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Rocky Mountain Rail Authority

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High-Speed Rail Feasibility Study Business Plan - Appendices

Submitted by

TEMS

Transportation Economics & Management Systems, Inc.

in association with
Quandel Consultants, LLC
GBSM, Inc.

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A Membership by Jurisdiction

2008 RMRA Board of Officers & Executive Committee Members

Chairman: Harry Dale, Clear Creek County
Vice Chairman: Doug Lehnen, Castle Rock
Secretary: Gail Drumm, Monument
Treasurer: John Tangen, RFTA
Executive Committee at large: Bill Moore, City of Pueblo
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30. Yampa

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2. RFTA
3. RTD

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B *COMPASS*™ Model

COMPASS™ Model Calibration

The *COMPASS*™ Model System is a flexible multimodal demand-forecasting tool that provides comparative evaluations of alternative socioeconomic and network scenarios. It also allows input variables to be modified to test the sensitivity of demand to various parameters such as elasticities, values of time, and values of frequency. This section describes in detail the model methodology and process used in the study.

B.1 Description of the COMPASS™ Model System

The *COMPASS*™ model is structured on two principal models: Total Demand Model and Hierarchical Modal Split Model. For this study, these two models were calibrated separately for four trip purposes, i.e., Business, Commuter, Tourist, and Social. Moreover, since the behavior of short-distance trip making is significantly different from long-distance trip making, the database was segmented by distance, and independent models were calibrated for both long and short-distance trips, thus provide separate elasticities for trips over and under 80 miles. For each market segment, the models were calibrated on origin-destination trip data, network characteristics and base year socioeconomic data.

The models were calibrated on the base year data. In applying the models for forecasting, an incremental approach known as the "pivot point" method is used. By applying model growth rates to the base data observations, the "pivot point" method is able to preserve the unique travel flows present in the base data that are not captured by the model variables. Details on how this method is implemented are described below.

B.2 Total Demand Model

The Total Demand Model, shown in Equation 1, provides a mechanism for assessing overall growth in the travel market.

Equation 1:

$$T_{ijp} = e^{\beta_{0p}} (SE_{ijp})^{\beta_{1p}} e^{\beta_{2p} U_{ijp}}$$

Where,

T_{ijp}	=	Number of trips between zones i and j for trip purpose p
SE_{ijp}	=	Socioeconomic variables for zones i and j for trip purpose p
U_{ijp}	=	Total utility of the transportation system for zones i to j for trip purpose p
$\beta_{0p}, \beta_{1p}, \beta_{2p}$	=	Coefficients for trip purpose p

As shown in Equation 1, the total number of trips between any two zones for all modes of travel, segmented by trip purpose, is a function of the socioeconomic characteristics of the zones and the total utility of the transportation system that exists between the two zones. For this study, trip purposes include Business, Commuter, Tourist, and Social, and socioeconomic characteristics consist of population, employment and per household income. The utility function provides a measure of the quality of the transportation system in terms of the times, costs, reliability and level of service provided by all modes for a given trip purpose. The Total Demand Model equation may be interpreted as meaning that travel between zones will increase as socioeconomic factors such as population and income rise or as the utility (or quality) of the transportation system is improved by providing new facilities and services that reduce travel times and costs. The Total Demand Model can therefore be used to evaluate the effect of changes in both socioeconomic and travel characteristics on the total demand for travel.

B.2.1 Socioeconomic Variables

The socioeconomic variables in the Total Demand Model show the impact of economic growth on travel demand. The *COMPASS*™ Model System, in line with most intercity modeling systems, uses three variables (population, employment and per household income) to represent the socioeconomic characteristics of a zone. Different combinations were tested in the calibration process and it was found, as is typically found elsewhere, that the most reasonable and stable relationships consists of the following formulations:

Trip Purpose	*Socioeconomic Variable*
Business	$E_i E_j (I_i + I_j) / 2$
Commuter	$(P_iE_j+P_jE_i) / 2 (I_i+I_j) / 2$
Tourist and Social	$P_i P_j (I_i + I_j) / 2$

The Business formulation consists of a product of employment in the origin zone, employment in the destination zone, and the average per household income of the two zones. Since business trips are usually made between places of work, the presence of employment in the formulation is reasonable. The Commuter formulation consists of all socioeconomic factors, this is because commuter trips are between homes and places of work, which are closely related to population and employment. The formulation for Tourist and Social consists of a product of population in the origin zone, population in the destination zone and the average per household income of the two zones. Tourist and Social trips encompass many types of trips, but the majority is home-based and thus, greater volumes of trips are expected from zones from higher population and income.

