

ADVANCED GUIDEWAY SYSTEM (AGS) FEASIBILITY STUDY

CHAPTER 5 ESTIMATION OF BENEFITS

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5.1 Introduction

The most obvious benefit of the Advanced Guideway System (AGS) to travelers in the I-70 Mountain Corridor will be the ease in which a person will be able to travel from the Front Range to desirable destinations in the mountains. Currently, the trip to and from the mountains can be time-consuming and, in winter, sometimes impossible when I-70 is closed. A fast and all-weather AGS provides:

- Much quicker travel times – meaning more time for other destination activities.
- More comfortable travel – AGS vehicles will have comfortable seats and phone and internet access. Some technologies accommodate food and drink service.
- Less stress and anxiety – The AGS technologies have very high levels of reliability, combined with very high safety standards. This is a particular contrast to the delay issues due to congestion and weather facing motorists on the I-70 Mountain Corridor today.

The AGS will also have other benefits. These benefits, which are discussed in more detail in Chapter 6, include:

- Reduction in air pollutants associated with reduction in automobile trips.
- Reduction in accidents associated with reduction in automobile trips.
- Increases in land value associated with new AGS stations.
- Increases in direct jobs, both to build the system and then to operate and maintain it.

In this chapter, important metrics by which these benefits are measured are estimated:

- Ridership and farebox revenue estimates
- Reduction in Vehicle Miles Traveled (VMT)
- Reduction in Vehicle Hours Traveled (VHT)

In Chapter 6, the farebox recovery ratio and benefit/cost ratio will be calculated.

5.2 Ridership and Farebox Revenue

To create certain efficiencies and a systemwide travel model, the *Interregional Connectivity Study* (ICS) Team performed all ridership modeling for both the ICS and the AGS. Later in the Study, the AGS Study Team obtained the ICS ridership model and used it to model further scenarios.

The ICS Team applied a well-established travel demand forecasting methodology to analyze ridership and revenue for the ICS Level 2 alternatives. This methodology is quite detailed and is well-suited to a preliminary model that is a precursor to an “investment grade” ridership study. Figure 5-1 graphically illustrates the forecasting approach.

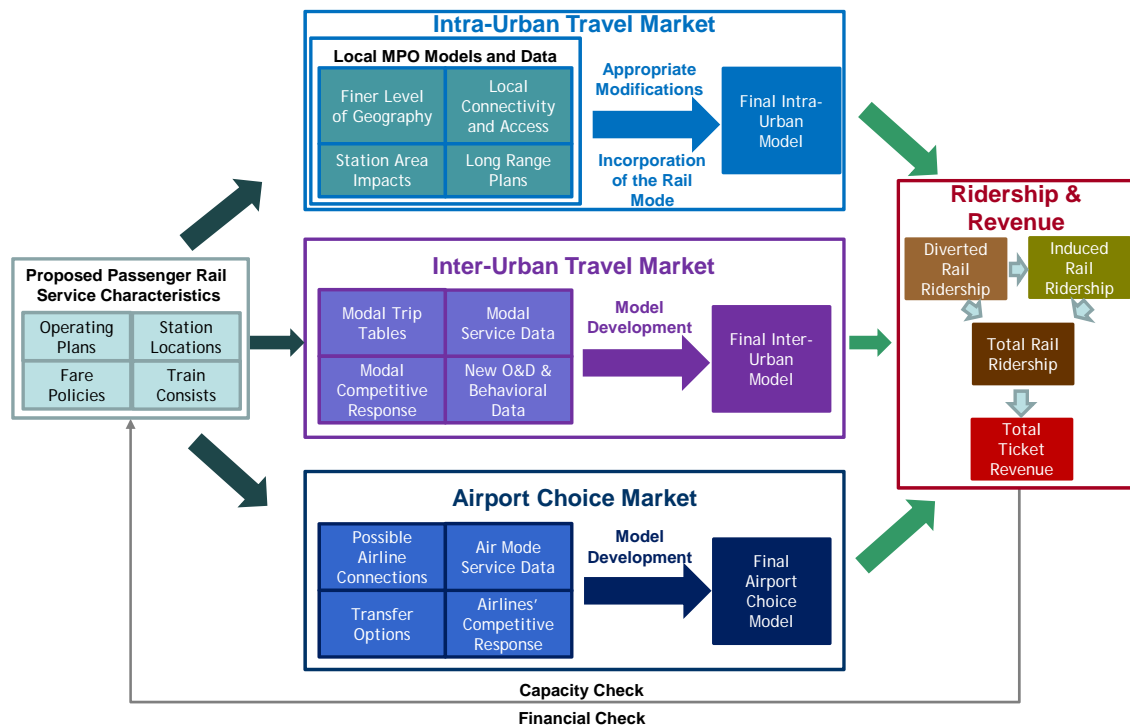


Figure 5-1: General Ridership and Revenue Forecasting Framework

As can be seen, the methodology addresses four distinct travel markets in the study area:

- Inter-urban travel market.
- Denver area intra-urban travel market, including access to Denver International Airport.
- Airport choice market.
- Induced demand market.

