Vail Tunnel Options

DRAFT

An Initial Look at
Tunneling Options To Relocate
Interstate 70 in Vail, Colorado

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Executive Summary

Over the past decade several discussions have focused on the impacts Interstate 70 (I-70) places on Vail and its future. Increasing traffic congestion, noise, air pollution, and safety issues from traffic on the interstate have been approached in several ways. Studies have been conducted on traffic, noise, and other issues without a solution that addressed all the issues satisfactorily. In addition, the Interstate bisects the community of Vail, creating connectivity and quality of life issues for its residents and guests.

A cut-and-cover tunnel under I-70 was briefly studied during transportation update planning. Fundamentally, a lid would be placed on the Interstate that would place traffic in a tunnel along the same alignment as the Interstate. With this, many of the I-70 issues could be virtually eliminated. Funding of the cut-and-cover tunnel, it was assumed, could come from transference of air rights above the tunnel, on which both limited commercial and residential development could occur. A boulevard could be created on the lid that would dramatically increase the connectivity in the community. Also, it was discussed that considerable open space could be provided to address the wildlife and recreational issues. The cut-and-cover tunnel under I-70 was tabled largely due to the cost and the impact construction would have on the community.

Currently, the Colorado Department of Transportation (CDOT) is studying options for increasing capacity of I-70 from Denver to Glenwood Springs. The Programmatic Environmental Impact Statement (PEIS) is evaluating options for increasing traffic capacity through Vail which includes widening of the Interstate to three (3) lanes in each direction and providing a corridor for a mass transit system. To address the rockfall and landslide issues associated with Dowd Canyon, CDOT has included an option that would divert the Interstate in Dowd Canyon into a tunnel exiting near Eagle-Vail and connecting back to the Interstate.

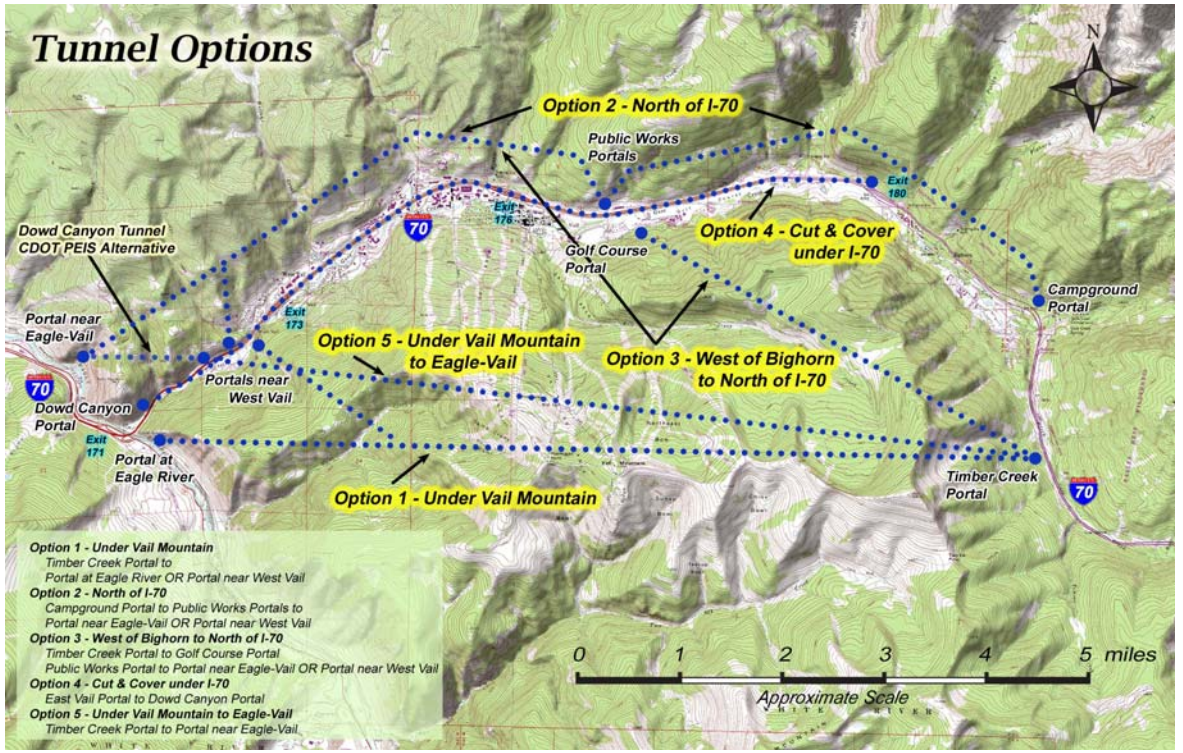
Separate from the PEIS In the past year, the discussions in Vail expanded to relocating I-70 into a tunnel away from Vail, rather than in a cut-and-cover tunnel beneath the existing Interstate. Several ideas brought forward developed into a set of five (5) options with alternative

portal locations. The options, shown below, provided various levels of Interstate relocation with connections to Vail. Options 1 and 5 included bypassing Vail altogether with east portals approximately four (4) miles east of the East Vail Interchange and west portals near the Eagle River. Option 2 circumvents north of I-70 with alternative west portal locations in West Vail and Dowd Junction. Option 3 attempts to provide an interchange connection near the Public Works Facilities while bypassing the Bighorn area. Option 4, the cut-and-cover tunnel under I-70 was also included as one of the options under study (Option 4). This document provides an initial look at the various options for tunneling.

A preliminary evaluation of the options included initial study on the geology, tunnel portal locations, excavation methods, ventilation, facilities, infrastructure, tunnel excavation material disposal, cost, and schedule. Each of the options included two (2) three-lane tunnels for traffic and a separate mass transit and service tunnel. The options were compared in terms of cost, schedule, expandability, construction impacts, and general public benefit.

Preliminary geological study shows that tunneling is possible in each of the options; however, tunneling north of I-70 (Option 2) and west of Bighorn (Option 3) could prove to be the most costly in terms of tunnel excavation and tunnel support. In as well, Option 3 shows a high impact on the Vail Golf Course area with its portal and associated interchange.

Interchange and portal location alternatives were studied to provide various connections to Vail with consideration given to traffic flow, connectivity, and impact to the community. Connectivity near the Public Works Facilities and in West Vail was addressed in each of the options.



No recommendations are made in this study for connectivity as only through intensive long range development and transportation planning can the right choices for interchange and portal locations be made.

Excavation methods, ventilation, facilities, and infrastructure were addressed in each of the options. It was determined that feasible means and methods are available and within tunnel design possibility, even though some of the options represent the longest tunnels in North America. It should be noted here that longer tunnels are in operation in Europe.

A prime consideration in evaluating the tunnel options in Vail includes the haulage, use, and disposal of the rock excavated from the tunnel. Haulage of the excavated material would be very costly and impactive to the community in some options. For instance, as much as 8 million cubic yards of material may need to be hauled from the tunnel sites in Option 2 – North of I-70. If all of the excavated material were hauled in trucks over the existing Interstate, more than 40 trucks per hour could be realized on the Interstate over a few years. Innovative means for tunnel excavation material haulage and disposal may include its use for construction of future water reservoirs and wildlife crossings. In some options, the use of the Union Pacific's Tennessee Pass railroad for haulage could minimize the haulage impact though Vail.

In terms of cost and schedule, the longest tunnels (Options 1 & 5) may actually provide the lowest cost per linear foot of tunnel and shortest schedule using tunnel boring machines for excavation. Tunnel construction could be expected to last from 4 to 5 years. With the right excavation methods and innovative haulage of excavated material, Options 1 and 5 would provide the least impact to Vail during construction. A key issue with these options, however, is that development could not occur on the area recovered from the existing Interstate until the tunnel was complete and in operation. This differs dramatically from Option 4 Cut-and-Cover Under I-70 as the cut-and-cover tunnel can be readily phased to complete short sections of tunnel so that development can occur prior to completion of the entire tunnel, potentially creating a more favorable funding scenario.

From initial study, it appears that Options 1 and 5, where a long tunnel bypasses Vail, may have the greatest public benefit in terms of mitigating the impact of I-70 through Vail and minimizing the impact of construction. Option 4 – Cut-and-Cover Under I-70 has the greatest potential for phasing, but has the highest cost of the options studied. The preliminary order of magnitude costs for 9.4 miles of two (2) three-lane tunnels and a separate transit/ service tunnel for Option 5 is in the range of $2.5 to $3.1 billion. For the same tunnel configuration for the Option 4 - Cut-and Cover Under I-70, costs in the range of $2.8 to $3.5 billion could be expected. Interchanges, right-of-way, and impact mitigation costs are not included in these costs.

Only with additional project definition and extensive geotechnical investigation can these options, costs, schedule, impacts, and benefits be further evaluated.

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1.0 Introduction

Vail, Colorado, an international destination resort, experiences increasing traffic congestion, noise, air pollution, and safety issues from traffic on Interstate 70 (I-70) through Vail. As documented in the *I-70 Draft Programmatic Environmental Impact Statement* (PEIS), person-trips are projected to increase nearly 80% between 2000 and 2025 through Vail. Especially problematic areas have been identified on Vail Pass and through Dowd Junction.

Vail is a resort community separated by an interstate highway and frontage roads. The 2002 update to the *Vail Transportation Master Plan* discussed capping the interstate through Vail with a "lid". A cut-and-cover tunnel in which to place the interstate traffic was discussed as a potential opportunity to create a more cohesive and livable community. While solving these transportation issues, a lid on the interstate provides for a substantial opportunity for new commercial, residential, recreational, and open space development by creating more than 350 acres of developable land in Vail over the interstate.

The overall concept for funding this massive effort included development companies financing the cut-and-cover tunnel construction, operation, and maintenance costs in exchange for development rights on and adjacent to the lid. The concept included: 1) transference of the air rights above the interstate to development companies; 2) the continuance of projected Colorado Department of Transportation (CDOT) funding levels for capital improvements, operations, and maintenance; and 3) a no-cost scenario for the Town of Vail. In 2002, the range of developable land values near Lionshead and Vail Village were between $2.5 to $6.0 million per acre, and outside these areas, $0.5 to $1.8 million per acre, depending on location and zoning.

The feasibility of the cut-and-cover tunnel was not extensively investigated as the anticipated construction costs and impacts were extremely high. Creating a cut-and-cover tunnel under I-70 required maintaining the interstate traffic through Vail during the construction. The overall construction and socioeconomic impacts to Vail and the surrounding area during the several years of construction through Vail was not palatable for the businesses and residents of Vail.

Recently, the concept of constructing a tunnel under Vail Mountain, bypassing the Town of Vail altogether, was discussed as a long-term vision for Vail. An essentially straight alignment from east of East Vail, near Timber Creek, to the Dowd Junction area could be constructed and avoid many of the impacts associated with the cut-and-cover tunnel approach under Interstate 70.

Another concept discussed was to tunnel around the north side of I-70 from the area near Gore Creek Campground to the Dowd Junction or West Vail areas. This concept could be divided into east and west segments, with the segments connecting near the Vail Public Works facilities. The east segment could have an

alternate that essentially takes a straight shot approach west of Bighorn from the area near Timber Creek to Vail Public Works. The west segment could daylight near West Vail or at the Eagle River near Eagle-Vail.

This document presents the initial thoughts on these tunnel option concepts. The document will identify and quantify the basic elements of tunneling options and the general considerations in tunneling. Options are presented with a schematic alignment and portal locations, an initial interpretation of the geology, and general tunneling considerations. Information is provided on project costs, schedules, and potential phasing alternatives. Each of the tunnel options are compared against public benefit and impacts. And, finally, recommendations are discussed for the next steps in determining the overall viability of the endeavor.

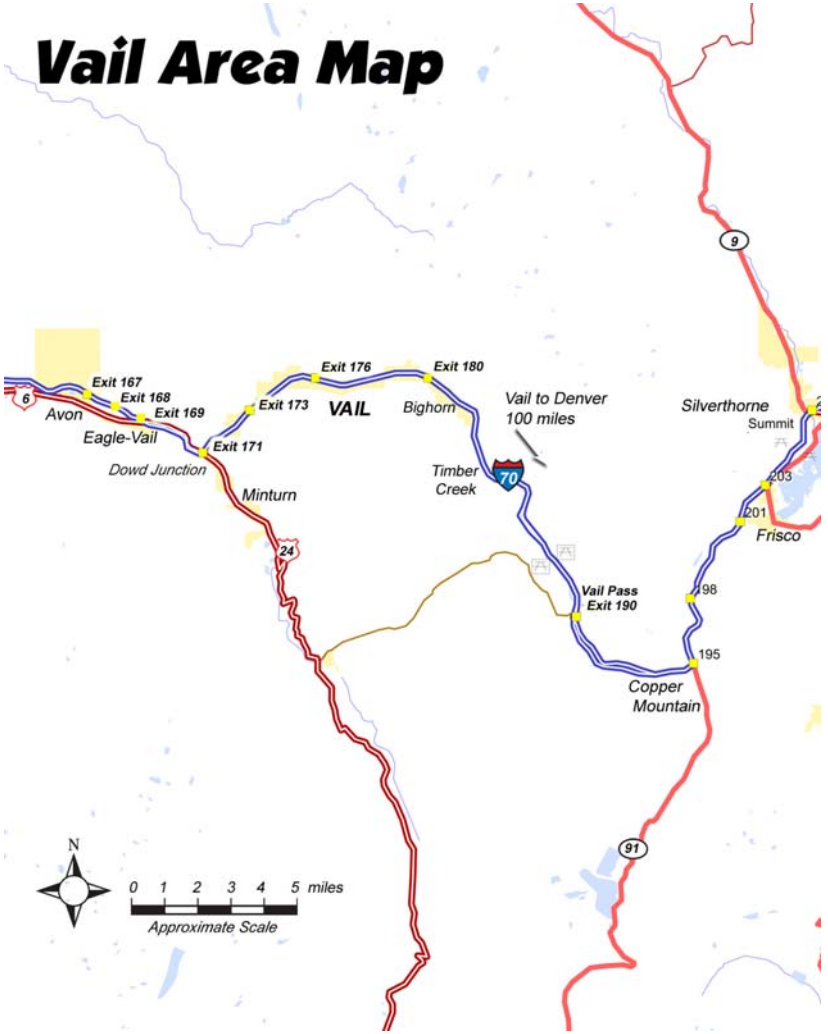


Figure 1. General Area of Vail

2.0 Transportation Considerations

Given the projected increases in traffic along I-70, the tunneling concepts consider providing additional roadway capacity and transit to the existing system. For the purposes of this document, two tunnels are considered with three (3) lanes in each tunnel, each tunnel adding a lane in each direction to the current I-70. Interchanges would be constructed at both ends of the tunnel for connection to I-70 and Vail.

In terms of transit, it is critical to look at both statewide and regional transit. Several studies have been conducted, each indicating the need for transit, as Vail has been identified as a critical intermodal center in many studies. If a high speed system were to be constructed from Denver to the mountains, Vail is a key station on the route. Regionally, Vail draws much of its workforce outside the town limits, largely along the I-70 corridor to the west and from Leadville. High-speed transit from Denver could either be placed in a tunnel or continue along the existing interstate through Vail. If a regional mass transit system, other than buses, was installed, it would likely continue into Vail. The two systems would have at least one common station in the Vail area.

High-speed transit in the tunnel would require widening of one of the roadway tunnels or a separate tunnel. A separate transit tunnel is considered in this study. The transit tunnel can also provide for some tunnel services, including ventilation, infrastructure utilities, and emergency excapeway.

Interstate hazardous material transport would likely be hauled through the tunnel, bypassing Vail. Special considerations in tunnel design and additional operations equipment are required in transporting hazardous materials through tunnels.

