a metropolitan freeway system are being recognized by the Department of Homeland Security as potential terrorist targets.

Hazardous material transport

ADOT would evaluate the transport of hazardous materials based on the length of the tunnels and the location of alternative routes. They could prohibit the transport of hazardous materials through any of the tunnel options. In that case, vehicles transporting hazardous materials would need to use alternative routes, either I-17 through downtown Phoenix or surface streets on the Gila River Indian Community or within the City of Phoenix.

Cost

Relative to the proposed E1 Alternative, use of the SEM to construct the tunnel alternative would cost an additional \$1.101 billion for the underground profile option, \$236 million for the low-profile option, and \$246 million for the medium-profile option.

Relative to the proposed E1 Alternative, use of the boring method to construct the tunnel alternative would cost an additional \$2.512 billion for the underground profile option, \$560 million for the low-profile option, and \$426 million for the medium-profile option.

Conclusion

Considering that current construction techniques do not allow for construction of tunnels that would meet the minimally acceptable characteristics and that tunnel options would not fully achieve the desired outcomes, ADOT and FHWA have determined the additional costs presented by tunnel options would not be warranted and, therefore, not justified. For these reasons tunnel alternatives were eliminated from further study.