The demand forecasting steps for each of these travel markets are briefly described below. An analysis of the ridership model is provided in Appendix H.

To forecast demand for the combined technology, speed, alignment, and stopping pattern of an AGS + ICS System, the model used the following service characteristics of the alternatives:

- Operating characteristics (stopping patterns, running and dwell times, schedule or frequency).
- Station-to-station fares.
- Station sites and connectivity/accessibility/parking.

5.2.1 Inter-Urban Travel

The process that the demand model applies to forecast the inter-urban ridership and revenue of a proposed rail service entails five broad steps:

Step 1 Establish the study area geographic scope and its zone structure – The inter-urban model covers a geographic area that generally follows the AGS + ICS

System corridors and extends approximately 50 miles on each side of the proposed alignments. The study area is split into 3,142 zones. In Metropolitan Planning Organization (MPO) areas, the zones are based on the MPO model traffic analysis zones (TAZ) or some aggregation of them; in other areas, they are based on zones used in the *I-70 Mountain Corridor Final Programmatic Environmental Impact Statement*.

- Step 2 Develop input data including service characteristics for each mode and zone pair** – Modeling input data includes the study area network, historic and future socio-economic variables (population, employment, income, general economic conditions, information on visitors, commuters, etc.), and information about the service characteristics of existing and future travel modes.
- Step 3 Estimate the current in-scope travel market** – The inter-urban travel market includes trips by air, bus, and private automobile; and for different travel purposes. As part of the forecasting model development, data on the patterns and levels of trip making in these markets is prepared on a detailed zone-to-zone basis. While inter-urban air volume data is available from well-established sources, and inter-urban bus volumes can be adequately estimated from published schedules, there is little current information on inter-urban automobile travel in the I-70 Mountain Corridor, resulting in a large data gap. This prompted the AGS Study Team to undertake a program of original travel data collection, using anonymous cell phone data to understand the origins and destinations of auto travelers in the study corridors.
- Step 4 Estimate how each market will grow in the future** – This step involves the development of econometric travel growth models for the auto and bus modes, reflecting trends in socioeconomic variables, such as population and employment. Future year air trip tables are prepared based on published Federal Aviation Administration Terminal Area forecasts of total annual airport enplanements for each of the study area airports.
- Step 5 Estimate the potential market share that the new AGS + ICS System service will capture (i.e., the ridership)** – A standard model form, called a nested logit model, is used to predict the market share of each inter-urban mode based on the respective service characteristics of the modes in competition between each zone pair. Service characteristics include time, cost, frequency, reliability, and quality of service, with time and cost broken down into their access, egress, transfer, terminal, and line haul components. Mode-specific constants account for the effects of other (not explicitly modeled) characteristics of the AGS + ICS System relative to other modes. These shares are then applied to the total zone-to-zone travel volume to predict the volume of travel by each mode, including the new AGS + ICS System mode. This process is carried out separately for the different trip purposes, and the results aggregated.

The nested logit model incorporates information about how travelers assess and trade off different modal service characteristics (cost, time, etc.) based on traveler characteristics (income, size of travel group, etc.). This information was obtained from the Stated Preference (SP) Survey of I-70 Mountain Corridor travelers that was conducted as part of the forecasting effort. This type of survey is routinely used to elicit traveler preferences and tradeoffs involving different modal attributes.

5.2.2 Intra-Urban Travel

Because some of the alternatives include multiple stations in the Denver metropolitan area, they provide intra-urban as well as inter-urban service. The travel forecasting activity considers interactions between the AGS + ICS System and the Denver metropolitan transportation system, both the metropolitan access/egress portion of inter-urban AGS + ICS System trips and the intra-urban AGS + ICS System as a local travel mode within the Denver area. The forecasting activity uses the Denver Regional Council of Governments (DRCOG) Compass model to forecast Denver-area AGS + ICS System travel demand, treating the AGS + ICS System as an additional travel mode within the already-defined mix of available urban modes and making adjustments as required. This approach makes maximum use of the detailed understanding of Denver-area travel patterns and behavior embodied in the Compass model system.