3.0 Tunnel Options

This document considers five (5) general tunnel options for relocating I-70 through Vail. The general tunnel options originated from discussions with Town of Vail Staff and other associated individuals. Essentially, the options include 1) a tunnel connecting on I-70 at approximate milepost 184 (MP-184), east of the East Vail Interchange, to the Dowd Junction area (MP-171); 2) a tunnel around the north side of I-70, connecting on I-70 at approximate MP-182, near the Gore Creek Campground, to the Dowd Junction area; 3) a tunnel connecting on I-70 at approximate MP-184, exiting at the Golf Course and re-entering a tunnel on the north side of I-70 to connect to the Dowd Junction area; 4) the initial concept of a cut-and-cover under I-70 from the East Vail Interchange (MP-180) to the Dowd Junction area; and 5) a tunnel connecting on I-70 at approximate milepost 184 (MP-184), east of the East Vail Interchange, extending to the Eagle-Vail area (MP-170);

Three of the tunnel options have alternative west portal locations at the area near West Vail or near the Eagle River in the Dowd Junction area. The prime consideration

for these alternate west portal locations is the ability to connect closer to the West Vail area. It is assumed that if the portal is located in the West Vail area, the additional capacity and safety improvements needed on I-70 through Dowd Canyon are be accomplished though the CDOT Dowd Canyon Tunnel alternative presented in the draft PEIS and shown on Figure 2.

The tunnel options presented in this document represent a first-look at the options to relocate I-70 through Vail. It is the intent to narrow the focus of tunnel options for future tunnel feasibility studies. The general tunneling options considered in this study include the following general alignments and portal locations. Option 1 has two alternative west portal locations. Options 2 and 3 each have two segments, an East Segment and a West Segment, with the West Segments having two west portal alternatives.

An overview schematic of all considered tunnel options is shown in Figure 2. A schematic map of each tunnel option is presented with a discussion of the option on subsequent pages.

Option 1 - Tunnel under Vail Mountain

- East Portal near Timber Creek
- West Portal Alternatives
  - South of Dowd Junction near Eagle River
    Tunnel Length 8.6 miles, 2.9% grade
  - West Vail area
    Tunnel Length 8.0 miles, 2.6% grade

Option 2 – Tunnel North of I-70

East Segment

- East Portal near Campground
- West Portal at Public Works
  Tunnel Length 5.6 miles, 1.5% grade

West Segment

- East Portal at Public Works
- West Portal Alternatives
  - North of Dowd Junction near Eagle-Vail
    Tunnel Length 6.4 miles, 1.3% grade
  - West Vail area
    Tunnel Length 5.2 miles, 0.9% grade

Option 3 – Tunnel West of Bighorn to North of I-70

East Segment – West of Bighorn

- East Portal at Timber Creek
- West Portal near Golf Course
  Tunnel Length 4.2 miles, 3.1% grade

West Segment – North of I-70 (same as Option2)

- East Portal at Public Works
- West Portal Alternatives
  - North of Dowd Junction near Eagle-Vail
    Tunnel Length 6.4 miles, 1.3% grade
  - West Vail area
    Tunnel Length 5.2 miles, 0.9% grade

Option 4 - Cut-and-Cover Tunnel under I-70

- East Portal at East Vail Interchange
- West Portal at Dowd Junction
  Tunnel Length 8.0 miles, 0.4% grade

Option 5 - Tunnel under Vail Mountain to Eagle-Vail

- East Portal near Timber Creek
- North of Dowd Junction near Eagle-Vail
  Tunnel Length 9.4 miles, 2.6% grade

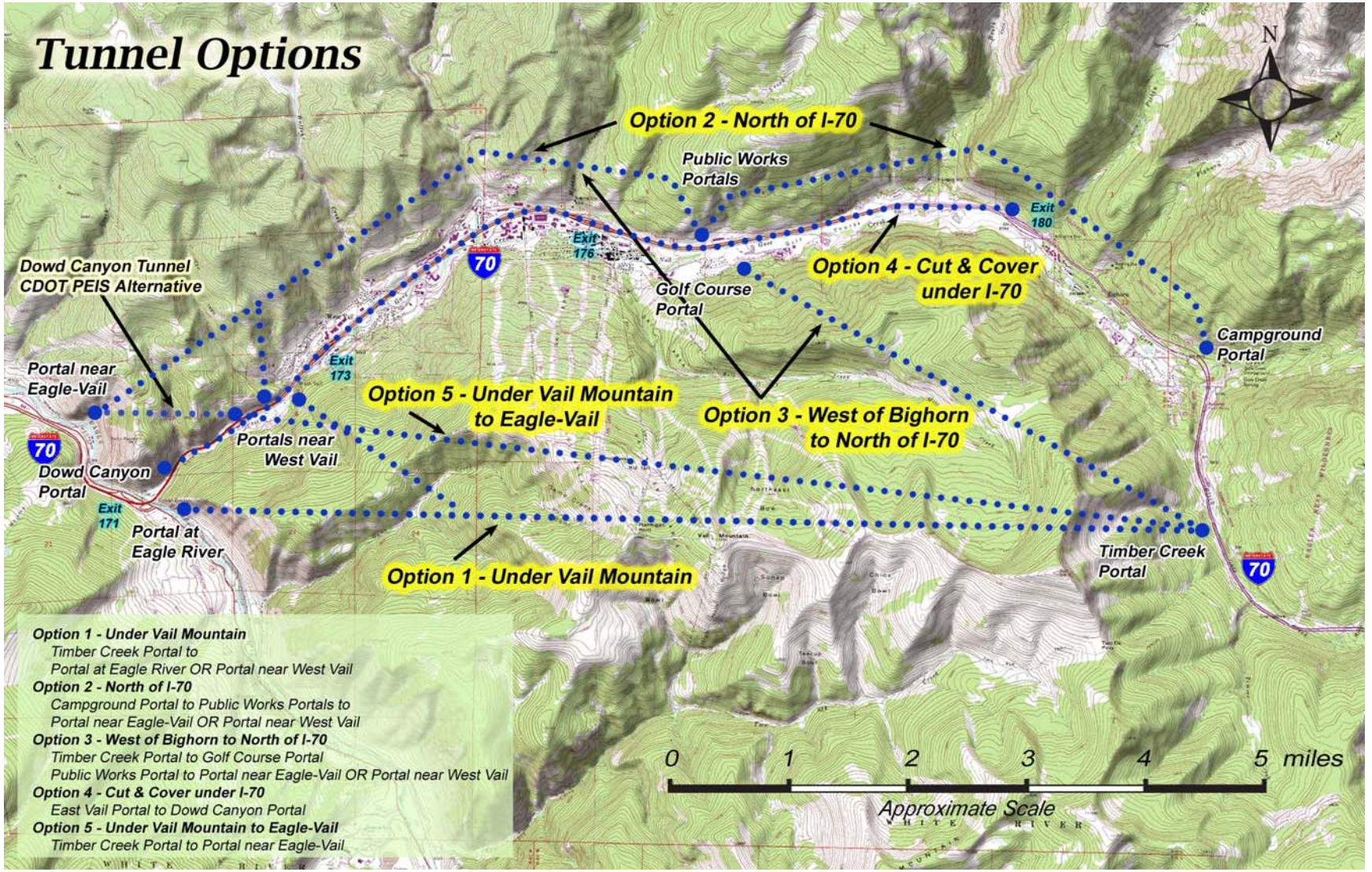


Figure 2. Overview of Tunnel Options

4.0 Tunnel Considerations

Project Overview Relocating I-70 through any of the options presented in this document will require interchange construction to connect the tunnel to I-70 and some detouring of interstate traffic. Each of the options will be different and general considerations for interchange construction and traffic detouring are presented with the discussion on each tunnel option.

The mobilization and staging of any of the tunnel options may require areas at both portal locations. A few acres for staging of materials may be required at each portal. Staging areas used during construction could be used for locating permanent tunnel infrastructure. The availability of adequate staging areas will be presented with the discussion on each tunnel option.

Tunnel Alignment and Portal Locations To derive reasonable alignments for the general tunnel options, alignments were based upon terrain mapping and an initial interpretation of available USGS geology mapping by Yeh and Associates, Inc. The alignments derived for this document were chosen with reasonable locations for portals and attempt to avoid many of the major faulting shown on the geology maps. Future studies should investigate specific alignments and portal locations.

Tunnel Excavation Assumptions For purposes of calculating an approximate quantity of tunnel excavation, an arched tunnel section with a width of 52 feet and height of 37 feet is assumed for three (3) lanes of traffic. The cross section approximates the Dowd Canyon Tunnel depicted in the PEIS. Cross passages are considered with a width of 20 feet, height of 12 feet, and at an average of 1,100 feet spacing. If a separate mass transit/service tunnel were added, an approximate diameter of 25 feet is considered for a separate tunnel, likely situated between the two tunnels.

The material excavated from the tunnel expands, or bulks, into a higher volume. For the excavated material in this area, a bulk, or fluff factor of 40% is considered. In other words, for every 100,000 cubic yards of in-situ material, 140,000 cubic yards will be the approximate volume considered for either use at the portal areas or hauled to disposal sites. It is assumed that approximately 70% of the excavated material will need to be hauled from the tunnel area. Haulage and disposal of tunnel excavation material is discussed under *Tunnel Excavation Disposal* later in this section.

The assumptions made for tunnel dimensions, excavation factors, and haulage of excavated material are used for Options 1, 2, 3, and 5. Option 4 – Cut-and-Cover I-70 uses slightly different dimensions, excavation factors, and haulage of excavated material. The assumptions for the cut-and-cover tunnel will be presented in the discussion on Option 4 – Cut-and-Cover under I-70.

Geology & Groundwater Yeh and Associates, Inc. provided an initial interpretation of the USGS geology maps for each of the options. Option specific geology is

provided within each of the option discussions. The Yeh and Associates interpretation memorandums are included in the Appendix.

Excavation Methods The initial interpretation of the geology indicates that traditional drill and blast methods, coupled with the New Austrian Tunnel Method (NATM) could be used to excavate the tunnels. Typically, for the tunnel cross section assumed for the options in this document, approximately 25 feet per day of tunnel length production can be anticipated.

Obtaining the best overall schedule using drill and blast methods, excavation would proceed from both ends of the tunnel, allowing four faces to be worked at once. With likely tunnel excavation material disposal sites west of the Vail area, the major production effort should be from the west portal in order to minimize tunnel excavation material haulage impacts.

The use of a tunnel boring machines (TBM) may be applicable dependent on the rock quality, availability of TBM's, and the availability of electric power. A considerable advantage in using a TBM is the higher production rate, about four (4) times that of drill and blast methods. A TBM could average approximately 100 feet per day. Typically, the TBM's would drive the tunnels up-grade to minimize problems with groundwater during excavation. This would provide all excavation to exit the west portals, virtually eliminating the major impact of haulage of tunnel excavation material over the interstate through Vail.

Obviously, the initial high capital cost of the TBM's would need to be compared with other excavation methods and production rates. A new TBM can be expected to perform well for the first five (5) miles or so of excavation before it will need a major maintenance overhaul.

At the current time, however, there is no TBM that could bore a three (3) lane tunnel of the assumed dimensions. TBM's although, have been made to excavate a four (4) lane tunnel, with two (2) lanes at ground level and two (2) lanes on a deck above the ground-level lanes. A two-over, two-under lane configuration may not be suitable for the options presented in this document.

One concept discussed during the preparation of this document was excavating each tunnel with two 25-foot diameter TBM's, arranged side by side, leaving a pillar in the middle which would be excavated by conventional drill and blast methods. The spacing of the TBM's would largely depend on the needed cross section for ventilation requirements. The TBM's would drive uphill from one direction only. This concept should be explored in the feasibility study as the higher production rate of TBM's would compress the overall schedule of drill and blast methods.

Tunnel Support Ground support systems would be installed as the tunnel is excavated. Based on the initial interpretation of the geology, tunnel support requirements could include a system of rock bolts, shotcrete, and mesh designed for the conditions.

Generally, different classes of support systems are designed for a tunnel and implemented as the ground conditions dictate. Areas where faults or otherwise poor ground conditions are encountered may require additional support systems. Tunnel support should not be a fatal flaw in any of the options.

Tunnel Excavation Disposal All of the tunnel options will require several million cubic yards of excavated material to be removed from the tunnel and either used or disposed. A portion of the tunnel excavation material can be used to create staging areas, fills, and abutments in the portal areas and interchanges. A substantial portion of the tunnel excavation material, however, will need to be hauled from the immediate portal and interchange areas. For the purposes of this document, it is assumed that approximately 70% of the excavated material will need to be hauled from the portal areas for each of the tunnel options, except for Option 4 – Cut-and-Cover I-70.

The cut-and-cover option would not necessarily have large bridge abutments as in the other options. It is assumed for this document that as much as 80% of the excavated material may need to be hauled away from the tunnel and Vail, depending on how much can be used in the "cover" and adjacent areas of the tunnel.

There appear to be some areas down valley of Vail where existing terrain is too steep for development without cuts or fills. Tunnel excavation material could be used to bring these areas to a developable state. Gravel pits down valley of Vail may also be a potential for tunnel excavation material disposal.

Discussions revealed that additional water reservoirs may be needed in the area over the next fifty years or so, and some of the tunnel excavation material can be used for constructing portions of the reservoirs, adjoining facilities, and roadways. The tunnel excavation material should be able to be used for embankment construction for roads, dams or for general site grading. Additional processing of the tunnel material could produce structural fill material. Most dams require an impermeable core material for which the tunnel excavation material would likely be unsuitable.

The haulage of the tunnel excavation material will also present some considerations different than in tunnels of a much shorter length. With all of the tunnel options exceeding four (4) miles in length, in-tunnel haulage will likely be served by a continuous system, belt conveyors, to remove the muck from the tunnel. Once on the surface, it needs to either used in that location, or hauled away.

If end-dump trucks were to haul 70% of the entire amount of tunnel excavation material, a significant impact would be expected on the interstate traffic. Each tunnel option provides a discussion of the anticipated haulage impacts.

Provisions may be able to be made with the railroad to activate a portion of the Tennessee Pass Line for

movement of tunnel excavation material away from the tunnel site. Tipples could be established at the railroad for loading railcars. Considering the size of the excavated material, side-dump rail cars will be required in lieu of standard ballast or coal cars. By far, this may be the most suitable and cost effective option for hauling the excavated material away from Vail.

Depending on the amount of material and the location for its use, temporary overland conveyors may also provide beneficial use in getting tunnel excavation material to a specified location.

Further investigation is needed to determine specific locations for tunnel excavation material use and disposal. The haulage of the tunnel excavation material has a significant impact on the cost of the overall project and use or disposal should be as close to the tunnel as possible.

Tunnel Ventilation Ventilation will be a challenge, but is not expected to be a fatal flaw in the design of any of the options. Both ventilation during excavation and ventilation during operation must be addressed in these long tunnels. Ventilation during excavation of the longer tunnel options will present a considerable challenge due to the length of the tunnel. The separate transit/service tunnel mentioned earlier may be a means to provide adequate tunnel excavation ventilation through a three (3) entry room-and-pillar development. The third tunnel could also be a key component in the overall ventilation system during tunnel operation.

The use of jet fans in tunnels have shown significant success in ventilating long tunnels and should be investigated further. Other considerations for tunnel ventilation include intermediate adits or openings to the surface for supplementing ventilation.

In all cases with tunnels of this length, it is critical to provide the least frictional resistance for airflow in the tunnels. An exfoliating paint on a tunnel concrete liner with a waterproof membrane is a cost effective way of minimizing frictional resistance for airflow. The exfoliating paint would be a considerably less-expensive treatment than using tiles on a liner as with many current tunnels. The tunnel liner would not be considered as a ground support element.

A subsequent feasibility study should prepare ventilation studies to determine the best approach to tunnel ventilation, both during excavation and operation.