B.2.2 Travel Utility

Estimates of travel utility for a transportation network are generated as a function of generalized cost (GC), as shown in Equation 2:

Equation 2:

$$U_{ijp} = f(GC_{ijp})$$

Where,

GC_{ijp} = Generalized Cost of travel between zones *i* and *j* for trip purpose *p*

Because the generalized cost variable is used to estimate the impact of improvements in the transportation system on the overall level of trip making, it needs to incorporate all the key attributes that affect an individual's decision to make trips. For the public modes (i.e., rail, bus and air), the generalized cost of travel includes all aspects of travel time (access, egress, in-vehicle times), travel cost (fares, tolls, parking charges), schedule convenience (frequency of service, convenience of arrival/departure times) and reliability.

The generalized cost of travel is typically defined in travel time (i.e., minutes) rather than dollars. Costs are converted to time by applying appropriate conversion factors, as shown in Equation 3. The generalized cost (GC) of travel between zones *i* and *j* for mode m and trip purpose p is calculated as follows:

Equation 3:

$$GC_{ijmp} = TT_{ijm} + \frac{TC_{ijmp}}{VOT_{mp}} + \frac{VOF_{mp} OH}{VOT_{mp} F_{ijm} C_{ijm}} + \frac{VOR_{mp} \exp(-OTP_{ijm})}{VOT_{mp}}$$

Where,

TT_{ijm} = Travel Time between zones *i* and *j* for mode *m* (in-vehicle time + station wait time + connection wait time + access/egress time + interchange penalty), with waiting, connect and access/egress time multiplied by a factor (greater than 1) to account for the additional disutility felt by travelers for these activities

TC_{ijmp} = Travel Cost between zones *i* and *j* for mode *m* and trip purpose *p* (fare + access/egress cost for public modes, operating costs for auto)

VOT_{mp} = Value of Time for mode *m* and trip purpose *p*

VOF_{mp} = Value of Frequency for mode *m* and trip purpose *p*

VOR_{mp} = Value of Reliability for mode *m* and trip purpose *p*

F_{ijm} = Frequency in departures per week between zones *i* and *j* for mode *m*

C_{ijm} = Convenience factor of schedule times for travel between zones *i* and *j* for mode *m*

OTP_{ijm} = On-time performance for travel between zones *i* and *j* for mode *m*

OH = Operating hours per week

Station wait time is the time spent at the station before departure and after arrival. Air travel generally has higher wait times than other public modes because of security procedures at the airport, baggage checking, and the difficulties of loading a plane. On trips with connections, there would be additional wait times incurred at the connecting station. Wait times are weighted higher than in-vehicle time in the generalized cost formula to reflect their higher disutility as found from previous studies. Wait times are weighted 70 percent higher than in-vehicle time.

Similarly, access/egress time has a higher disutility than in-vehicle time. Access time tends to be more stressful for the traveler than in-vehicle time because of the uncertainty created by trying to catch the flight or train. Based on previous work, access time is weighted 30 percent higher than in-vehicle time for air travel and 80 percent higher for rail and bus travel.

The third term in the generalized cost function converts the frequency attribute into time units. Operating hours divided by frequency is a measure of the headway or time between departures. Tradeoffs are made in the stated preference surveys resulting in the value of frequencies on this measure. Although there may appear to some double counting because the station wait time in the first term of the generalized cost function is included in this headway measure, it is not the headway time itself that is being added to the generalized cost. The third term represents the impact of perceived frequency valuations on generalized cost. TEMS has found it very convenient to measure this impact as a function of the headway.

The fourth term of the generalized cost function is a measure of the value placed on reliability of the mode. Reliability statistics in the form of on-time performance (i.e., the fraction of trips considered to be on time). One feature of the RMRA model is that auto travel on I-70 is frequently unreliable due to weather conditions. As such, the reliability of auto travel in the corridor was reduced by 10 percent in winter months. The negative exponential form of the reliability term implies that improvements from low levels of reliability have slightly higher impacts than similar improvements from higher levels of reliability.

B.2.3 Calibration of the Total Demand Model

In order to calibrate the Total Demand Model, the coefficients are estimated using linear regression techniques. Equation 1, the equation for the Total Demand Model, is transformed by taking the natural logarithm of both sides, as shown in Equation 4:

Equation 4:

$$\log(T_{ijp}) = \beta_{0p} + \beta_{1p}\log(SE_{ijp}) + \beta_{2p}(U_{ijp})$$

Equation 4 provides the linear specification of the model necessary for regression analysis.