5.2.3 Airport Choice

Denver International Airport (DIA) is an important national and international hub because it serves a large number of destinations, and there are several major carriers operating from DIA. Locally, it provides connection options for air trips that begin or end at the study area regional airports in Colorado Springs, Pueblo, and Eagle County. Because some of the alternatives include an AGS + ICS System station at DIA, air travelers who begin or end their trip at Colorado Springs Airport or Eagle County Regional Airport and change planes at DIA will also have the option to access DIA by the AGS + ICS System. The AGS + ICS System travel demand forecasting effort develops an airport choice model to forecast these potential shifts by connecting air travelers.

5.2.4 Induced Demand

Induced travel refers to trips that were not made before a project opens, but that come to be made as a result of a project's mobility and accessibility improvements. Induced travel resulting from the introduction of the AGS + ICS System is forecasted using a simple elasticity-based approach, where the elasticity is expressed as the percentage impact on travel volumes resulting from a percent change in accessibility. Accessibility, in turn, is defined in terms of a generalized cost or logsum variable computed from the nested logit model developed for this Study from the SP Survey data.

5.2.5 Travel Time

A key factor in ridership is the speed of the system that translates to travel time. The model data clearly shows that the shorter the travel time, the higher the ridership. Travel times for each of the alignment/technology pairs were developed. For High Speed Rail, travel time was simulated using proprietary software developed by one of the AGS Study Team members, using actual operating data for a Talgo 250 vehicle. For Hybrid/120 mph Maglev, travel times were estimated by American Maglev Transport (AMT). For High Speed Maglev, travel times were estimated by Transrapid. The estimated travel times for the Full System (Eagle County Regional Airport to I-70/C-470 or DIA) are shown in Table 5-1.

Table 5-1: Travel Characteristics for Full System

Eagle County Regional Airport to I-70/C-470	Travel Time (minutes)	Distance (miles)	Average Speed (mph)
High Speed Rail	65.0	100.8	93.0
High Speed Maglev	79.0	121.7	92.4
Hybrid/High Speed Maglev	73.0	115.2	94.7
Hybrid/120 mph Maglev	107.4	115.2	64.4
Eagle County Regional Airport to DIA	Travel Time (minutes)	Distance (miles)	Average Speed (mph)
Hybrid/High Speed Maglev	95.0	152.2	96.1

Estimated travel times for the Minimum Operable Segment (MOS) (Breckenridge to I-70/C-470 or DIA) are shown in Table 5-2.

Table 5-2: Travel Characteristics for MOS

Breckenridge to I-70/C-470	Travel Time (minutes)	Distance (miles)	Average Speed (mph)
High Speed Rail	37.0	60.8	98.6
High Speed Maglev	33.0	63.5	115.5
Hybrid/High Speed Maglev	31.0	58.2	112.6
Hybrid/120 mph Maglev	46.2	57.9	75.2
Breckenridge to DIA	Travel Time (minutes)	Distance (miles)	Average Speed (mph)
Hybrid/High Speed Maglev	55.0	94.0	102.5

For context, Table 5-3 compares the travel time from key AGS stations to the I-70/C-470 station using an unimpeded passenger automobile and the Hybrid/High Speed Maglev alignment/technology pair.

Time savings with the Hybrid/High Speed Maglev from Eagle County Regional Airport to Keystone and Breckenridge are much greater because an automobile has to travel some distance from I-70 to reach those stations. The Vail station is along I-70.

Table 5-3: Travel Time Comparison, Automobile vs. AGS

	Travel Time (minutes) from Originating Station to I-70/C-470 Station		
	Automobile*	Hybrid High Speed Maglev	Time Savings
Eagle County Regional Airport	119	73	46
Vail	86	50	36
Breckenridge	78	33	45
Keystone	68	24	44

* Based on Google Maps calculations of travel time.

5.2.6 Operating Plans

Another key factor in ridership is the frequency of service. In conjunction with the ICS Team, operating scenarios were developed. All scenarios are based on an 18-hour daily span of service, 7 days a week. For highest-demand days (considered Thursday through Sunday for the AGS), hourly service is assumed for 12 hours of the day and 30-minute frequencies during 6 hours of the day. For lighter days (Monday through Wednesday), an hourly frequency is assumed for most of the day.

High Speed Rail – The High Speed Rail Alignment serves Breckenridge with a separate branch, so there are two line patterns. The main line serves Eagle County Regional Airport, Georgetown, Lakeside (between Frisco and Silverthorne), and Vail; it ends at I-70/C-470. The spur line proceeds from Georgetown, Lakeside, and Breckenridge to I-70/C-470. The basic operating plan assumes 24 round trips daily from Thursday through Sunday (18 on mainline, 6 on branch), and 15 round trips Monday through Wednesday (9 on mainline, 6 on branch).