Tunnel Infrastructure The essential infrastructure systems and facilities for all tunnel options include:

- Power Supply & Distribution
- Ventilation
- Fire Life Safety
- Tunnel Lighting
- Water Supply and Drainage
- Surveillance and Control
- Emergency & Service Vehicles
- Service Buildings

Electrical substations will be required for the tunnel operation and during construction, especially if TBM's are used for excavation. The substations can be housed within the tunnel or in out-buildings.

If jet fans are used for ventilation, much of the ventilation infrastructure seen at the Eisenhower Tunnel could be avoided, as the jet fans are located within the tunnels, spaced according to the ventilation needs. If centralized ventilation were chosen, infrastructure would be needed that at daylights at the surface.

Fire-life safely considerations for tunnels are well defined by law. If a transit/service tunnel were included, it could serve some of the functions to meet the established criteria.

The lighting of tunnels has varied from tunnel to tunnel, but one consideration common in recent tunnels, is the need to have transitional lighting – that is lighting at the entrance and exit of the tunnel that helps the driver's eyes adapt to the tunnel conditions and then to the outside. In some longer tunnels, transitional lighting has been used in the portal areas with no lighting in the tunnel. Some tunnels have continuous lighting.

The tunnels will require a water supply system, both for operations and emergency use. It is practical to assume that water wells can provide the needed supply, as long as water right issues are addressed. A drainage system will also be needed. The drainage system will need to assure adequate water quality upon discharge from the tunnels. It is likely that the water and drainage system could all be installed within the tunnels.

Surveillance and control systems will be required in the tunnel. This will include closed circuit video monitoring, air and water quality monitoring, fire detection, AM/FM radio rebroadcast, and traffic control devices. Typically, variable message signs will be located on the tunnel approaches. The surveillance and control systems will need a centralized control room that can be housed either within the tunnel or in a structure located outside the tunnel with connections to other CDOT control systems.

With the assumption that hazardous material transport will flow through the tunnels, emergency support equipment will be necessary close, if not, within the tunnels. The equipment would include various emergency and fire fighting equipment, tow trucks, and other tunnels service vehicles.

As can be seen, most of the tunnel infrastructure can be all housed within the underground environment, as with the I-70 Hanging Lake Tunnels, however, housing infrastructure underground is usually more costly than on the surface. If the tunnel daylights at a location that has adequate space for the infrastructure and is relatively shielded from residential areas, the portal surface area may be an appropriate location for some of the infrastructure facilities. If the tunnel daylights in an area with minimal space or near residential areas, the location of the facilities may be forced underground.

5.0 Option 1 - Tunnel under Vail Mountain

Tunneling under Vail Mountain provides the opportunity to relocate I-70 from approximately MP-184 to MP-170, relocating approximately 14 miles of I-70 into 8.6 miles of tunnel. Two alternative west portal locations are presented. Schematic tunnel alignments for these two alternatives under Option 1 are shown in Figure 3.

One alternative for location of the west portal is located south of Dowd Junction towards Minturn at the Eagle River (A). With this location, the total tunnel length would be 45,400 feet with an average grade of 2.9%. This area could provide adequate staging for tunneling and interchange construction, as well as an ideal location for transferring tunnel excavation material onto railroad cars, if that haulage option was chosen. With this west portal location, the alignment bypasses Vail altogether. This alignment would require bridge structures and a reconfigured interchange to reconnect to I-70. Landslides in the Dowd Junction area would have a considerable affect on the design and cost of the bridges and interchange.

The other alternative for the west portal is located near West Vail (B). At this location, the total tunnel length would be 42,100 feet at an average grade of 2.6%. While this may be an ideal location for connection to Vail, this west portal location presents impacts in the West Vail area, especially during construction. It would be a considerable challenge to arrange staging, tunnel operations, and haulage operations from this location due to the proximity of residential areas. The location of the west portal would be identified by keeping the alignment on public property, thereby minimizing any major residential impacts. This alignment provides an opportunity for a connection closer to Vail and, with a bridge over the interstate, a connection to the Dowd Canyon Tunnel depicted in the PEIS. A portal in this area would have a greater visual and noise impact on residential property in West Vail than the other portal alternative. An alternative not considered in this option would tunnel under Gore Creek and I-70 and connect directly to the Dowd Tunnel, thereby reducing the visual and noise impacts in West Vail. This option should be considered in the feasibility study and future discussions, albeit, this added tunneling comes at a high cost.

The east portal could be located in the area of Timber Creek at approximate MP-184 and should be oriented to provide the best configuration between I-70 and tunnel alignment. The east portal area could provide adequate staging for tunneling and interchange construction. Interchange construction at the east end of the tunnel would provide similar traffic impact during construction as with most other interstate highway interchanges.

The table below shows the elevations of the portals, tunnel lengths, and roadway grade for each of the two alternatives for Option 1 discussed. The length and grade of these alignments are within tunnel design possibility.

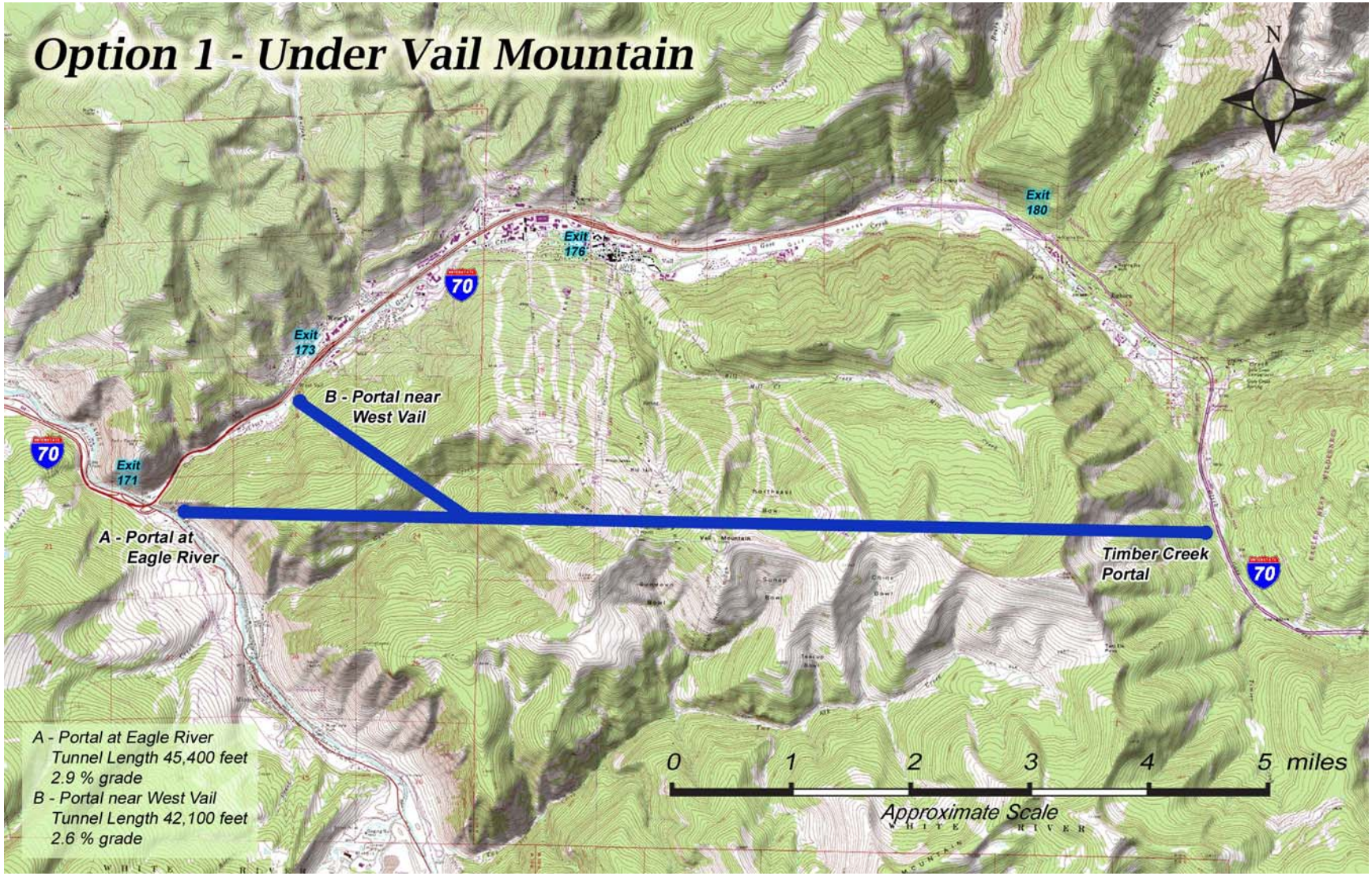


Figure 3. Option 1 - Tunnel under Vail Mountain

Option 1 - Tunnel under Vail Mountain Elevation, Length, Grade	Alignment with Portal South of Dowd Junction	Alignment with Portal near West Vail
East Portal Elevation	9,100 ft.	9,100 ft
West Portal Elevation	7,800 ft.	8,000 ft.
Portal Elevation Difference	1,300 ft.	1,100 ft.
Tunnel Length	45,400 ft.	42,100 ft.
Tunnel Grade	2.9 %	2.6 %

Geology & Groundwater The tunnel alignment presented here would encounter the 2000 to 6000 foot thick Minturn Formation, which consists of Middle Pennsylvanian aged interbedded conglomerate, course and finer grained sandstone and shale layers interstratified with beds of carboniferous rock. The excavated rock will consist of carboniferous rock such as limestones, dolomites, sandstones and shales.

The eastern end of the alignment encounters the middle to upper stratigraphic portions of the formation while the western sections will encounter the lower units within the formation. These lower units are visible in the I-70 road cut just to the west of the west Vail interchange. The middle and upper parts of the formations are exposed on the south side of the Vail Valley near the East Vail interchange. The alignment crosses several mapped structural synclines so that the relatively gentle dip of the bedding is to the west at the eastern end of the alignment and dipping to the east at the western end of the alignment. The existing mapping shows the bedding dips of accessible outcroppings at generally less than 20 degrees.

In addition to the synclines, the mapping also identifies several high angle faults along the alignment with predicted displacements of several hundred feet. Tunneling through faulted ground is a fairly common practice, especially in mountainous terrain. Faults and shear zones can indicate areas of rock which are more altered and fractured. Additional ground water inflow may also occur in faulted and highly fractured areas. Early recognition and planning are important factors in limiting the impact of geological problems if it is discovered that faulted ground is a common condition along the alignment.

Numerous Quaternary landslides are mapped along the south side of the Vail Valley. These surficial features may extend to several hundred feet in depth and may affect portal location but are unlikely to affect the tunnel alignment itself.

Groundwater forms ice flows along the south side of the valley near east Vail. These ice flows indicate that some groundwater will be present during excavation. The affect of the water on cost, construction and performance of the tunnel will depend on horizontal and vertical permeability of the formation and on whether the ice flows are formed by a perched water table or regional groundwater influences.

Most of the excavated material will be suitable for embankment construction for roads, dams or for general site grading. Additional material processing would be required to produce structural materials.

Tunnel Excavation Considering the alignment with the west portal south of Dowd Junction, for two (2) 3-lane tunnels, the total tunnel excavation calculates to approximately 5.5 million in-situ cubic yards. This volume of tunnel muck amounts to approximately 11.6 million tons. With a fluff factor of 40%, this equates to 7.8 million cubic yards that would need to be either used at the portal locations or hauled and disposed. It is assumed that approximately 70% of the excavated material will need to be hauled from the tunnel area, or 5.4 million cubic yards.

If a separate transit/service tunnel were added, approximately 0.4 million in-situ cubic yards would be additionally excavated. With a fluff factor of 40%, this excavation equates to 0.6 million cubic yards or 0.9 million tons that would need to be used at the portal areas or hauled and disposed.

Option 1 – Tunnel Under Vail Mountain West Portal South of Dowd Junction		
Excavation	**2 – 3-Lane Tunnels**	**2 – 3-Lane Tunnels + Transit/Service Tunnel**
In-situ Excavation	5.5 million cy	6.0 million cy
Excavated Tons	11.6 million tons	12.5 million tons
Material Disposal	5.4 million cy	5.8 million cy

The alignment with the west portal near West Vail is approximately 0.6 miles shorter than the tunnel with the west portal south of Dowd Junction. The table below provides the quantification of the excavation for this alternative portal location.

Option 1 – Tunnel Under Vail Mountain West Portal near West Vail		
Excavation	**2 – 3-Lane Tunnels**	**2 – 3-Lane Tunnels + Transit/Service Tunnel**
In-situ Excavation	5.1 million cy	5.5 million cy
Excavated Tons	10.8 million tons	11.6 million tons
Material Disposal	5.0 million cy	5.4 million cy

As mentioned earlier, conventional drill and blast methods can be employed to excavate the tunnel, however, of all the options discussed in this document, the concept of using multiple TBM's may have its highest applicability in the alignment with the west portal south of Dowd Junction. The portal location south of Dowd Junction would be the staging area for the TBM's driving uphill to the east and would provide an excellent transfer location of tunnel excavation material to end dump trucks, or more preferably, onto railroad cars for disposal.

Tunnel excavation though the alignment with the west portal near West Vail will be more difficult than at the portal south of Dowd Junction, primarily due to it being closer to existing development and the associated impacts. If staging could be arranged, excavation can proceed similarly to that at the portal south of Dowd Junction, albeit, without the connection to the railroad.

Tunnel Support From an initial look, tunnel support requirements could include a system of rock bolts, shotcrete, and mesh. Areas where faults or otherwise poor ground conditions are encountered may require additional support systems. The west portal located at south of Dowd Junction may require consideration of potential rock fall hazard mitigation.

Tunnel Excavation Disposal The west portal south of Dowd Junction provides the most suitable location for creating fills with tunnel excavation material close to the tunnel. Other than areas for bridge abutments and minor tunnel infrastructure elements, the west portal near West Vail may not provide significant area for material disposal in the form of fills.

For the alignment with the west portal south of Dowd Junction with two (2) 3-lane tunnels, it is calculated that approximately 5.4 million cubic yards will need to be hauled from the tunnel area. Using an average of 12 cubic yards per end dump truck, this equates to approximately 450,000 loaded trucks hauling material on the roads. If the transit/service tunnel were included, a total of approximately 490,000 loaded truck trips could occur.

For the alignment with the west portal near West Vail, approximately 420,000 loaded trucks would be needed for the two (2) 3-lane tunnels and 450,000 loaded truck trips for the two (2) 3-lane tunnels plus the transit/service tunnel.

The number of loaded truck trips on the road on a daily basis is dependent on the production rate. Considering that either of the alternatives in this option would require about four (4) years of excavation, between 300 and 390 loaded truck trips per day would be expected. If haulage occurred for two (2) shifts per day, six (6) days per week, sixteen (16) hours per day, approximately 20 to 24 loaded truck trips per hour could be expected. In terms of both loaded and returning unloaded truck trips, the overall impact would be in the range of 40 to 50 trucks per hour on the roads for either of the alternatives in this option.

The alternative of subcontracting the haulage to the Union Pacific Railroad, utilizing the Tennessee Pass line will likely provide a less expensive and less impactive disposal of haulage for this option.

Tunnel Ventilation Ventilation of this long tunnel will be difficult and costly. If the transit/service tunnel were included in the project, it could serve as a key component in the ventilation, for both construction and operation. If the separate transit/service tunnel is not chosen, a supplemental ventilation adit may be needed in addition to jet fans to adequately ventilate the tunnel. Access roads exist to the area above the tunnel on Vail Mountain where a ventilation adit may be located. The ventilation system for this option should be designed early in the process so as to determine what type of system is most practical and if a supplemental adit will be necessary. If an adit is needed, environmental

clearance through the NEPA process will be necessary in conjunction with the tunnel process.