The segmentation of the database by trip purpose and trip length resulted in eight sets of models. Trips that would cover a distance more than 80 miles are considered long-distance trips. Shorter trips that are less than 80 miles are considered short-distance trips. This segmentation by trip length was chosen because by analyzing the trip data, we found that traveler behaviors differ in the two categories, and usually, air service is generally an unavailable or unreasonable mode for short-distance travelers. Although the calibrated models without distance segmentation were satisfactory, we decided to develop long-distance and short-distance models separately to better simulate travelers' decision-making. The results of the calibration for the Total Demand Models are displayed in Exhibit B-1.

Exhibit B-1: Total Demand Model Coefficients [1]

Long-Distance Trips *(longer than 80 miles)*

Business $\log(T_{ij}) = -15.759 + 0.670 \log(SE_{ij}) + 1.789\ U_{ij}$ R^2=0.48
(23) (21)
where $U_{ij} = \log[\exp(5.406 + 0.898 U_{Pub}) + \exp(-0.009\ GC_{Car})]$

Commuter $\log(T_{ij}) = -7.243 + 0.407 \log(SE_{ij}) + 1.493\ U_{ij}$ R^2=0.42
(19) (31)
where $U_{ij} = \log[\exp(3.554 + 0.682\ U_{Pub}) + \exp(-0.016 GC_{Car})]$

Tourist $\log(T_{ij}) = -8.580 + 0.405 \log(SE_{ij}) + 1.267\ U_{ij}$ R^2=0.33
(30) (40)
where $U_{ij} = \log[\exp(4.154 + 0.809\ U_{Pub}) + \exp(-0.007 GC_{Car})]$

Social $\log(T_{ij}) = -13.905 + 0.634 \log(SE_{ij}) + 2.001\ U_{ij}$ R^2=0.48
(24) (25)
where $U_{ij} = \log[\exp(3.682 + 0.745\ U_{Pub}) + \exp(-0.012 GC_{Car})]$

Short-Distance Trips *(shorter than 80 miles)*

Business $\log(T_{ij}) = -6.580 + 0.367 \log(SE_{ij}) + 0.680\ U_{ij}$ R^2=0.42
(25) (40)
where $U_{ij} = \log[\exp(-5.325 + 1.321\ U_{Pub}) + \exp(-0.032 GC_{Car})]$

Commuter $\log(T_{ij}) = -8.134 + 0.458 \log(SE_{ij}) + 1.038\ U_{ij}$ R^2=0.48
(28) (47)
where $U_{ij} = \log[\exp(-4.049 + 1.258\ U_{Pub}) + \exp(-0.035 GC_{Car})]$

Tourist $\log(T_{ij}) = -0.391 + 0.197 \log(SE_{ij}) + 1.324\ U_{ij}$ R^2=0.38
(11) (46)
where $U_{ij} = \log[\exp(-3.200 + 1.010\ U_{Pub}) + \exp(-0.026 GC_{Car})]$

Social $\log(T_{ij}) = 0.870 + 0.164 \log(SE_{ij}) + 0.706\ U_{ij}$ R^2=0.34
(10) (45)
where $U_{ij} = \log[\exp(-3.334 + 0.928\ U_{Pub}) + \exp(-0.062 GC_{Car})]$

[1] t-statistics are given in parentheses.

In evaluating the validity of a statistical calibration, there are two key statistical measures: t-statistics and R^2. The *t*-statistics are a measure of the significance of the model's coefficients; values of 1.95 and above are considered "good" and imply that the variable has significant explanatory power in estimating the level of trips. The R^2 is a statistical measure of the "goodness of fit" of the model to the data; any data point that deviates from the model will reduce this measure. It has a range from 0 to a perfect 1, with 0.3 and above considered "good" for large data sets.

Based on these two measures, the total demand calibrations are good. The *t*-statistics are high, aided by the large size of the data set. The R^2 values imply good fits of the equations to the data.

As shown in Exhibit B-1, the socioeconomic elasticity values for the Total Demand Model are in the range of 0.16 to 0.45 for short distance trips and 0.4 to 0.74 for long distance trips, meaning that each one percent growth in the socioeconomic term generates approximately a 0.16 to 0.4 percent growth in short distance trips and a 0.4 to 0.74 percent growth in long distance trips.