High Speed Rail and Hybrid/120 mph Maglev from Eagle County Regional Airport to I-70/C-470 – This alignment is assumed to operate between Eagle County Regional Airport and I-70/C-470, with intermediate stations Avon, Vail, Copper Mountain (for Hybrid/120 mph Maglev only), Breckenridge, Keystone, and Idaho Springs. The basic operating plan assumes 24 round trips daily from Thursday through Sunday, and 15 round trips daily from Monday through Wednesday.

High Speed Rail and Hybrid/120 mph Maglev from Eagle County Regional Airport to DIA – This alignment operates between Eagle County Regional Airport and DIA, with additional stations at DIA and I-76/72nd Avenue in the Denver area. The basic operating plan assumes 24 round trips daily from Thursday through Sunday, and 15 round trips daily from Monday through Wednesday.

MOS (All Technologies) – This alignment operates between Breckenridge and I-70/C-470. There would be four stations for all alignment/technology pairs. The basic operating plan assumes 24 round trips daily Thursday through Sunday, and 15 round trips Monday through Wednesday.

5.2.7 Fares

Fares were developed on a cost per mile basis, priced for individual travel. Initially, a fare of \$0.35 per mile per person was assumed. Subsequently, a sensitivity analysis showed that a fare of \$0.26 per mile would result in optimized ridership and revenue.

5.2.8 Ridership and Revenue

Many different scenarios were modeled. In the initial phases, the modeling focused on a combination of the AGS with a number of ICS System options through the Denver metropolitan area. Those options included various alignments to travel from I-70/C-470 station DIA to, as well as ways for the ICS System to travel north-south through the metropolitan area.

After significant analysis, two options remained. The first option is the one that best suits AGS because it would allow a one-seat ride from the I-70 Mountain Corridor to DIA (a key goal of the AGS PLT). The alignment leaves DIA, travels to I-76, and then follows I-76 to I-70 to the I-70/C-470 station. The ICS north-south system would tie into this east-west system at a station at DIA.

In the second option, the ICS System alignment accesses DIA from C-470 and E-470. It links to AGS at the I-70/C-470 station. If the AGS used a different technology than the ICS System, this option would require a transfer at the I-70/C-470 station. Only if the same technologies were used would a one-seat ride be possible (unless parallel systems were built, which would be cost prohibitive).

Three technologies with different assumptions were modeled, as follows:

- High Speed Rail was modeled for the ICS System + AGS and as a standalone from Eagle County Regional Airport to I-70/C-470.
- High Speed Maglev was modeled for Eagle County Regional Airport to I-70/C-470 and for Eagle County Regional Airport to DIA with and without a connection to the ICS System at I-70/C-470.
- The 120 mph Maglev was modeled only for Eagle County Regional Airport to I-70/C-470 with and without a connection to the ICS System at I-70/C-470 station.

For those scenarios where the AGS and the ICS System are combined, ridership and revenue are assigned to the AGS for any trip that has an origin or destination within the I-70 Mountain Corridor. For instance, a trip originating in Colorado Springs and ending in Breckenridge would be counted as an AGS trip. The reverse trip from Breckenridge to Colorado Springs would also be an AGS trip.

Table 5-4 and Table 5-5 present annual ridership and revenue estimates for a variety of alignment/ technology pairs at the initial \$0.35/mile and the optimized \$0.26/mile fares.

Table 5-4: 2035 Forecast Annual Ridership and Revenue Data, \$0.35/Mile Fare

Alignment Through Denver Metro	Alignment/Technology	Fare/Mile	Coverage	Ridership (Passengers /Year)	Revenue (\$/Year)
I-76	Hybrid/High Speed Maglev	\$0.35	ECRA to I-70/C-470 ICS System + AGS*	3,636,914	\$123,745,259
Not applicable	Hybrid/High Speed Maglev	\$0.35	Breckenridge to I-70/C-470 No ICS System	1,236,174	\$22,247,496
Not applicable	Hybrid/120 mph Maglev	\$0.35	Breckenridge to I-70/C-470 No ICS System	1,026,172	\$18,408,144
C-470/E-470	High Speed Rail	\$0.35	ECRA to I-70/C-470 ICS System + AGS	4,340,584	\$137,364,179

* Maglev from Eagle County Regional Airport to DIA.

ECRA = Eagle County Regional Airport. Revenues are in 2013\$.