Tunnel Infrastructure As mentioned earlier, the essential infrastructure systems and facilities can be located at the portals or can be all housed within the underground environment. The east portal near Timber Creek is in US Forrest land and it would natural to assume minimizing surface infrastructure. The alignment with the west portal south of Dowd Junction has the best opportunity for providing surface infrastructure systems and facilities. The alignment with the west portal near West Vail could have some infrastructure located on the surface, but sensitivity to the nearby residential areas will be of paramount importance.

6.0 Option 2 - North of I-70

Tunneling north of I-70 relocates approximately 14 miles of I-70 into 11 to 12 miles of tunnel. For this option, two tunnels are constructed, East and West Segments, presenting an opportunity to phase the construction of the tunnels and provide a direct connection to Vail.

The East Segment has an east portal located near the Gore Creek Campground at approximately MP-182. The west portal considered is near the Vail Public Works facilities. The West Segment has an east portal located near Vail Public Works and two (2) alternatives for a west portal. One alternative is to locate the west portal in the same area as where the CDOT Dowd Canyon Tunnel is located, near Eagle-Vail. The other alternative is to portal out near West Vail, as in Option 1, but on the north side of I-70. Schematic tunnel alignments for these two alternatives under Option 2 are shown on Figure 4.

This option will be discussed in two parts, the East Segment followed by the West Segment. Note that the West Segment of this option is the same as the West Segment of Option 3 – West of Bighorn to North of I-70.

EAST SEGMENT - *Option 2 - North of I-70*

The East Segment has an approximate length of 29,300 feet at an average grade of 1.5%. For the East Segment, the east portal alignment has a natural transition for a tunnel north of I-70. The East Portal has area suitable for staging and interchange construction, however, impacts to the residential areas and campground and require consideration. The area at the Vail Public Works facilities, with modification, could provide staging for the East Segment.

The table below summarizes the tunnel magnitude

Option 2 – North of I-70 East Segment Elevation, Length, Grade	
East Portal Elevation	8,700 ft.
West Portal Elevation	8,250 ft.
Portal Elevation Difference	450 ft.
Tunnel Length	29,300 ft.
Tunnel Grade	1.5 %

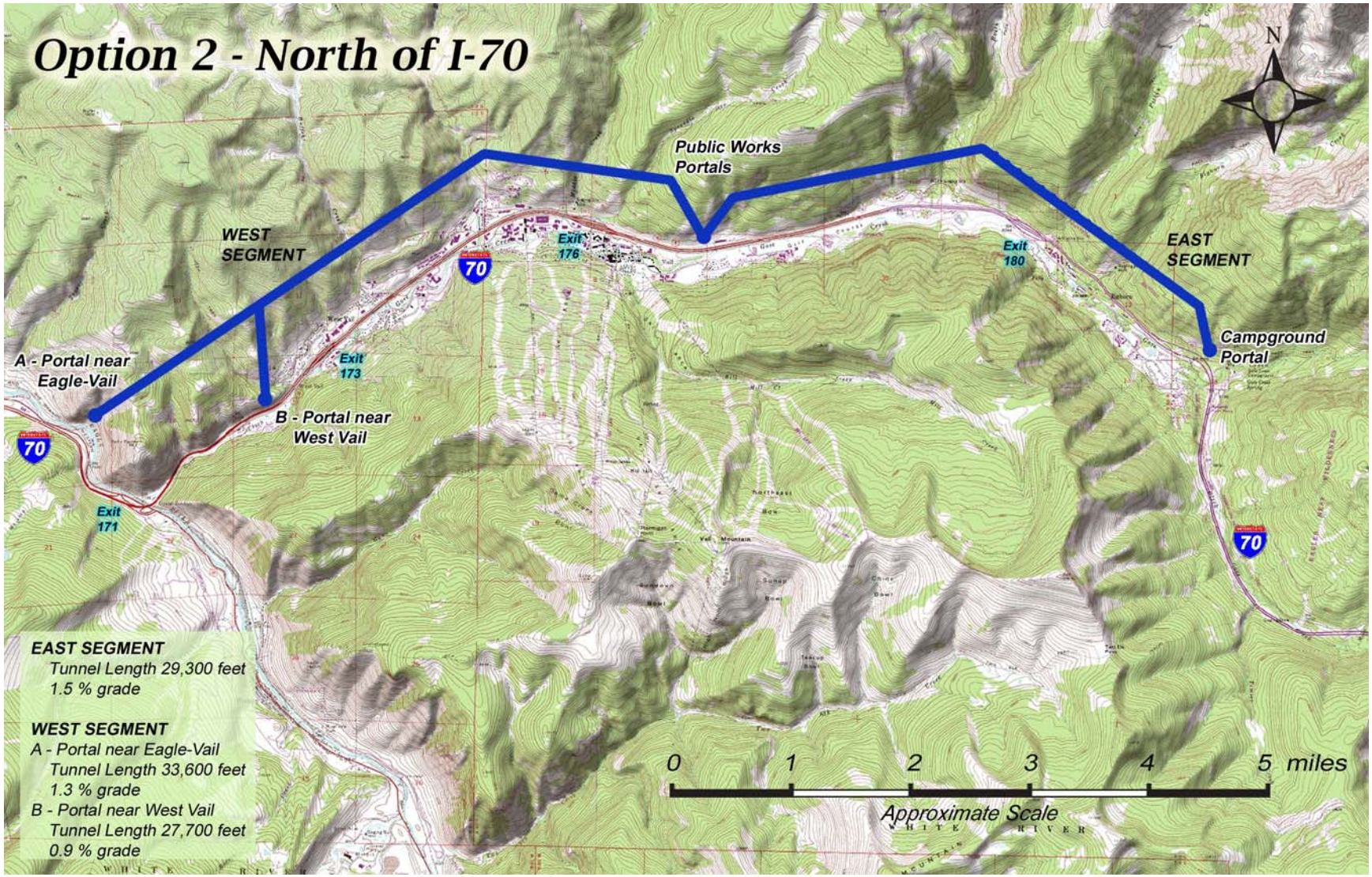


Figure 4. Option 2 - Tunnel North of I-70

Geology & Groundwater The eastern 4,000 to 10,000 feet of this segment would be excavated through the Precambrian aged Cross Creek granite. The USGS describes this as "granodiorite and quartz monzonite, porphyritic in part". The degree of alteration and fracturing is unknown; however the igneous rock is likely to be more blocky and hard than the sedimentary Minturn Formation. Where the alignment traverses the contact between the Precambrian granites and the Minturn Formation sandstones, shales and carboniferous sedimentary rock, there is a higher potential for extensive alteration and fracturing as well as frequent changes in joint and bedding orientation, shear zones and smaller faults. It is not possible to predict where this contact will occur without additional study.

The east portal and tunnel in this section may encounter deposits of glacial drift of unknown thickness which will impact tunneling and portal location and development. At the west portal near the Vail Public Works facilities there is a Quaternary landslide deposit that periodically exhibits high groundwater and minor movement which has affected the interstate over several hundred feet several times in the past 25 years. Tunneling in or portaling out in this landslide deposit will be problematic. The Spraddle Creek Fault, a graben like structure and the presence of steeply dipping beds all indicate potential problems at this end of the East Segment as well as for the west end of the West Segment. Fracturing, alteration of the rock and groundwater inflows are all potential problems here that will require further investigation.

Some of the excavated material will be suitable for embankment construction for roads, dams or for general site grading. Additional material processing would be required to produce structural materials.

Tunnel Excavation The table below provides the quantification of the excavation for the East Segment.

Option 2 – North of I-70 East Segment		
Excavation	**2 – 3-Lane Tunnels**	**2 – 3-Lane Tunnels + Transit/Service Tunnel**
In-situ Excavation	3.6 million cy	3.8 million cy
Excavated Tons	7.5 million tons	8.0 million tons
Material Disposal	3.5 million cy	3.8 million cy

As mentioned in the Geology & Groundwater section above, tunneling through this area will be more problematic than with most other options. With that in mind, the use of a TBM may not be as applicable in this segment. Conventional drill and blast methods can be employed to excavate the tunnel, driving from both ends of the tunnel, with primary staging near the Vail Public Works facilities.

Tunnel Support As in other options, tunnel support requirements could include a system of rock bolts, shotcrete, and mesh. Areas where faults or otherwise poor ground conditions are encountered will likely require additional support systems. Both portal locations may require consideration of additional support. The

west portal, near the Vail Public Works facilities should be investigated for potential rock fall hazard mitigation.

Tunnel Excavation Disposal The west portal near the Vail Public Works facilities provides the most suitable location for creating fills with tunnel excavation material close to the tunnel. With the Gore Creek Campground nearby, the east portal may not provide an appropriate location for tunnel excavation material disposal.

The only practical means for haulage of tunnel excavation material from this site is by trucks over the interstate. With two (2) 3-lane tunnels, it is calculated that to haul the 3.5 million cubic yards of tunnel muck, approximately 290,000 loaded trucks hauling material on the roads. If the transit/service tunnel were included, a total of approximately 314,000 loaded truck trips could occur.

Considering about three (3) years of excavation for this excavation, between 310 and 330 loaded truck trips per day would be expected. If haulage occurred for two (2) shifts per day, six (6) days per week, sixteen (16) hours per day, approximately 20 loaded truck trips per hour could be expected. In terms of both loaded and returning unloaded truck trips, the overall impact would be in the approximately 40 trucks per hour on the roads.

The alternative of subcontracting the haulage to the Union Pacific Railroad, utilizing the Tennessee Pass line may not provide a cost effective solution for this segment due to the multiple handlings of the material.

Tunnel Ventilation Ventilation of this segment is possible without supplementary adits, however, the proximity to the surface of some areas along this alignment, may provide opportunities for a more efficient ventilation system with a supplementary adit. As with other options, the ventilation system for this segment should be designed early in the process so as to determine what type of system is most practical and if a supplemental adit will provide a more cost effective solution.

Tunnel Infrastructure The essential infrastructure systems and facilities may be best located near the Vail Public Works facilities or housed within the underground environment. The east portal near Gore Creek Campground is in US Forrest land and it would natural to assume minimizing surface infrastructure.

WEST SEGMENT - *Option 2 - North of I-70*

For the West Segment, if the west portal was located north of Dowd Junction towards Eagle-Vail at the Eagle River, the approximate length is 33,600 feet with an average grade of 1.3%. Staging at the Vail Public Works facilities could also provide staging for the West Segment. Staging operations at the west portal near Eagle-Vail would be more difficult, but feasible. The alignment and interchange configuration could be similar to that as developed by CDOT for the Dowd Canyon Tunnel, with a bridge over the Eagle River. This west portal location provides the opportunity for a simple transfer of tunnel excavation material to the railroad for disposal down valley.

If the west portal was located near West Vail, the total West Segment tunnel length would be 27,700 feet at an average grade of 0.9%. This west portal location presents impacts in the West Vail area, especially during construction. It would be a considerable challenge to arrange staging, tunnel operations, and haulage operations from this location. This alignment, however, provides a connection to the Dowd Canyon Tunnel depicted in the PEIS. A portal in this area would have a greater visual and noise impact on residential property in West Vail than the other alternative in this option.

Option 2 – North of I-70 West Segment Elevation, Length, Grade	*Alignment with Portal North of Dowd Junction*	*Alignment with Portal near West Vail*
East Portal Elevation	8,250 ft.	8,250 ft
West Portal Elevation	7,800 ft.	8,000 ft.
Portal Elevation Difference	450 ft.	250 ft.
Tunnel Length	33,600 ft.	27,700 ft.
Tunnel Grade	1.3 %	0.9 %

Geology & Groundwater The east portal near the Vail Public Works facilities and the eastern 8,000 to 10,000 feet of this segment will present problems similar to those encountered in the western reaches and portal area of the East Segment of this option. Faults, steeply dipping and erratic bedding orientations, surface deposits of glacial drift and groundwater inflow may present more difficult tunneling conditions than are present in other areas. The Pleistocene aged Bull Lake deposit may be deep enough in this area to impact the tunnel alignment. In the western half of this section, the dips of the bedding steepen to 30 to 40 degrees to the northwest. Several smaller faults are mapped in this area. The steepened dip along this western half of this West Segment brings the bottom of the overlying Maroon Formation into proximity with the tunnel alignment. The Maroon Formation is comprised of reddish sandstone, siltstone and grit layers and will present significantly different tunneling conditions than the Minturn Formation.

With the west portal location north of Dowd Junction near Eagle-Vail, this area appears to run sub-parallel to several mapped faults. In addition, this section is in proximity to the contact between the Maroon Formation and the Minturn Formation.

With the portal location near West Vail, several steeply dipping faults intersect the valley near the portal area of this segment. In addition, there are surface deposits of glacial gravels which will impact portal location and development.

Some of the excavated material will be suitable for embankment construction for roads, dams or for general site grading. Additional material processing would be required to produce structural materials.

Tunnel Excavation The alignment with the west portal near West Vail is approximately 1.2 miles shorter than the tunnel with the west portal north of Dowd Junction near Eagle-Vail. The tables below provide the quantification of the excavation for these alternative

portal locations for the West Segment.

Option 2 – North of I-70 *West Segment - West Portal South of Dowd Junction*		
Excavation	**2 – 3-Lane Tunnels**	**2 – 3-Lane Tunnels + Transit/Service Tunnel**
In-situ Excavation	4.1 million cy	4.4 million cy
Excavated Tons	8.6 million tons	9.2 million tons
Material Disposal	4.0 million cy	7.6 million cy

Option 2 – North of I-70 *West Segment - West Portal near West Vail*		
Excavation	**2 – 3-Lane Tunnels**	**2 – 3-Lane Tunnels + Transit/Service Tunnel**
In-situ Excavation	3.4 million cy	3.6 million cy
Excavated Tons	7.1 million tons	7.6 million tons
Material Disposal	3.3 million cy	3.6 million cy

Conventional drill and blast methods can be employed to excavate the tunnel. The potential use of TBM's will require further investigation into the geology.

Tunnel excavation though the alignment with the west portal near West Vail will be more difficult that that at the portal north of Dowd Junction, due to the geology, the proximity of existing development, and the associated impacts.

Tunnel Support Tunnel support requirements would be different than that in the East Segment due the varying geology. The system, although, would still include rock bolts, shotcrete, and mesh. Areas where faults or otherwise poor ground conditions are encountered will likely require additional support systems. The east portal location may require consideration of additional support and consideration of potential rock fall mitigation as with the west portal of the East Segment.

Tunnel Excavation Disposal The west portal north of Dowd Junction may provide the most suitable location for creating fills with tunnel excavation material close to the tunnel. The east portal at the Vail Public Works facilities may also provide areas for disposal depending on the disposal sites chosen for the East Segment. Other than areas for bridge abutments and minor tunnel infrastructure elements, the west portal near West Vail may not provide significant area for material disposal in the form of fills.

For the alignment with the west portal north of Dowd Junction with two (2) 3-lane tunnels, it is calculated that approximately 3.3 million cubic yards will need to be hauled from the tunnel area. This equates to approximately 335,000 loaded trucks hauling material on the roads. If the transit/service tunnel were included, a total of approximately 360,000 loaded truck trips could occur.

For the alignment with the west portal near West Vail, approximately 276,000 loaded trucks would be needed for the two (2) 3-lane tunnels and 297,000 loaded truck trips for the two (2) 3-lane tunnels plus the transit/service tunnel.

Considering that either of the alternatives in this option would require about three (3) years of excavation, between 300 and 380 loaded truck trips per day would be expected. With haulage two (2) shifts per day, six (6) days per week, approximately 18 to 24 loaded truck trips per hour could be expected. In terms of both loaded and returning unloaded truck trips. The overall impact would be in the range of 36 to 50 trucks per hour on the roads for either of the alternatives in this option.

The alternative of subcontracting the haulage to the Union Pacific Railroad, utilizing the Tennessee Pass line will likely provide a less expensive and less impactive disposal of haulage for this option.