The coefficient on the utility term is not elasticity, but it can be used as an approximation. The utility elasticity is related to the scale of the generalized costs, for example, utility elasticity can be high if the absolute value of transportation utility improvement is significant. This is not untypical when new highways or rail system are built. In these cases, a 20 percent reduction in utility is not unusual and may impact more heavily on longer origin-destination pairs than shorter origin-destination pairs.

B.2.4 Incremental Form of the Total Demand Model

The calibrated Total Demand Models could be used to estimate the total travel market for any zone pair using the population, employment, per household income, and the total utility of all the modes. However, there would be significant differences between estimated and observed levels of trip making for many zone pairs despite the good fit of the models to the data. To preserve the unique travel patterns contained in the base data, the incremental approach or "pivot point" method is used for forecasting. In the incremental approach, the base travel data assembled in the database are used as pivot points, and forecasts are made by applying trends to the base data. The total demand equation as described in Equation 1 can be rewritten into the following incremental form that can be used for forecasting (Equation 5):

Equation 5:

$$\frac{T_{ijp}^{\ f}}{T_{ijp}^{\ b}} = \left(\frac{SE_{ijp}^{\ f}}{SE_{ijp}^{\ b}}\right)^{\beta_{1p}} \exp(\beta_{2p}\ (U_{ijp}^{\ f} - U_{ijp}^{\ b}))$$

Where,

T^f_{ijp} = Number of Trips between zones *i* and *j* for trip purpose *p* in forecast year *f*
T^f_{ijp} = Number of Trips between zones *i* and *j* for trip purpose *p* in base year *b*
SE^f_{ijp} = Socioeconomic variables for zones *i* and *j* for trip purpose *p* in forecast year *f*
SE^b_{ijp} = Socioeconomic variables for zones *i* and *j* for trip purpose *p* in base year *b*
U^f_{ijp} = Total utility of the transportation system for zones *i* to *j* for trip purpose *p* in forecast year *f*
U^b_{ijp} = Total utility of the transportation system for zones *i* to *j* for trip purpose *p* in base year *b*

In the incremental form, the constant term disappears and only the elasticities are important.

B.3 Hierarchical Modal Split Model

The role of the Hierarchical Modal Split Model is to estimate relative modal shares, given the Total Demand Model estimate of the total market that consists of different travel modes available to travelers. The relative modal shares are derived by comparing the relative levels of service offered by each of the travel modes. The *COMPASS*™ Hierarchical Modal Split Model uses a nested logit structure, which has been adapted to model the intercity modal choices available in the study area. A three-level hierarchical modal split model is shown in Exhibit B-2 and a two-level hierarchical modal split model is shown in Exhibit B-3, where Air mode is not available to travelers.

Exhibit B-2: Hierarchical Structure of the Three-Level Long Distance Modal Split Model

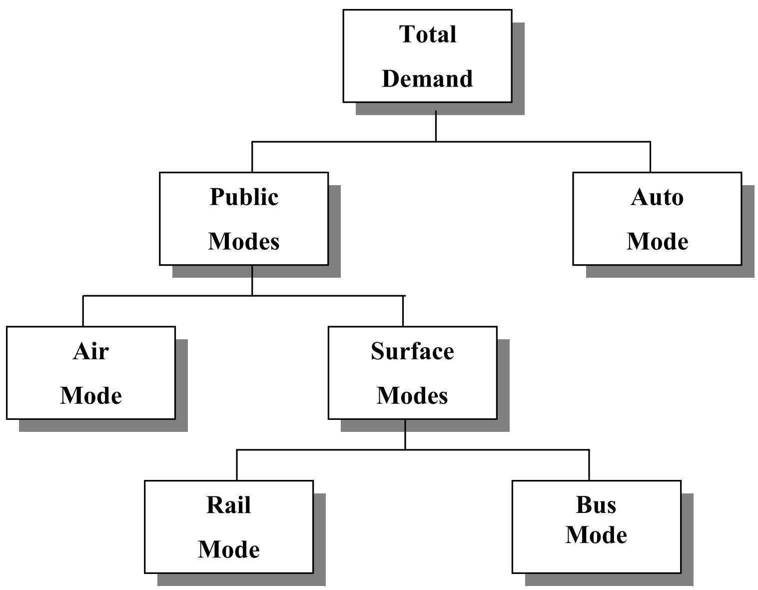
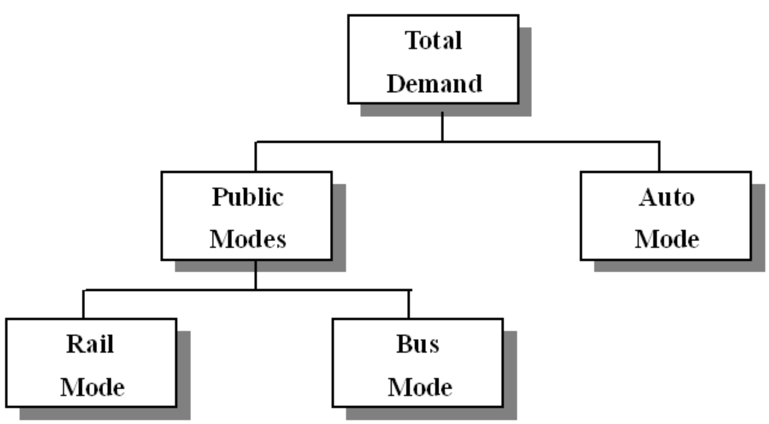