Table 5-5: 2035 Forecast Annual Ridership and Revenue Data, \$0.26/Mile Fare

Alignment Through Denver Metro	Alignment/Technology	Fare/Mile	Coverage	Ridership (Passengers /Year)	Revenue (\$/Year)
I-76	Hybrid/High Speed Maglev	\$0.26	ECRA to DIA ICS System + AGS*	4,635,464	\$113,911,654
C-470/E-470	Hybrid/High Speed Maglev	\$0.26	ECRA to DIA ICS System + AGS**	6,211,251	\$157,280,243
I-76	Hybrid/High Speed Maglev	\$0.26	ECRA to DIA No ICS System *	3,585,120	\$79,037,296
Not applicable	Hybrid/High Speed Maglev	\$0.26	Breckenridge to I-70/C-470 No ICS System	1,535,031	\$20,851,174
Not applicable	Hybrid/120 mph Maglev	\$0.26	Breckenridge to I-70/C-470 No ICS System	1,284,913	\$17,418,946
C-470/E-470	High Speed Rail	\$0.26	ECRA to DIA ICS System + AGS	6,349,807	\$159,912,578
I-76	Hybrid/High Speed Maglev	\$0.26	Breckenridge to DIA ICS System + AGS	2,906,471	\$66,943,427
I-76	High Speed Rail	\$0.26	Breckenridge to DIA ICS System + AGS	2,676,462	\$58,278,195
I-76	Hybrid/High Speed Maglev	\$0.26	Breckenridge to DIA No ICS System	1,775,726	\$28,723,660
I-76	Hybrid/120 mph Maglev	\$0.26	Breckenridge to DIA ICS System + AGS	2,508,416	\$56,779,587

* Maglev from Eagle County Regional Airport to DIA.

** Maglev from Eagle County Regional Airport to I-70/C-470.

ECRA = Eagle County Regional Airport. Revenues are in 2013\$.

As can be seen, decreasing the fare from \$0.35/mile to \$0.26/mile has a significant effect on ridership but not a significant change in revenue. This is because of lower overall trip fares between destinations. In one case, the revenue actually decreases because the increase in ridership is not enough to support the decrease in trip fares.

The other important takeaway from Table 5-4 and Table 5-5 is that ridership is very dependent on speed. A shorter trip time definitely attracts ridership. As a result, the 120 mph Maglev has significantly lower ridership than either of the two high-speed technologies.

To put the AGS ridership into context, consider the following:

- In 2035, about 12.41 million automobiles will travel through the Eisenhower-Johnson Memorial Tunnel (EJMT). Assuming that the average annual vehicle occupancy is 2.42 persons, there will be about 30 million person trips through the EJMT in 2035. Excluding truck and through trips, which equate to about 20 percent of the total trips, there will be about 24 million person trips through the EJMT in 2035 that could potentially divert to the AGS.
- Based on the lowest ridership estimate of 1.54 million passengers per year (120 mph Maglev MOS, Breckenridge to I-70/C-470), about 6.4 percent of eligible person trips would divert from automobiles to the AGS.
- Using the ridership estimates of 2.9 to 3.6 million passengers per year (Full System/High Speed Maglev with or without the ICS System on the Front Range, I-70/I-76 alignment through Denver, Eagle County Regional Airport to DIA), about 12 to 15 percent of eligible person trips would divert from automobiles to the AGS.
- Based on the ridership estimate of 6.2 million passengers per year (High Speed Maglev, AGS with ICS on the Front Range on the C-470/E-470 alignment), about 26 percent of eligible person trips would divert from automobiles to the AGS.

5.3 Reductions in Vehicle Miles Traveled

Vehicle miles traveled (VMT) are associated with higher emissions of air pollutants and greenhouse gases (GHG) and increased congestion. As people divert from private automobiles, buses, and shuttles to the AGS, fewer of these vehicles will be on the highway system. This will result in a reduction in VMT. The model was used to estimate the reductions in annual VMT. The results are shown in Table 5-6 and Table 5-7. Similar to ridership and revenue, VMT are measured for any trip having its origin or destination in the I-70 Mountain Corridor.

To put the reductions into perspective, using the 120-mile trip from Eagle County Regional Airport to I-70/C-470 as a basis, the AGS will result in the equivalent of between 266,000 and 2,410,000 120-mile trips removed from the I-70 Mountain Corridor per year.