Tunnel Ventilation Ventilation of this segment is possible without supplementary adits, however, the proximity to the surface of some areas along this alignment, may provide opportunities for a more efficient ventilation system with a supplementary adit. As with other options, the ventilation system for this segment should be designed early in the process so as to determine what type of system is most practical and if a supplemental adit will provide a more cost effective solution.

Tunnel Infrastructure The east portal near the Vail Public Works facilities or the west portal north of Dowd Junction may provide the best options for location of the infrastructure. The portal area near West Vail may not be suitable for major infrastructure due the proximity of residential development.

7.0 Option 3 – West of Bighorn to North of I-70

This option has two tunnels constructed, East and West Segments, presenting an opportunity to phase the construction of the tunnels and provide a direct connection to Vail. Tunneling in this option relocates approximately 14 miles of I-70 into approximately 10 miles of two tunnels. The East Segment was considered to connect to the area of the Vail Public Works facilities area with a shorter distance than the East Segment of Option 2. Initially, it was suggested to daylight the tunnel near Mill Creek for a section to minimize the tunneling expense. The daylighting was dismissed early on as the elevation of the roadway in that section would near 10,000 feet in elevation, which would create significant snow removal and safety issues.

The East Segment uses an east portal location the same as Option 1, near Timber Creek, just off I-70 at approximate MP-184. The alignment heads to the northwest towards the Vail Public Works facilities, with a portal located on the south side of I-70 near the Vail Golf Course. An interchange and bridge structures would connect to Vail and the West Segment across I-70.

The West Segment of this option is the same as that of the West Segment of Option 2 – North of I-70. Only the East Segment will be discussed in detail in this section. Reference is made to the West Segment of Option 2. Schematic tunnel alignments for Option 3 are shown on Figure 5.

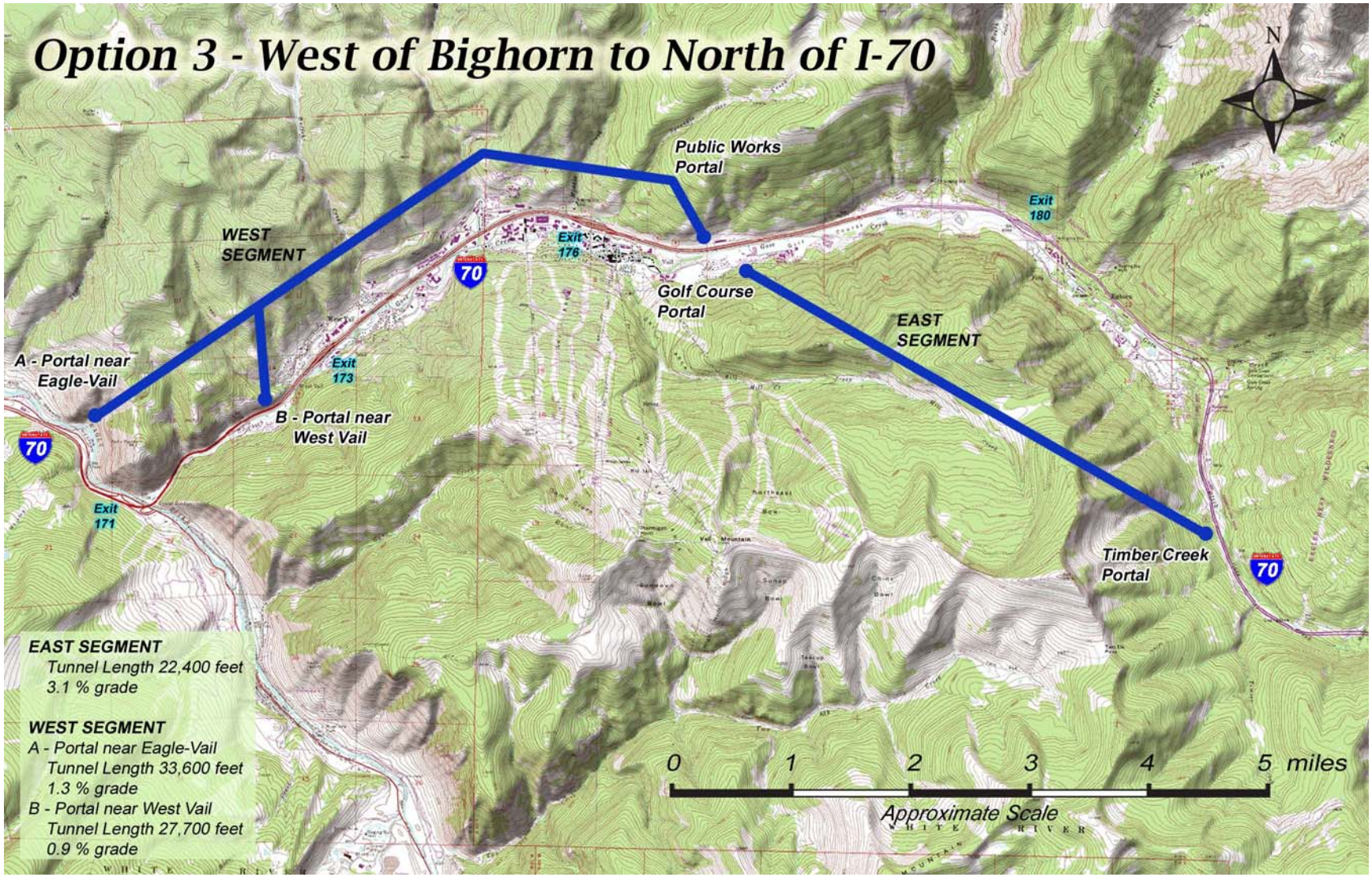


Figure 5. Option 3 – West of Bighorn to North of I-70

EAST SEGMENT - *Option 3 – West of Bighorn*

The East Segment has an approximate length of 22,400 feet at an average grade of 3.1%. This is approximately 6,900 feet shorter than the East Segment of Option 2.

The east portal could be located in the area of Timber Creek at approximate MP-184 and should be oriented to provide the best configuration between I-70 and tunnel alignment. The east portal area could provide adequate staging for tunneling and interchange construction.

The west portal for this segment daylights near the Vail Golf Course, a location that could create significant resistance from the public due to the extensive impacts. It may be possible to construct the interchange and bridge over the golf course and interstate and provide staging at the Vail Public Works facilities, but impacts are inherent, even with this scenario.

The table below summarizes the tunnel magnitude

Option 3 – West of Bighorn to North of I-70 *East Segment* *Elevation, Length, Grade*	
East Portal Elevation	9,100 ft.
West Portal Elevation	8,400 ft.
Portal Elevation Difference	700 ft.
Tunnel Length	22,400 ft.
Tunnel Grade	3.1 %

Geology & Groundwater Tunneling in this segment would likely encounter the lower to middle units in the Minturn Formation. The bedding generally dips at less than 20 degrees to the north along this section.

Groundwater surfaces along the south side of the valley near East Vail indicating that some groundwater will be present during excavation. The east portal would be the same as for Option 1. The western portal near the golf course could encounter several hundred feet of glacial drift which is a combination of gravel, cobble and boulder sized particles in a matrix of sands, silts and clays. Encountering this ground type would have significant impacts on tunneling and on the portal development. These older Pleistocene drift deposits have been effectively eroded by subsequent glaciation and post glacial periods and appear as isolated remnant deposits along the valley wall.

The tunnel and portal at the west end near the Vail Golf Course could be aligned to avoid these deposits. In addition, the western portal area may be located near the Spraddle Creek Fault. Mapped marker beds in the Minturn Formation, along the south side of the valley in East Vail, do not show obvious displacements, however faulting and fractured zones are a possibility in this section.

Some of the excavated material will be suitable for embankment construction for roads, dams or for general site grading. Additional material processing would be required to produce structural materials.

Tunnel Excavation The table below provides the quantification of the excavation for the East Segment.

Option 3 – West of Bighorn to North of I-70 East Segment		
Excavation	**2 – 3-Lane Tunnels**	**2 – 3-Lane Tunnels + Transit/Service Tunnel**
In-situ Excavation	2.7 million cy	2.9 million cy
Excavated Tons	5.7 million tons	6.1 million tons
Material Disposal	2.7 million cy	2.9 million cy

Tunneling through this area will be more problematic than with most other options. With that in mind, the use of a TBM may not be as applicable in this segment. Conventional drill and blast methods can be employed to excavate the tunnel, driving from both ends of the tunnel, with primary staging near the east portal at Timber Creek.

As the excavation from the portal area near the Golf Course would have significant impact on the Town of Vail, excavation may have to be driven mainly from the east portal, which means that the excavation operation would most always have water issues at the face – not a preferred means for tunnel excavation.

Tunnel Support Tunnel support requirements could include a system of rock bolts, shotcrete, and mesh, but likely at higher levels than in other options. Areas where faults or otherwise poor ground conditions are encountered will require additional support systems.

Tunnel Excavation Disposal Haulage of tunnel excavation material from this tunnel would be more difficult than other options unless the west portal at the Golf Course could be used for excavation and staging. Likely, though, most of the staging and excavation would be from the east portal with haulage of tunnel excavation material over I-70.

Unless a water reservoir is created in conjunction with the tunnel excavation towards Vail Pass, the only practical means for haulage of tunnel excavation material from this site is by trucks over the interstate. With two (2) 3-lane tunnels, approximately 2.7 million cubic yards will need to be hauled from the tunnel area, equating to approximately 223,000 loaded trucks hauling material on the roads. If the transit/service tunnel were included, a total of approximately 240,000 loaded truck trips could occur.

Considering about three (3) years of excavation for this excavation, between 240 and 255 loaded truck trips per day would be expected. With haulage two (2) shifts per day, six (6) days per week, approximately 15 loaded truck trips per hour could be expected. In terms of both loaded and returning unloaded truck trips, the overall impact would be in the approximately 30 trucks per hour on the roads.

The alternative of subcontracting the haulage to the Union Pacific Railroad, utilizing the Tennessee Pass line may not provide a cost effective solution for this segment due to the multiple handlings of the material.

Tunnel Ventilation Ventilation of this segment is possible without supplementary adits, however, the proximity to the surface of some areas along this alignment, may provide opportunities for a more efficient ventilation system with a supplementary adit. As with other options, the ventilation system for this segment should be designed early in the process so as to determine what type of system is most practical and if a supplemental adit will provide a more cost effective solution.

Tunnel Infrastructure The essential infrastructure systems and facilities may be best located near the east portal near Timber Creek or housed within the underground environment. The west portal near the Vail Golf Course would not provide a suitable location for surface infrastructure.

WEST SEGMENT - *Option 3 - North of I-70*

The West Segment of this option is the same as that of the West Segment of Option 2 – North of I-70. Reference is made to the West Segment of Option 2 on page 19. The table below summarizes the tunnel magnitude.

Option 3 – North of I-70 West Segment Elevation, Length, Grade	*Alignment with Portal North of Dowd Junction*	*Alignment with Portal near West Vail*
East Portal Elevation	8,250 ft.	8,250 ft
West Portal Elevation	7,800 ft.	8,000 ft.
Portal Elevation Difference	450 ft.	250 ft.
Tunnel Length	33,600 ft.	27,700 ft.
Tunnel Grade	1.3 %	0.9 %

The tables below provide the quantification of the excavation for the alternative portal locations for the West Segment of Option 3.

Option 3 – North of I-70 West Segment - West Portal South of Dowd Junction		
Excavation	**2 – 3-Lane Tunnels**	**2 – 3-Lane Tunnels + Transit/Service Tunnel**
In-situ Excavation	4.1 million cy	4.4 million cy
Excavated Tons	8.6 million tons	9.2 million tons
Material Disposal	4.0 million cy	7.6 million cy

Option 3 – North of I-70 West Segment - West Portal near West Vail		
Excavation	**2 – 3-Lane Tunnels**	**2 – 3-Lane Tunnels + Transit/Service Tunnel**
In-situ Excavation	3.4 million cy	3.6 million cy
Excavated Tons	7.1 million tons	7.6 million tons
Material Disposal	3.3 million cy	3.6 million cy

Conventional drill and blast methods can be employed to excavate the tunnel. The potential use of TBM's will require further investigation into the geology.

8.0 Option 4 – Cut-and-Cover under I-70

Creating a cut-and-cover tunnel under I-70 has been discussed for the last decade as a means to obtain the air rights above the tunnel area for development and open space in Vail. Residential development and some commercial development is generally not allowed above

Figure 6. Option 4 – Cut-and-Cover I-70

the tunnels, but can be located adjacent to the tunnels. Due to this restriction, the actual amount of developable land returned may not be as much as with other tunneling options. In past discussions, a cut-and-cover tunnel extended for 12 miles along the interstate with daylighting primarily at interchanges and other locations. For this document to provide a comparison of options, 8 miles of cut-and-cover tunnel is used thereby relocating 8 miles of I-70. It is likely that if this option were chosen, tunnel sections of a mile or two may be constructed in phases.

The east portal of the cut-and-cover tunnel could be located just west of the East Vail Interchange at approximate MP-180. The west portal is assumed at approximate MP-170 in Dowd Canyon. It is also assumed that the cut-and-cover tunnel would daylight at existing interchanges and other locations favorable to development and without significant impact to the Town of Vail.

Option 4 – Cut-and-Cover Elevation, Length, Grade	
East Portal Elevation	8,300 ft.
West Portal Elevation	8,150 ft.
Portal Elevation Difference	150 ft.
Tunnel Length	42,200 ft.
Tunnel Grade	0.4 %

Geology & Groundwater Replacement of the current on grade road platform along I-70 with a covered tunnel structure would require extensive excavation along the current alignment of I-70. The westbound lanes of the interstate are generally on cut section and the proposed excavation would likely occur in alluvial and glacial deposits consisting of rounded to sub-angular gravels, sands silts, and to a lesser extent in glacial clays. Very large boulders may be encountered in the glacial deposits which would have negative cost and constructibility impacts. In some areas, excavation into the Minturn Formation bedrock may be required. The landslide deposit just to the west of the Vail Public Works facilities intersects the alignment for several thousand feet and will be problematic and it is likely that special techniques will be required to excavate along the toe of the slope.

Many parts of the eastbound alignment are constructed on fill, which was most likely generated from the alluvial and glacial soils seen in the cut slopes above the westbound lanes. The grain size distribution and the density of the fills would need to be determined to provide meaningful commentary on construction.

Although the vertical profile of the current alignment is well above the elevation of Gore Creek, it is likely that groundwater will be encountered in some of the excavations along this section. Cut depths, soil type, groundwater and steep natural and fill slopes will combine to mandate either large cuts or temporary shoring to achieve safe slopes for most of this section.

Tunnel Excavation Constructing a cut-and-cover tunnel is vastly different than tunneling. The cut-and-cover tunnel under I-70 would be constructed in this simplified sequence:

- Create detour for existing I-70 traffic
- Excavate the tunnel cross section from the surface
- Install tunnel support system
- Install tunnel roadway and infrastructure
- Cover the tunnel support system and grade area
- Move traffic into tunnel
- Regrade detour
- Create roadways above the tunnel

The creation of a detour for I-70 may require that two (2) lanes of traffic allow a 50 mile per hour speed limit in each direction. The cut-and-cover distance undertaken at one time will be largely dependent on the constructor's resources and the overall phasing of the tunnel. The area between the South Frontage Road and the eastbound lanes of I-70 could be regraded to accept two (2) lanes of traffic for eastbound traffic. Once traffic was routed on the new eastbound lanes, westbound traffic could be routed onto the old eastbound traffic. Enough room then should be available to excavate for three (3) lanes in each direction between the detour and the North Frontage Roads. It is likely that temporary excavation support will be necessary to achieve the needed work areas. Excavation would be by a typical earthwork operation using dozers with rippers, loaders, and haul trucks. Blasting will be required in some areas for excavation. Careful consideration must be given to the sequence of the operations to avoid multiple handling of material.