Exhibit B-3: Hierarchical Structure of the Two-Level Short Distance Modal Split Model

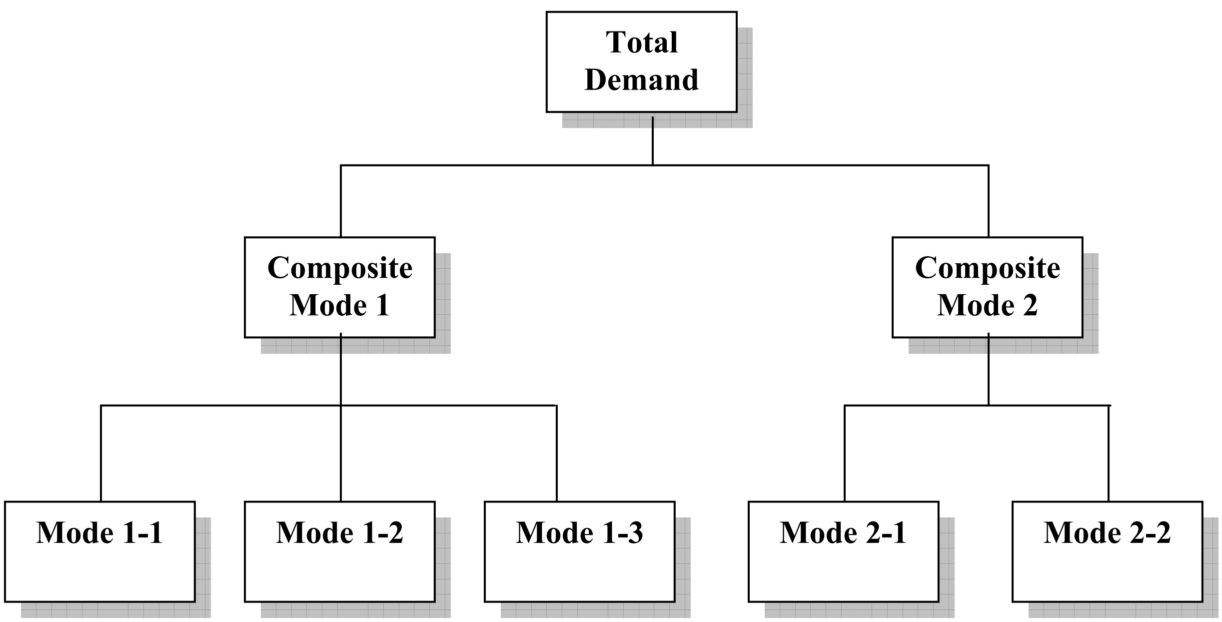


The main feature of the Hierarchical Modal Split Model structure is the increasing commonality of travel characteristics as the structure descends. The first level of the hierarchy separates private auto travel – with its spontaneous frequency, low access/egress times, low costs and highly personalized characteristics – from the public modes. The second level of the three–level structure separates air – the fastest, most expensive and perhaps most frequent public mode – from the rail and bus surface modes. The lowest level of the hierarchy separates rail, a potentially faster, more comfortable, and more reliable mode, from the bus.

B.3.1 Form of the Hierarchical Modal Split Model

The modal split models used by TEMS derived from the standard nested logit model. Exhibit B-4 shows a typical two-level standard nested model. In the nested model shown in Exhibit B-4, there are five travel modes that are grouped into two composite modes, namely, Composite Mode 1 and Composite Mode 2.