Table 5-6: 2035 Forecast Reductions in Annual Vehicle Miles Traveled, \$0.35/Mile Fare

Alignment Through Denver	Alignment/Technology	Fare/Mile	Coverage	Reduction in VMT
I-76	Hybrid/High Speed Maglev	\$0.35	ECRA to DIA ICS System + AGS*	162,980,029
Not applicable	Hybrid/High Speed Maglev	\$0.35	Breckenridge to I-70/C-470 No ICS System	38,624,456
Not applicable	Hybrid/120 mph Maglev	\$0.35	Breckenridge to I-70/C-470 No ICS System	31,873,037
C-470/E-470	High Speed Rail	\$0.35	ECRA to I-70/C-470 ICS System + AGS	186,041,118

* Maglev from Eagle County Regional Airport to DIA.

ECRA = Eagle County Regional Airport.

Table 5-7: 2035 Forecast Reductions in Annual Vehicle Miles Traveled, \$0.26/Mile Fare

Alignment Through Denver	Alignment/Technology	Fare/Mile	Coverage	Reduction in VMT
I-76	Hybrid/High Speed Maglev	\$0.26	ECRA to DIA ICS System + AGS*	191,432,412
C-470/E-470	Hybrid/High Speed Maglev	\$0.26	ECRA to DIA ICS System + AGS**	266,031,869
I-76	Hybrid/High Speed Maglev	\$0.26	DIA to ECRA No ICS System*	152,226,347
Not applicable	Hybrid/High Speed Maglev	\$0.26	Breckenridge to I-70/C-470 No ICS System	47,583,933
Not applicable	Hybrid/120 mph Maglev	\$0.26	Breckenridge to I-70/C-470 No ICS System	39,696,174
C-470/E-470	High Speed Rail	\$0.26	ECRA to I-70/C-470 ICS System + AGS	289,257,126
I-76	Hybrid/High Speed Maglev	\$0.26	Breckenridge to DIA ICS System + AGS	96,935,072
I-76	High Speed Rail	\$0.26	Breckenridge to DIA ICS System + AGS	89,843,332
I-76	Hybrid/High Speed Maglev	\$0.26	Breckenridge to DIA No ICS System	57,495,203
I-76	Hybrid/120 mph Maglev	\$0.26	Breckenridge to DIA ICS System + AGS	82,730,444

* Maglev from Eagle County Regional Airport to DIA.

** Maglev from Eagle County Regional Airport to I-70/C-470.

ECRA = Eagle County Regional Airport.

5.4 Reductions in Vehicle Hours Traveled (VHT)

As people divert from private automobiles, buses, and shuttles to the AGS, there are fewer vehicles and less congestion. This allows average speeds to increase, which lowers VHT.

The model was used to estimate the reductions in annual VHT. The results are shown in Tables 5-8 and 5-9. Similar to ridership and revenue, VHT are measured for any trip having an origin or destination in the I-70 Mountain Corridor.

Table 5-8: 2035 Forecast Reductions in Annual Vehicle Hours Traveled, \$0.35/Mile Fare

Alignment Through Denver	Alignment/Technology	Fare/Mile	Coverage	Reduction in VHT
I-76	Hybrid/High Speed Maglev	\$0.35	ECRA to DIA ICS System + AGS*	640,580
Not applicable	Hybrid/High Speed Maglev	\$0.35	Breckenridge to I-70/C-470 No ICS System	175,603
Not applicable	Hybrid/120 mph Maglev	\$0.35	Breckenridge to I-70/C-470 No ICS System	56,846
C-470/E-470	High Speed Rail	\$0.35	ECRA to I-70/C-470 ICS System + AGS	812,467

* Maglev from Eagle County Regional Airport to DIA.

ECRA = Eagle County Regional Airport.

Table 5-9: 2035 Forecast Reductions in Annual Vehicle Hours Traveled, \$0.26/Mile Fare

Alignment Through Denver	Alignment/Technology	Fare/Mile	Coverage	Reduction in VHT
I-76	Hybrid/High Speed Maglev	\$0.26	ECRA to DIA ICS System + AGS*	675,455
C-470/E-470	Hybrid/High Speed Maglev	\$0.26	ECRA to DIA ICS System + AGS**	950,985
I-76	Hybrid/High Speed Maglev	\$0.26	ECRA to DIA No ICS System*	852,987
Not applicable	Hybrid/High Speed Maglev	\$0.26	Breckenridge to I-70/C-470	215,174
Not applicable	Hybrid/120 mph Maglev	\$0.26	Breckenridge to I-70/C-470	69,402
C-470/E-470	High Speed Rail	\$0.26	ECRA to I-70/C-470 ICS System + AGS	1,151,656
I-76	Hybrid/High Speed Maglev	\$0.26	Breckenridge to DIA ICS System + AGS	29,116
I-76	High Speed Rail	\$0.26	Breckenridge to DIA ICS System + AGS	(28,874)
I-76	Hybrid/High Speed Maglev	\$0.26	Breckenridge to DIA No ICS System	210,468
I-76	Hybrid/120 mph Maglev	\$0.26	Breckenridge to DIA ICS System + AGS	(148,742)

* Maglev from Eagle County Regional Airport to DIA.