As the excavation is complete for a section, a steel tunnel support system is installed along with the roadway and tunnel infrastructure. When the support and infrastructure systems are in place, the tunnel would be covered and graded. I-70 traffic can then be moved into the tunnel the detour regraded to the desired profile for development. Roadways and appropriate development can then proceed on the newly created land.

For two (2) 3-lane tunnels, the total tunnel excavation calculates to approximately 5.2 million in-situ cubic yards. This volume of tunnel muck amounts to approximately 10.8 million tons. With a fluff factor of 40%, this equates to 7.2 million cubic yards that would need to be either used for the cover or hauled and disposed. As there are no significant areas for placing tunnel excavation material, it is assumed that approximately 80% of the excavated material will need to be hauled from the tunnel area, or 5.8 million cubic yards.

If a separate transit/service tunnel were added, approximately 0.4 million in-situ cubic yards would be additionally excavated. With a fluff factor of 40%, this excavation equates to approximately 0.5 million cubic yards or 0.8 million tons that would need to be used for the cover or hauled and disposed. The table below

provides the quantification of the excavation for the full eight (8) miles of cut-and-cover tunnel.

Option 4 – Cut-and-Cover Under I-70		
Excavation	**2 – 3-Lane Tunnels**	**2 – 3-Lane Tunnels + Transit/Service Tunnel**
In-situ Excavation	5.2 million cy	5.6 million cy
Excavated Tons	10.8 million tons	11.6 million tons
Material Disposal	5.8 million cy	6.2 million cy

Tunnel Support Tunnel support requirements would be based upon the load carried including the cover, traffic, and other loads imposed on it from development. The loads would need to be defined enough to be able to design the tunnel support system which would fully enclose the tunnels. In the case for a cut-and-cover tunnel, the geology has a less of a bearing on the support than the loads imposed by the surface features.

Tunnel Excavation Disposal Haulage of tunnel excavation material for the cut-and-cover tunnel would involve at least two handlings, one to excavate and stockpile a portion of the material for the cover, and the second to regrade the cover. The only practical option for haulage of unneeded excavated material is to use trucks to haul over the interstate to disposal sites.

With two (2) 3-lane tunnels, it is calculated that approximately 5.8 million cubic yards will need to be hauled from the tunnel area. This equates to approximately 480,000 loaded trucks hauling material on the roads. If the transit/service tunnel were included, a total of approximately 520,000 loaded truck trips could occur.

Considering the minimum time the tunnel could be constructed, about four (4) years of excavation, between 385 and 415 loaded truck trips per day would be expected. With haulage two (2) shifts per day, six (6) days per week, approximately 25 loaded truck trips per hour could be expected. In terms of both loaded and returning unloaded truck trips, the overall impact would be approximately 50 trucks per hour on the roads.

Due to multiple handlings of the material, the alternative of subcontracting the haulage to the Union Pacific Railroad, utilizing the Tennessee Pass line may not provide a cost effective solution for this segment.

Tunnel Ventilation Ventilation of the cut-and-cover tunnel would be the least expensive of the tunnel options discussed. Ventilation during construction would not be needed as with an excavated tunnel. Permanent tunnel ventilation could be easily supplemented with adits to provide a cost effective system due to the proximity to the surface,

Tunnel Infrastructure The essential infrastructure systems and facilities may be best located near the Vail Public Works facilities or other areas along the interstate where future development is limited. Infrastructure can also be housed underground but at a higher cost than on the surface.

9.0 Option 5 – Under Vail Mountain to Eagle-Vail

This option is similar to Option 1, with the east portal near Timber Creek, but with an essentially straight shot to a portal near Eagle-Vail. Tunneling under Vail Mountain provides the opportunity to relocate I-70 from approximately MP-184 to MP-170, relocating approximately 14 miles of I-70 into 9.4 miles of tunnel. An interchange near West Vail for this option is not considered in this study. A schematic tunnel alignment for this option is shown on Figure 7.

As with Option 1, the east portal could be located in the area of Timber Creek at approximate MP-184 with adequate room for staging and interchange construction. With the west portal located north of Dowd Junction near Eagle-Vail, the total tunnel length would be 49,400 feet with an average grade of 2.6%. This west portal area could provide adequate staging for tunneling, as well as an ideal location for transferring tunnel excavation material onto railroad cars, if that haulage option was chosen. The length and grade of this alignment are within tunnel design possibility.

Option 5 – Under Vail Mountain to Eagle-Vail Elevation, Length, Grade	
East Portal Elevation	9,100 ft.
West Portal Elevation	7,800 ft.
Portal Elevation Difference	1,300 ft.
Tunnel Length	49,400 ft.
Tunnel Grade	2.6 %

Geology & Groundwater The geology and groundwater conditions for this alignment are similar to that of Option 1. Reference is made to the discussion under Option 1 and the CDOT Dowd Canyon Feasibility Study.

Tunnel Excavation Tunnel excavation is similar to Option 1with the quantification of the excavation shown below.

Option 5 – Under Vail Mountain to Eagle-Vail		
Excavation	**2 – 3-Lane Tunnels**	**2 – 3-Lane Tunnels + Transit/Service Tunnel**
In-situ Excavation	6.0 million cy	6.5 million cy
Excavated Tons	12.6 million tons	13.5 million tons
Material Disposal	5.9 million cy	6.5 million cy

As with Option 1, the concept of using multiple TBM's may have high applicability in this option.

Tunnel Support Tunnel support requirements are similar to Option 1. Tunnel support requirements could include a system of rock bolts, shotcrete, and mesh. Areas where faults or otherwise poor ground conditions are encountered may require additional support systems.

Tunnel Excavation Disposal For this alignment with two (2) 3-lane tunnels, it is calculated that approximately 5.9 million cubic yards will need to be hauled from the tunnel area. If transfer of the tunnel excavation cannot utilize the railroad for haulage, approximately 492,000 loaded trucks would be needed for hauling material. If the transit/service tunnel were included, a total of about

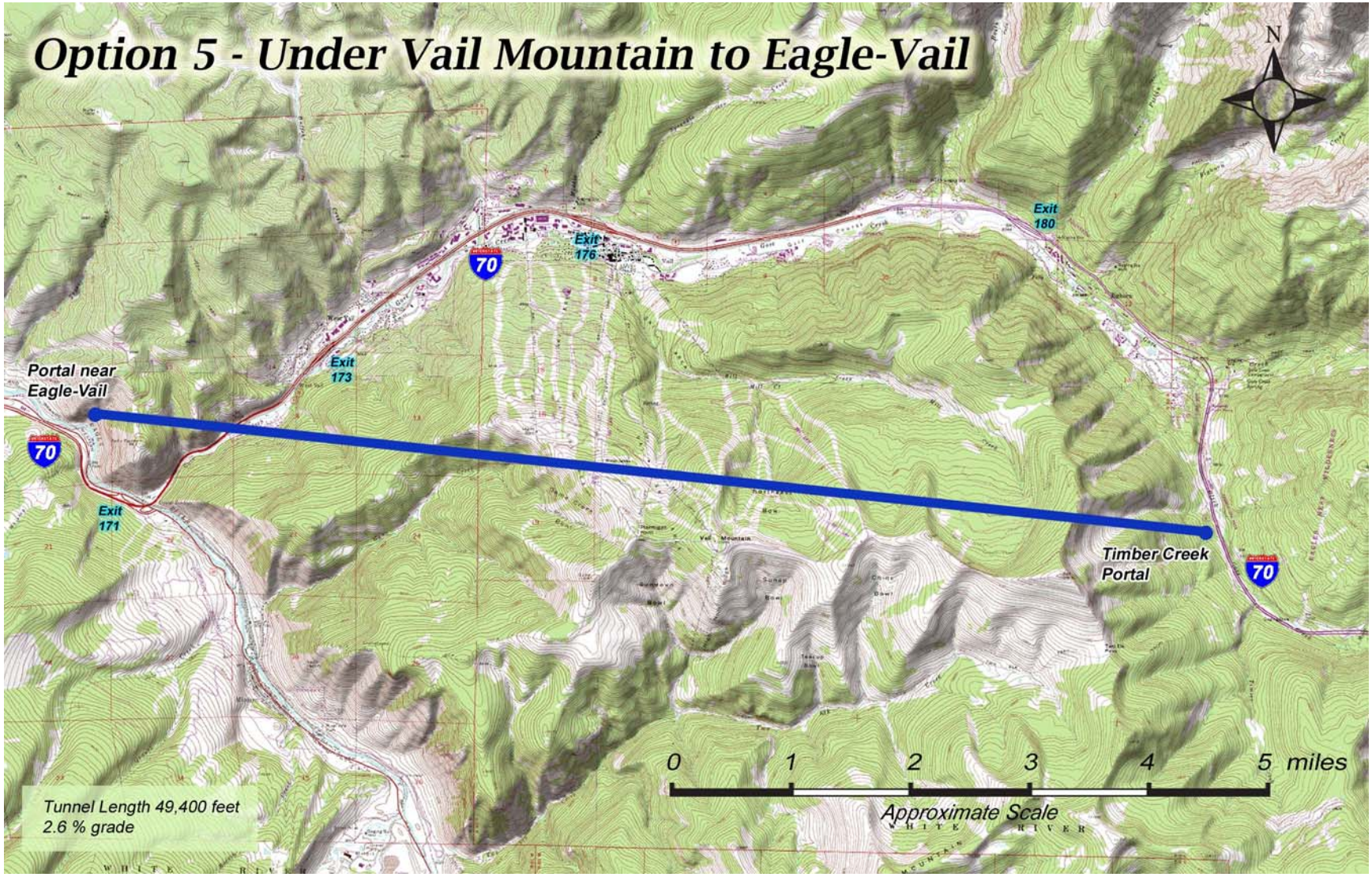


Figure 7. Option 5 - Under Vail Mountain to Eagle-Vail

529,000 loaded truck trips could occur.

Considering this option would require about four (4) years of excavation, between 350 and 375 loaded truck trips per day would be expected. This calculates to approximately 22 to 25 loaded truck trips per hour. In terms of both loaded and returning unloaded truck trips, the overall impact would be in the range of 40 to 50 trucks per hour on the roads. The alternative of subcontracting the haulage to the Union Pacific Railroad, utilizing the Tennessee Pass line will likely provide a less expensive and less impactive disposal of haulage for this option.

Tunnel Ventilation Ventilation of the longest of the tunnel options will be the most difficult and costly. As in other options, if the transit/service tunnel were included in the project, it could serve as a key component in the ventilation, for both construction and operation. If the separate transit/service tunnel is not chosen, a supplemental ventilation adit may be needed in addition to jet fans to adequately ventilate the tunnel. The ventilation system for this option should be designed early in the process so as to determine what type of system is most practical and if a supplemental adit will be necessary.

Tunnel Infrastructure. The east portal near Timber Creek is in US Forrest land and it would natural to assume minimizing surface infrastructure. The west portal near Eagle-Vail has the best opportunity for providing surface infrastructure systems and facilities.

10.0 Cost Information

Cost information is presented in this document for discussion purposes and is intended only to give a preliminary order of magnitude of the overall costs and comparison of options. Cost information provided in this section is expressed in 2005 dollars.

Accurate costs for this endeavor can only be generated once feasible options are developed in a feasibility study, additional geotechnical investigations are conducted, preliminary design is complete, and the project put to bid. Generally, a feasibility study should be able to better define the costs to be expected, but likely will include at a 30% contingency. Once preliminary design is complete, the contingency should be reduced to 20%, and upon final design, the contingency gets to 10%.

For the purposes of this document, a design-build contract package is considered in the costs and schedule. Design-build packaging generally delivers a project with a shorter overall schedule and with some cost savings. The Anton Anderson Memorial Tunnel in Whittier, Alaska was packaged as a successful design-build project.

Pre-Construction Prior to any construction, considerable study needs to be accomplished. A key first step is to determine the overall feasibility study of the project, including the means for financing.

A tunnel advisory group, consisting of experienced tunnel experts, should be developed to lead the project design and provide expertise in decision making. Appropriate government agency representatives should be a component of this group. The major tasks that should be included in the scope of work for the feasibility study are included in Section 15.0 Next Steps.

Much of the work for the feasibility study is dependent on the geotechnical and ground water investigations which will define the parameters for much of the design. It is likely a year or more would be needed to complete the study. The feasibility study could cost a few hundred thousand to a half million dollars.

An Environmental Impact Statement (EIS) will need to be developed in order to clear the project. The process is defined by federal regulations – National Environmental Protection Act (NEPA). The duration of clearance process could be expected to last two (2) to three (3) years.

Design costs for a construction project typically range from 7% to 10% of the overall construction cost. Design of the interchanges could be expected to be in this range. Given the length of the tunnel options, however, design costs for the tunnel should be considerably less than these percentages. Overall, the pre-construction costs, including feasibility study, EIS, and design could be expected to be in the neighborhood of $20 to $30 million for Options 1, 2, 3, and 5. The pre-construction costs for Option 4 - Cut-and-Cover under I-70 could be as much as twice this range, or $40 to $60 million as the EIS process will include significantly more impact investigation and the design will include significantly more design and impact mitigation.

Estimated pre-construction costs are included in the preliminary order of magnitude of costs

Interchanges Construction Without specific details, an accurate estimate is impractical. Guesstimates can be made that roughly reflect the extent of the interchange needed. A simple interchange, like that required for Option 2 at the Gore Creek Campground might be in the range of $30 million to $40 million. An interchange and bridge structure like that for the west portal for Option 1 may likely be in the $100 to $200 million range.

Interchange cost estimates are not included in the preliminary order of magnitude of costs.

Tunnel Excavation and Infrastructure Without necessary design information, an accurate cost estimate for the tunnel is virtually impossible to determine. Cost per linear foot is often used in tunnels in the early stages of project development. Recent tunnel estimates for a 3-lane tunnel of about a mile in length are approximately $20,000 to $30,000 per linear foot. In this case, where the tunnel is significantly longer than any other tunnel in the US, precise unit cost projections become very difficult as the unit cost is driven down as the tunnel length increases. As tunnel length increases, however, the tunnel infrastructure costs also increase.

For purposes of this document, a range of $20,000 to $24,000 per linear foot is used for each of the 3-lane tunnels and a range of $10,000 to $12,000 per linear foot for the transit/service tunnel. These costs include tunneling and tunnel infrastructure. For Option 4 – Cut-and-Cover under I-70, these ranges increase to $25,000 to $30,000 per linear foot of 3-lane tunnel, and to $15,000 to $20,000 per linear foot of transit/service tunnel. Only continued study will generate a more accurate estimate, and again, actual tunnel costs will largely depend on what is encountered underground.

Tunnel Excavation Material Disposal As disposal sites are not specified at this time, it will be assumed that 70% of the tunnel excavation material will need to be hauled an average of 15 miles to dispose to generate an order of magnitude of haulage costs for Options 1, 2, 3, and 5. Option 4, Cut-and-Cover under I-70, assumes that 80% of the tunnel excavatio9n material is hauled. Costs can be expected in the $3 to $4 per cubic yard hauled and are included in the preliminary order of magnitude of costs.

Another consideration for haulage of tunnel excavation material, as mentioned earlier, may be to utilize a portion of the Tennessee Pass Line of the Union Pacific Railroad. This option may prove worthy especially if the portal location was located along the railroad near Dowd Junction. A tipple, or rail loading facility could be constructed near the portal and eliminate the truck haulage from at least the west portals. It may be possible to have tunnel excavation material from the east portals trucked to the west portal for loading trains. It is likely, that due to the size of rocks excavated, side-dump rail cars will be needed as opposed to standard ballast or coal cars. It is possible that this method of haulage may be less expensive overall than using only truck haulage. The feasibility study should investigate these options and provide a comparison of costs and impacts.

For the right conditions and locations, haulage of the tunnel excavation material by overland conveyor likely would be less expensive than truck haulage. Perhaps the biggest issues are the environmental clearance of the routing, the location of the disposal sites, and the availability of power for the conveyors.

Right-of-way It appears that most of the project will be constructed on public lands. Environmental clearance and agreements will be needed to provide access and use of the public lands. Once I-70 traffic is routed through the tunnels, conveyance of the interstate air rights through Vail could occur.

Depending on alignments, some private property may be impacted during and after construction. The primary impacts would be visual and noise.

The selection of west portal locations may largely depend on Town of Vail zoning and land use. A planning process will be required during the feasibility study to determine the appropriate portal locations from a Town of Vail standpoint. In addition, the debate on risk, duration of construction, and cost will need to occur

during the planning and feasibility processes.

Right-of-way and impact mitigation costs are not included in the preliminary order of magnitude of costs.

Quality Control / Geotechnical Engineering Construction management costs on construction projects typically range from 7% to 10% of the overall construction cost. As this tunnel project would not be typical, an assumption that quality control and geotechnical engineering during construction would require a staff of approximately 10 people per shift average, three shifts per day, with an average rate of $60 per hour.

Quality control and geotechnical costs during construction are included in the preliminary order of magnitude of costs.

Operating & Maintenance Costs Without specifics of the tunnel and infrastructure, it is impossible to determine an accurate estimate of the operations and maintenance costs. The costs for operational and maintenance of the tunnel in excess of that currently used and projected for the area of I-70 replaced by the tunnel should be borne by the development companies as part of the overall financing.

Operating and maintenance costs are not included in the preliminary order of magnitude of costs.

Preliminary Order of Magnitude Costs

A preliminary order of magnitude costs are summarized in the following table. Costs include preconstruction costs, tunnel and infrastructure, haulage of tunnel excavation material, and quality control and geotechnical engineering during construction. Interchange, right-of-way, and impact mitigation costs are not included.

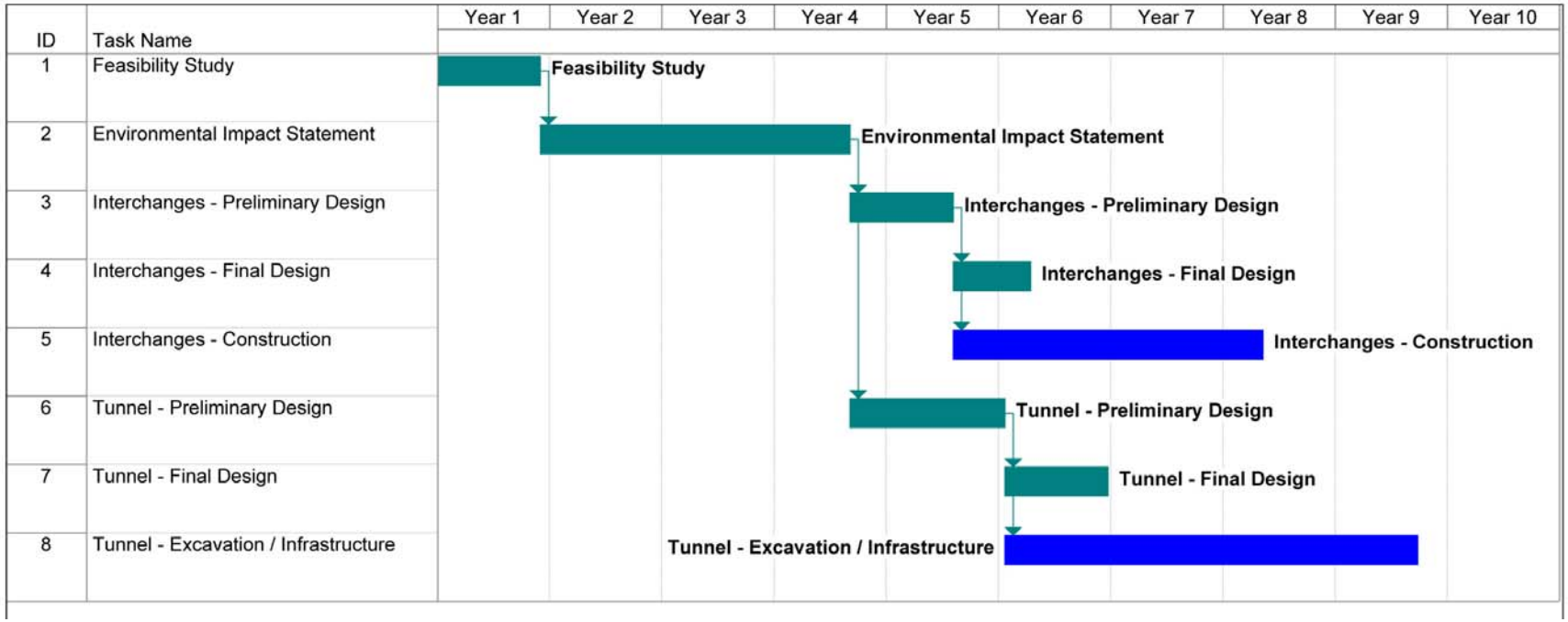
Vail Tunnel Options Preliminary Order of Magnitude Cost Range	Length (miles)	2 – 3-lane Tunnels Cost Range (millions)		2 – 3-lane Tunnels + Transit/Service Tunnel Cost Range (millions)	
Option 1 – Under Vail Mountain					
West Portal south of Dowd Junction	8.6	$ 1,876	$ 2,262	$ 2,332	$ 2,808
West Portal near West Vail	8.0	$ 1,743	$ 2,102	$ 2,165	$ 2,608
Option 2 – North of I-70					
East Segment	5.5	$ 1,213	$ 1,467	$ 1,507	$ 1,819
West Segment					
West Portal near Eagle-Vail	6.4	$ 1,387	$ 1,675	$ 1,724	$ 2,080
West Portal near West Vail	5.2	$ 1,148	$ 1,389	$ 1,426	$ 1,722
Totals for Option 2 East & West Segments					
West Portal near Eagle-Vail	11.9	$ 2,600	$ 3,142	$ 3,231	$ 3,899
West Portal near West Vail	10.8	$ 2,361	$ 2,856	$ 2,933	$ 3,541
Option 3 – West of Bighorn to North of I-70					
East Segment	4.2	$ 935	$ 1,132	$ 1,159	$ 1,402
West Segment					
West Portal near Eagle-Vail	6.4	$ 1,387	$ 1,675	$ 1,724	$ 2,080
West Portal near West Vail	5.2	$ 1,148	$ 1,389	$ 1,426	$ 1,722
Totals for Option 3 East & West Segments					
West Portal near Eagle-Vail	10.6	$ 2,322	$ 2,807	$ 2,883	$ 3,482
West Portal near West Vail	9.5	$ 2,083	$ 2,521	$ 2,585	$ 3,124
Option 4 – Cut-and-Cover I-70	8.0	$ 2,180	$ 2,622	$ 2,811	$ 3,464
Option 5 – Under Vail Mountain to Eagle-Vail	9.4	$ 2,038	$ 2,456	$ 2,533	$ 3,050

11.0 Schedule Information

As a starting point for discussion, a general schedule is presented with the major tasks to be undertaken in a logical overall process for a design-build project. Essentially, project design is completed to a 30% level. The project is bid as a design-build and once awarded; the tunnel contractor completes the design and commences the construction.

The schedule includes each of the general tasks with an approximated duration as shown on the right.

- Feasibility Study – 1 to 1.5 years
- Environmental Impact Statement – 2 to 3 years
- Interchange Preliminary Design - 1 to 1.5 years
- Tunnel Preliminary Design – 1.5 to 2 years
- Tunnel Excavation & Infrastructure
    - Option 1 – 3 to 4 years
    - Option 2 – 4 to 5 years
    - Option 3 – 4 to 5 years
    - Option 4 – 4 to 6 years
    - Option 5 – 4 to 5 years



12.0 Comparison of Tunnel Options

Cost From a cost standpoint, it appears that tunneling under Vail Mountain, Options 1 and 5 are the least expensive of the options discussed. Options 2 and 3 are higher due to the increased length and the necessity for two tunnel segments. The cut-and-cover appears to be the highest cost of the options discussed.

Schedule Options 1 and 5 also appear to have the shortest overall schedule of the options, again due to the length and not needing to construct two (2) tunnel segments each with infrastructure.

Phasing Option 4, the cut-and-cover tunnel has the most opportunity for phasing as segments can be designed according to the availability of financing. Options 2 and 3 provide the opportunity to phase the tunnel segments, unlike Options 1 and 5.

Financing The transfer of development rights, and consequent return on investment cannot occur until traffic has been moved to the tunnel. A phased approach would then be favored. Option 4 may have the best opportunity for financing if a short segment, say a mile or two were constructed, traffic moved, and the area vacated developed. With the cost and construction impact from the cut-and-cover operation being higher than other options, further investigation is needed to determine which option has best financing potential. If it were just a matter of time, a phased approach constructing the West Segments in Options 2 and 3 would provide good financing potential.

Expandability Any of the options can be expanded at a later date should traffic demand dictate, albeit, at a very high cost for Options 1, 2, 3, and 5. Option 4 may be the least costly to expand, however, this would be at the expense of reducing developable land.

Construction Impact – Available Resources Options 1 and 5 may ultimately require the least amount of labor resources to construct the tunnel. If a shorter segment of a cut-and-cover tunnel under I-70 were chosen, then the labor resources may be similar to Option 1 or 5. At this time, shortages of labor resources cannot be predicated. The availability of TBM's, if chosen as feasible, also cannot be predicated.

Construction Impact - Tunnel Excavation Disposal If the railroad can be used to haul material from the Dowd Junction area with inline loading directly from the tunnel, Options 1 and 5 would have the least impact. Following Options 1 and 5, the West Segment portaling out at the Eagle River of Option 2 and 3 is the least impactive; as portals can be located close to the railroad and truck haulage can be minimized. The West Segments of Options 2 and 3 portaling near West Vail would have impact, but not as much as the East Segments and the cut-and-cover tunnel. The East Segments of Options 2 and 3, along with the cut-and-cover tunnel would have the greatest impact on roadways and traffic.

Construction Impact – Noise Option 4 would by far have the greatest impact on the Town in terms of noise during construction, followed by Options 2 and 3. Options 1 and 5 would have the least noise impact on the Town during construction.

Construction Impact – Air & Water Quality Air and water quality on construction projects is regulated and standards will need to be met. The cut-and-cover may have the greatest impact on air quality of the options due to its proximity to the Town.

Construction Impact – Traffic Each of the options will have an impact when constructing the interchanges that connect the tunnel. With a continuous detour needed to construct the cut-and-cover tunnel, Option 4 will have the greatest impact on traffic of the options discussed.

Construction Impact – Right-of-Way Option 1 with either west portal alternative will have the least overall needs for and impact on private right-of-way. If the Option 5 tunnel is daylighted near West Vail with an interchange, some impact to private land may be expected. The West Segment of Option 2 with either portal alternative will have a significant impact on private land. The East Segment of Options 2 and 3 will have considerable impacts, especially near the Golf Course.

Public Benefit – Developable Land Options 1 and 5 would provide the most available developable land of the options discussed. Options 2 and 3 may have less due to the interchange at the Vail Public Works facilities. Due to restrictions on what can be developed and where over a cut-and-cover tunnel, Option 4 may produce the lowest amount of developable land of the options discussed.

Public Benefit – Visual Opportunities Options 1 and 5 would relocate interstate traffic away from Town, thereby creating the best opportunity in terms of minimizing visual impact from the interstate. Options 2 and 3 with an interchange located near the Vail Public Works and possibly near West Vail would have a visual impact from the Town. Option 4 would have some impact from the portal areas and where the tunnel daylights but may not be as significant as with Options 2 and 3.

Public Benefit – Noise, Air and Water Quality Options 1 and 5 would have the most public benefit of the options in terms noise, air and water quality. Noise and some issues with air quality may be experienced near the portals or ventilation adits of Option 2, 3, and 4.

Public Benefit – Traffic Relocating all of the interstate traffic away from Town would create a new experience altogether for Vail. Options 1 and 5 provide the greatest benefit by far in these terms. In any of the other options interstate traffic would still flow in some locations in Vail.

Public Benefit – Transit For both high-speed transit and regional transit to connect at an intermodal center within

the Town, Options 2, 3, and 4 provide the best opportunities. If Option 1 or 5 were chosen, the intermodal center may need to be located at Dowd Junction with the regional system continuing into Town.

Coordinating Agency Involvement The highest risk for State and Federal governing agencies would be the cut-and-cover tunnel, if for some reason the project started and was not completed. For this reason alone, Options 1 and 5 may have the most support from the coordinating agencies as the existing interstate would remain in place until the tunnel was completed and traffic relocated. The risk associated with Options 2 and 3 would likely be between Options 1 and 4.

13.0 General Conclusions

From the initial look a the tunnel options for Vail and in terms of tunneling ground conditions, Option 1 – Tunnel under Vail Mountain, Option 4 – Cut-and-over I-70, and Option 5 – Under Vail Mountain to Eagle-Vail are favored over the Options 2 and 3.

Options 1 and 5 would be expected to provide the lowest cost per mile of tunnel, provided the financing works. Options 1 and 5 also have the lowest overall construction impact of the options. And the highest overall public benefit can be expected from these options.

The East Segment of Option 3 – West of Bighorn to North of I-70 has many impacts with minimal benefits and could be eliminated from further study at this time.

The added length of tunneling through tougher ground conditions north of I-70 may prove to have a higher cost without a commensurate increase in public benefit. This is especially true of the East Segment of Option 2 – North of I-70.

Careful consideration should be given to locations for west portals at the Eagle River and near West Vail. The connection benefit at West Vail should be compared to the other criteria in determining the best west portal location, even considering the additional tunnel excavation necessary to portal out at the Eagle River.

If financing is the driving issue, completion of a short section of Option 4 – Cut-and-Cover I-70 should receive additional study. By creating a short section of the cut-and-cover tunnel, relocating interstate traffic, and developing the land on the cover, a return on investment can be realized quicker than with any of the other options discussed.

14.0 Agency Coordination

A partial list of government agencies and organizations that likely will be involved in the project include:

- Federal Highway Administration (FHWA)
- Colorado Department of Transportation (CDOT)
- National Fire Protection Association (NFPA)
- US Forrest Service (USFS)
- Bureau of Land Management (BLM)
- Army Corps of Engineers
- Division of Wildlife
- Union Pacific Railroad
- Sierra Club
- Eagle County
- Eagle County Transit (eco)
- Eagle River Water & Sanitation District
- Vail, Minturn, Eagle-Vail, Avon

15.0 Next Steps

Three major tasks need to be accomplished prior to the design and construction of the project:

1. *Agency Coordination* – Any work on public right-of-way needs to have close coordination and buy in from appropriate government agencies, including the FHWA, CDOT, USFS, local governments, and other relevant agencies.

   A suggested first step would be to make contact with the Federal Highway Administration (FHWA) and the Colorado Department of Transportation. The Programmatic Environmental Impact Statement (PEIS) process is underway, and if this project proves financially feasible, inclusion in the PEIS may be necessary.
2. *Financial Feasibility* - With the financing scenario discussed early in this document of having developers finance the project, potential developers should be contacted. The financiers should be able to generate potential financing scenarios for a range of estimated project costs.