** Maglev from Eagle County Regional Airport to I-70/C-470.

ECRA = Eagle County Regional Airport.

For most of the MOS runs, the model system suggests there will be VHT savings in 2035. This is reasonable because travelers formerly using autos are diverted to AGS. However, the results from the Breckenridge to DIA scenarios with the Full ICS System indicate there will

be a negative VHT savings. The increase in VHT for these scenarios is due to the way VHT savings are calculated in the AGS model system. VHT is calculated by subtracting the total end-to-end AGS travel time from the total end-to-end auto travel time of those same diverted auto trips. With the Full ICS System in the background, there are enough trip interchanges where long auto trips are diverted to a longer AGS trip. Travelers ride AGS not only for shorter travel times, but also for comfort, reliability, and other undefined attributes. Therefore, while the results are in the correct direction (i.e., there is a VHT savings with AGS) for most scenarios, some results are counter-intuitive. This is not incorrect, but strictly the result of how VHT is calculated in the I-70 AGS model system.

5.5 Air Quality Savings

With decreased VMT, there would be fewer harmful particulates and greenhouse gas emissions. Both businesses and the general public would benefit from a better environment and better overall public health. The benefits are estimated at \$0.199 per reduction in VMT based on research into public health and environmental benefits by the Victoria Transportation Policy Institute.¹ The estimated benefit in annual air quality is shown in Table 5-10 and 5-11.

5.6 Benefit of Travel Time Savings

Reductions in travel time can be equated with increased productivity. While time can be valued at different rates depending on the activity (leisure, work, etc.), the average wage rate of \$23 per hour was used for purposes of this analysis. The average wage rates for Colorado and the United States were similar at approximately \$23 per hour². Table 5-12 and 5-13 presents the yearly value of the VHT reductions associated with the AGS.

Table 5-10: 2035 Forecast Annual Air Quality Benefits, \$0.35/Mile Fare (2013\$)

Alignment Through Denver	Technology	Fare/Mile	Coverage	Annual Air Quality Savings
I-76	Hybrid High Speed Maglev	\$0.35	ECRA to DIA ICS System + AGS*	\$32,433,026
Not applicable	Hybrid High Speed Maglev	\$0.35	Breckenridge to I-70/C-470 No ICS System	\$7,686,267
Not applicable	Hybrid 120 mph Maglev	\$0.35	Breckenridge to I-70/C-470 No ICS System	\$6,342,734
C-470/E-470	High Speed Rail	\$0.35	ECRA to I-70/C-470 ICS System + AGS	\$37,022,182

* Maglev from Eagle County Regional Airport to DIA.

ECRA = Eagle County Regional Airport.

¹ Victoria Transportation Policy Institute, "Transportation Cost and Benefit Analysis II – Air Pollution Costs", February 22, 2012

² Bureau of Labor Statistics, 2012 for Colorado and the U.S.

Table 5-11: 2035 Forecast Annual Air Quality Benefits, \$0.26/Mile Fare (2013\$)

Alignment Through Denver	Technology	Fare/Mile	Coverage	Annual Air Quality Savings
I-76	Hybrid High Speed Maglev	\$0.26	ECRA to DIA ICS System + AGS*	\$38,095,050
C-470/E-470	Hybrid High Speed Maglev	\$0.26	ECRA to DIA ICS System + AGS**	\$52,940,342
I-76	Hybrid High Speed Maglev	\$0.26	ECRA to DIA No ICS System*	\$30,293,043
Not applicable	Hybrid High Speed Maglev	\$0.26	Breckenridge to I-70/C-470	\$9,469,203
Not applicable	Hybrid 120 mph Maglev	\$0.26	Breckenridge to I-70/C-470	\$7,899,539
C-470/E-470	High Speed Rail	\$0.26	ECRA to I-70/C-470 ICS System + AGS	\$57,562,168
I-76	Hybrid High Speed Maglev	\$0.26	Breckenridge to DIA ICS System + AGS	\$19,290,079
I-76	High Speed Rail	\$0.26	Breckenridge to DIA ICS System + AGS	\$17,878,823
I-76	Hybrid High Speed Maglev	\$0.26	Breckenridge to DIA No ICS System	\$11,441,545
I-76	Hybrid 120 mph Maglev	\$0.26	Breckenridge to DIA ICS System + AGS	\$16,463,358

* Maglev from Eagle County Regional Airport to DIA.

** Maglev from Eagle County Regional Airport to I-70/C-470.

ECRA = Eagle County Regional Airport.

Table 5-12: 2035 Forecast Annual Travel Time Benefits, \$0.35/Mile Fare (2013\$)

Alignment Through Denver	Technology	Fare/Mile	Coverage	Annual Value of VHT Reduction
I-76	Hybrid High Speed Maglev	\$0.35	Full System ICS System + AGS*	\$14,733,340
Not applicable	Hybrid High Speed Maglev	\$0.35	Breckenridge to I-70/C-470 No ICS System	\$4,038,869
Not applicable	Hybrid 120 mph Maglev	\$0.35	Breckenridge to I-70/C-470 No ICS System	\$1,307,458
C-470/E-470	High Speed Rail	\$0.35	Full System ICS System + AGS	\$18,686,741

* Maglev from DIA to Eagle County Regional Airport.

Table 5-13: 2035 Forecast Annual Travel Time Benefits, \$0.26/Mile Fare (2013\$)

Alignment Through Denver	Technology	Fare/Mile	Coverage	Annual Value of VHT Reduction
I-76	Hybrid High Speed Maglev	\$0.26	Full System ICS System + AGS*	\$15,535,465
C-470/E-470	Hybrid High Speed Maglev	\$0.26	Full System ICS System + AGS**	\$21,872,655
I-76	Hybrid High Speed Maglev	\$0.26	ECRA to DIA No ICS System*	\$19,618,701
Not applicable	Hybrid High Speed Maglev	\$0.26	Breckenridge to I-70/C-470	\$4,949,002
Not applicable	Hybrid 120 mph Maglev	\$0.26	Breckenridge to I-70/C-470	\$1,596,246
C-470/E-470	High Speed Rail	\$0.26	Full System ICS System + AGS	\$26,488,088
I-76	Hybrid High Speed Maglev	\$0.26	Full System ICS System + AGS	\$669,668
I-76	High Speed Rail	\$0.26	Full System ICS System + AGS	-\$664,102
I-76	Hybrid High Speed Maglev	\$0.26	Breckenridge to DIA No ICS	\$4,840,764
I-76	Hybrid 120 mph Maglev	\$0.26	Breckenridge to DIA ICS System + AGS	-\$3,421,066

* Maglev from Eagle County Regional Airport to DIA.

** Maglev from Eagle County Regional Airport to I-70/C-470.

ECRA = Eagle County Regional Airport.

5.7 Benefit of Stations

New AGS stations have the potential to create new economic benefits in the communities in which they are sited. The benefits can come from:

- Increased visitor traffic.
- New jobs.
- Area-wide population increases due to faster commutes.
- Development potential around the stations.

In discussions with the I-70 Mountain Corridor counties through the land use meetings discussed in Chapter 3, there was agreement that inclusion of transit-oriented development (TOD) around the stations was desirable. The inclusion of TOD around the stations will generate financial benefits from increased land values and associated increased property taxes, sales taxes, and other types of taxes. The economist for the ICS, Ms. Arleen Taniwaki, places the value of a station in the I-70 Mountain Corridor at \$370 million per station, over a 30-year period. Table 5-14 provides the expected economic benefits of the AGS stations.

Table 5-14: Economic Benefits of AGS Stations (2013\$)

Alignment/Technology	Number of Stations	Economic Value of Stations (30 years)
Hybrid/120 mph Maglev	8	\$2,960,000,000
Hybrid/High Speed Maglev	7	\$2,590,000,000
High Speed Maglev	8	\$2,960,000,000
High Speed Rail	6	\$2,220,000,000

5.8 Conclusions

The results of the ridership modeling can be summarized as follows:

- The High Speed Maglev has shorter travel times than the slower Hybrid/120 mph Maglev.
- As a standalone system (no connection to the ICS System), AGS ridership is low.
- The ridership for the MOS is also low. This is true even if it is assumed the MOS runs from Breckenridge to DIA.
- When combined with the ICS System, ridership on the AGS for both the Eagle County Regional Airport to I-70/C-470 or DIA and the MOS from Breckenridge to I-70/C-470 or DIA increases to a point where it becomes more viable. It is clear that to be viable the AGS needs to be linked to the ICS System via a direct route or via transfers at DIA or the I-70/C-470 station.