3. *Feasibility Study* - The major tasks that should be undertaken in the scope of work for the feasibility study include:

   - Geotechnical & Groundwater Investigations
   - Rock Quality Determination
   - Feasible Alignments & Profiles
   - Feasible Tunnel Cross Sections
   - Feasible Portal Locations
   - Feasible Infrastructure Locations
   - Property Identifications & Initial Survey
   - Town of Vail Planning Process
   - Feasible Excavation Methods
   - Feasible Tunnel Support Requirements
   - Feasible Ventilation Requirements
   - Tunnel Excavation Haulage & Disposal Details
   - Preliminary Tunnel Finishes
   - Tunnel Infrastructure Requirements
   - General Construction Phasing Requirements
   - General Impact Analysis
   - Conceptual Cost Estimates

References

- Vail Transportation Master Plan Update 2002
- I-70 Draft Programmatic Environmental Impact Statement
- Dowd Canyon Feasibility Study
- Tunnel Engineering Handbook, 2nd Edition
- Various Tunnel Related Websites

APPENDIX A

The following letters provide an initial look at the geology of general area of the tunnel options for Vail provided by Yeh and Associates, Inc. The information was interpreted from USGS Geology maps.

Yeh and Associates, Inc.
Geotechnical Engineering Consultants
5700 East Evans Avenue, Denver, CO 80222, Tel: (303) 781-9590, Fax: (303) 781-9583
0170 Mel Ray Road, Glenwood Springs, CO 81601, Tel: (970) 384-1500, Fax: (970) 384-1501

May 9, 2005
Mr. Joseph Kracum, P.E.
Kracum Resources, LLC
P.O. Box 2539
Glenwood Springs, Colorado 81602

Project 25-064

Subject: Preliminary Geological and Geotechnical Comments on Conceptual Tunnel Alignments to the South of the Vail Valley.

Dear Mr. Kracum:

In accordance with your request for geological input on the conceptual alignments for tunneling to the south of Vail, we offer the following:

Geology
Based on the existing geological mapping, conceptual alignments for the proposed tunnel encounter the 2000 to 6000 foot thick Minturn Formation, which consists of Middle Pennsylvanian aged interbedded conglomerate, course and finer grained sandstone and shale layers interstratified with beds of carboniferous rock. Bedding units may be lenticular and show large variations in thickness.

The eastern end of the alignment encounters the middle to upper stratigraphic portions of the formation while the western sections will encounter the lower units within the formation. These lower units are visible in the I 70 road cut just to the west of the west Vail interchange. The middle and upper parts of the formations are exposed on the south side of the Vail Valley near the east Vail interchange. The alignment crosses several mapped structural synclines so that the relatively gentle dip of the bedding is to the west at the eastern end of the alignment and dipping to the east at the western end of the alignment. The existing mapping shows the bedding dips of accessible outcroppings at generally less than 20 degrees.

The excavated rock will consist of carboniferous rock such as limestones and dolomites as well as sandstones and shales. Most of the excavated material will be suitable for embankment construction for roads, dams or for general site grading. Additional material processing would be required to produce structural materials. Most dams require an impermeable core material for which the tunnel muck would likely be unsuitable.

In addition to the synclines the mapping also identifies several high angle faults along the alignment with predicted displacements of several hundred feet. It is likely that heavy vegetation on the slope

in combination with the weathering characteristics of the formation mask the surface expressior other faults in the area. Tunneling through faulted ground is a fairly common practice, especiall mountainous terrain. Faults and shear zones can indicate areas of rock which are more altered a fractured. Additional ground water inflow may also occur in faulted and highly fractured areas. Early recognition and planning are important factors in limiting the impact of geological proble if it is discovered that faulted ground is a common condition along the alignment.

Numerous quaternary landslides are mapped along the south side of the Vail Valley. These surf features may extend to several hundred feet in depth and may affect portal location but are unlik to affect the tunnel alignment itself.

Groundwater which forms the ice flows along the south side of the valley near east Vail indicat that some groundwater will be present during excavation. The affect of the water on cost, construction and performance of the tunnel will depend on horizontal and vertical alignment, horizontal and vertical permeability of the formation and on whether the ice flows are formed b perched water table or regional groundwater influences.

Geological and Geotechnical Investigations

The geological and geotechnical investigation for a tunnel is an iterative process which must be flexible enough to utilize information from previous phases of the investigation. The geology of site is the major factor affecting cost and technical feasibility. In general the sooner and more accurately that the geology and hydrogeology is defined the greater is the potential for using the information to improve the efficiency of the design and to more clearly identify cost factors. Geotechnical input is required from the inception of the project through and after completion of construction. The following general phasing can be considered the skeletal outline for producing final products of the geological and geotechnical work.

Feasibility Level Study

Collection and evaluation of existing data. This phase includes review of any existing mapping, borings, wells, aerial photography, satellite imaging, seismic data related to exploration or earthquakes, government or private studies, and other geological, geotechnical or hydrogeologic data.

Geological reconnaissance is conducted in the field to verify and expand upon the body of knowledge available from the literature.

Feasibility investigation and conceptual design will provide information to determine the techni feasibility and to provide reasonable cost estimates with which financial feasibility can be determined. Some drilling and testing is likely to be required at this phase to ensure meaningful results.

Preliminary site investigation is intended to provide factual data to confirm and expand upon assumptions made during the feasibility study. A significant portion of the geotechnical effort is expended during this phase. Drilling, geophysical methods, laboratory testing and field testing

should provide information needed to develop preliminary designs and to nearly finalize the tunnel alignment and portal location.

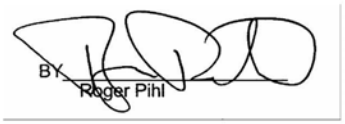
Tunnel Design

Final site investigation is conducted to answer questions and provide additional, more accurate data for final tunnel design. In addition, information needed to ensure accurate, informed bids can be obtained. Drilling, geophysical methods, laboratory testing and field testing will be part of this phase and will supplement data obtained in earlier phases. One of the products of this phase can be a Geotechnical Design Summary Report (GDSR) or a combination of a Geotechnical Data Report (GDR) and a Geotechnical Baseline Report (GBR). These documents provide data developed during the investigations as well as certain assumptions upon which a contractor may develop his bid. These documents can also be useful in dealing with changes and disputes during and after construction. Bidding assistance should be available to the project staff so that uniform and accurate information can be provided to the contractors.

Construction Support

Construction services provide continuity of knowledge through the design and construction phases. Natural and unpredictable variability of geological formations combined with the difficulty of attaining and extrapolating data will require flexibility in the application of the design and in construction methods. Many decisions cannot be made until the ground is exposed at the heading and therefore must be made in a timely manner. Experienced on-site staff who are familiar with the geology and the design will be necessary to prevent costly delays and potentially unsafe conditions. Monitoring the behavior of the ground with precise geotechnical instrumentation during excavation is an essential part of modern tunneling. This approach allows assessment of the in-place ground support during and after excavation which provides a higher level of safety efficiency and economy.

Sincerely,
YEH AND ASSOCIATES, INC.
Roger Pihl, P.G.
Principal Scientist



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June 7, 2005

Mr. Joseph Kracum, P.E.
Kracum Resources, LLC
P.O. Box 2539
Glenwood Springs, Colorado 81602

Project 25-064

Subject: Preliminary Geological and Geotechnical Comments on Conceptual Tunnel Alignments around the Vail Valley, Eagle County, Colorado.

Dear Mr. Kracum:

In accordance with your request for geological input on the conceptual alignments for tunneling in the area of Vail, we would like to offer our initial comments related to the various additional potential alignments recently discussed. A previous letter from Yeh and Associates, Inc. to you dated May 9th, 2005 provides our initial input on a conceptual alignment to the south of the valley with two versions of the western end of tunnel, one which portals out in the Eagle River Valley and one in the Gore Creek valley designated as Sections A, A1 and A2. A report prepared for the Colorado Department of Transportation (CDOT) titled "Dowd Canyon Feasibility Study, Phase 1 Interim Report", provides a discussion of alternatives related to the area between West Vail and Eagle Vail.

This letter provides our input on one additional alignment to the south of the valley called Section B and one to the north of the valley, which is comprised of Sections C, D, D1, and D2. The alignment to the north of the valley has been divided into sections C and D. Sections C and D could be combined to bypass Vail or could portal out near the Public Works Center. Two western portal options are described by sections D1 and D2. A cut and cover tunnel along the existing I 70 alignment is described as Section E.

Based on the existing geological mapping, all of the conceptual alignments will likely be excavated in the 2000 to 6000 foot thick Minturn Formation, with the exception of the eastern 10,000 feet of Section C. As described in our previous letter, the formation consists of Middle Pennsylvanian aged interbedded conglomerate, course and finer grained sandstone and shale layers interstratified with beds of carboniferous rock. Bedding units may be lenticular and show large variations in thickness.

Numerous tributary, perennial and abandoned drainages enter the Gore Creek valley from the north and from the south. Most of the drainages are mapped as being incised into the bedrock. Some of these are likely due to localized changes in the channels and stream capture on the higher ground to the north and south. Others may be remnants of hanging valleys created by the advance and retreat of the glaciers which formed the valley. These types of drainages are less likely to have impacts on tunneling than those caused by preferential erosion caused by faulting which could indicate problematic ground and water conditions. Most of the bottoms of the drainages are well above the likely tunnel alignment elevations.

Several Quaternary Age landslides are mapped along the south and the north side of the Vail Valley. These surficial features may extend to several hundred feet in depth and may affect portal location but are unlikely to affect the tunnel alignment itself.

SECTION A
This section was discussed in a letter by Yeh and Associates, Inc. dated May 9th, 2005.

SECTION B
Tunneling in this section would likely encounter the lower to middle units in the Minturn Formation. The bedding generally dips at less than 20 degrees to the north along this section. Groundwater surfaces along the south side of the valley near East Vail indicating that some groundwater will be present during excavation. The eastern portal would presumably be near the eastern portal of Section A. The western portal near the golf course could encounter several hundred feet of glacial drift which is a combination of gravel, cobble and boulder sized particles in a matrix of sands, silts and clays. Encountering this ground type would have significant impacts on tunneling and on the portal development. These older Pleistocene drift deposits have been effectively eroded by subsequent glaciation and post glacial periods and appear as isolated remnant deposits along the valley wall. The tunnel and portal at the west end could be aligned to avoid these deposits. In addition, the western portal area may be located near the Spraddle Creek Fault. Mapped marker beds in the Minturn Formation, along the south side of the valley in East Vail, do not show obvious displacements, however faulting and fractured zones are a possibility in this section.

SECTION C
The eastern 4,000 to 10,000 feet of this section would be excavated through the Precambrian aged Cross Creek granite. The USGS describes this as "granodiorite and quartz monzonite, porphyritic in part". The degree of alteration and fracturing is unknown; however the igneous rock is likely to be more blocky and hard than the sedimentary Minturn Formation. Where the alignment traverses the contact between the Precambrian granites and the Minturn Formation sandstones, shales and carboniferous sedimentary rock, there is a higher potential for extensive alteration and fracturing as well as frequent changes in joint and bedding orientation, shear zones and smaller faults. It is not possible to predict where this contact will occur without additional study.

The eastern portal and tunnel in this section may encounter deposits of glacial drift of unknown thickness which will impact tunneling and portal location and development. At the western portal area there is a Quaternary landslide deposit that periodically exhibits high groundwater and minor movement which has affected the interstate over several hundred feet several times in the past 25 years. Tunneling in or portalling out in this landslide deposit will be problematic. The Spraddle Creek Fault, a graben like structure and the presence of steeply dipping beds all indicate potential problems at this end of Section C as well as for the west end of Section D. Fracturing, alteration of the rock and groundwater inflows are all potential problems here that will require further investigation.

SECTION D
The eastern portal area and the eastern 8,000 to 10,000 feet of this section will present problems similar to those encountered in the western reaches and portal area of Section C. Faults, steeply

dipping and erratic bedding orientations, surface deposits of glacial drift and groundwater inflow may present more difficult tunneling conditions than are present in other areas. The Pleistocene aged Bull Lake deposit may be deep enough in this area to impact the tunnel alignment.

In the western half of this section, the dips of the bedding steepen to 30 to 40 degrees to the northwest. Several smaller faults are mapped in this area. The steepened dip along this western half of Section D as well as along Section D1 brings the bottom of the overlying Maroon Formation into proximity with the tunnel alignment. The Maroon Formation is comprised of reddish sandstone, siltstone and grit layers and will present significantly different tunneling conditions than the Minturn Formation.

SECTION D1
This section appears to run sub parallel to several mapped faults. In addition, this section is in proximity to the contact between the Maroon Formation and the Minturn Formation.

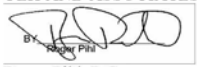
SECTION D2
Several steeply dipping faults intersect the valley near the portal area of this section. In addition, there are surface deposits of glacial gravels which will impact portal location and development.

SECTION E
Replacement of the current on grade road platform along Section E with a covered tunnel structure would require extensive excavation along the current alignment of I-70. The westbound lanes of the interstate are generally on cut section and the proposed excavation would likely occur in alluvial and glacial deposits consisting of rounded to sub-angular gravels, sands silts, and to a lesser extent in glacial clays. Very large boulders may be encountered in the glacial deposits which would have negative cost and constructability impacts. In some areas, excavation into the Minturn Formation bedrock may be required. The landslide deposit just to the west of the Public Works Facility intersects the alignment for several thousand feet and will be problematic and it is likely that special techniques will be required to excavate along the toe.

Many parts of the eastbound alignment are constructed on fill, which was most likely generated from the alluvial and glacial soils seen in the cut slopes above the westbound lanes. The grain size distribution and the density of the fills would need to be determined to provide meaningful commentary on construction in this section.

Although the vertical profile of the current alignment is well above the elevation of Gore Creek, it is likely that groundwater will be encountered in some of the excavations along this section. Cut depths, soil type, groundwater and steep natural and fill slopes will combine to mandate either large cuts or temporary shoring to achieve safe slopes for most of this section.

Sincerely,
YEH AND ASSOCIATES, INC.



Roger Pihl, P.G.
Principal Scientist

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APPENDIX B

The table on the following page shows the approximate cubic yards of material excavated from the each of the tunnel options and the cubic yards of material that will need to be hauled from the tunnel construction site.

Vail Tunnel Options Excavation & Haulage Summary	Length (miles)	2 – 3-lane Tunnels		2 – 3-lane Tunnels + Transit/Service Tunnel	
		Excavated CY	Hauled CY	Excavated CY	Hauled CY
Option 1 – Under Vail Mountain					
West Portal south of Dowd Junction	8.6	5,540,000	5,429,000	5,953,000	5,834,000
West Portal near West Vail	8.0	5,137,000	5,035,000	5,520,000	5,410,000
Option 2 – North of I-70					
East Segment	5.5	3,576,000	3,504,000	3,842,000	3,765,000
West Segment					
West Portal near Eagle-Vail	6.4	4,101,000	4,019,000	4,406,000	4,318,000
West Portal near West Vail	5.2	3,380,000	3,312,000	3,632,000	3,559,000
Totals for Option 2 East & West Segments					
West Portal near Eagle-Vail	11.9	7,676,000	7,523,000	8,248,000	8,083,000
West Portal near West Vail	10.8	6,955,000	6,816,000	7,473,000	7,324,000
Option 3 – West of Bighorn to North of I-70					
East Segment	4.2	2,733,000	2,678,000	2,936,000	2,877,000
West Segment					
West Portal near Eagle-Vail	6.4	4,101,000	4,019,000	4,406,000	4,318,000
West Portal near West Vail	5.2	3,380,000	3,312,000	3,632,000	3,559,000
Totals for Option 3 East & West Segments					
West Portal near Eagle-Vail	10.6	6,833,000	6,697,000	7,342,000	7,195,000
West Portal near West Vail	9.5	6,112,000	5,990,000	6,568,000	6,436,000
Option 4 – Cut-and-Cover I-70	8.0	5,175,000	5,796,000	5,557,000	6,224,000
Option 5 – Under Vail Mountain to Eagle-Vail	9.4	6,029,000	5,908,000	6,478,000	6,348,000