Exhibit B-4: A Typical Standard Nested Logit Model



Each travel mode in the above model has a utility function of U_j, j = 1, 2, 3, 4, 5. To assess modal split behavior, the logsum utility function, which is derived from travel utility theory, has been adopted for the composite modes in the model. As the modal split hierarchy ascends, the logsum utility values are derived by combining the utility of lower-level modes. The composite utility is calculated by

$$U_{N_k} = \alpha_{N_k} + \beta_{N_k} \log \sum_{i \in N_k} \exp(\rho U_i) \qquad (1)$$

where

N_k is composite mode k in the modal split model,
i is the travel mode in each nest,
U_i is the utility of each travel mode in the nest,
ρ is the nesting coefficient.

The probability that composite mode k is chosen by a traveler is given by

$$P(N_k) = \frac{\exp(U_{N_k} / \rho)}{\sum_{N_i \in N} \exp(U_{N_i} / \rho)} \qquad (2)$$

The probability of mode i in composite mode k being chosen is

$$P_{N_k}(i) = \frac{\exp(\rho U_i)}{\sum_{j \in N_k} \exp(\rho U_j)} \qquad (3)$$

A key feature of these models is a use of utility. Typically in transportation modeling, the utility of travel between zones i and j by mode m for purpose p is a function of all the components of travel time, travel cost, terminal wait time and cost, parking cost, etc. This is measured by generalized cost developed for each origin-destination zone pair on a mode and purpose basis. In the model application, the utility for each mode is estimated by calibrating a utility function against the revealed base year mode choice and generalized cost.

Using logsum functions, the generalized cost is then transformed into a composite utility for the composite mode (e.g. Surface and Public in Exhibit B-2). This is then used at the next level of the hierarchy to compare the next most similar mode choice (e.g. in Exhibit B-2, Surface is compared with Air mode).

B.3.2 Degenerate Modal Split Model

For the purpose of the Colorado High-Speed Rail Study (and other intercity high-speed rail projects) TEMS has adopted a special case of the standard logit model, the degenerate nested logit model [*Louviere, et.al., 2000*]. This is because in modeling travel choice, TEMS has followed a hierarchy in which like modes are compared first, and then with gradually more disparate modes as progress is made up the hierarchy, this method provides the most robust and statistically valid structure. This means however, that there are singles modes being introduced at each level of the hierarchy and that at each level the composite utility of two modes combined at the lower level (e.g. the utility of Surface mode combined from Rail and Bus modes) is compared with the generalized cost of a single mode (e.g. Air mode). It is the fact that the utilities of the two modes being compared are measured by different scales that creates the term degenerate model. The result of this process is that the nesting coefficient is subsumed into the hierarchy and effectively cancels out in the calculation. That is why TEMS set ρ to 1 when using this form of the model.

Take the three-level hierarchy shown in Exhibit B-2 for example, the utilities for the modes of Rail and Bus in the composite Surface mode are

$$U_{Rail} = \alpha_{Rail} + \beta_{Rail} GC_{Rail} \quad (4)$$

$$U_{Bus} = \beta_{Bus} GC_{Bus} \quad (5)$$

The utility for the composite Surface mode is

$$U_{Surface} = \alpha_{Surface} + \beta_{Surface} \log[\exp(\rho U_{Rail}) + \exp(\rho U_{Bus})] \quad (6)$$

The utility for the Air mode is

$$U_{Air} = \beta_{Air} \log[\exp(\rho GC_{Air})] = \rho \beta_{Air} GC_{Air} \quad (7)$$

Then the mode choice model between Surface and Air modes are

$$P(Surface) = \frac{\exp(U_{Surface} / \rho)}{\exp(U_{Surface} / \rho) + \exp(U_{Air} / \rho)} \quad (8)$$

It can be seen in equation (7) that $U_{Air} = \rho \beta_{Air} GC_{Air}$, the term of $\exp(U_{Air} / \rho)$ in equation (8) reduces to $\exp(\beta_{Air} GC_{Air})$, thus that the nesting coefficient ρ is canceled out in the single mode nest of the hierarchy. As a result, ρ loses its statistical meaning in the nested logit hierarchy, and leads to the degenerate form of the nested logit model, where ρ is set to 1.

B.3.3 Calibration of the Hierarchical Modal Split Model

Working from the bottom of the hierarchy up to the top, the first analysis is that of the rail mode versus the bus mode. As shown in Exhibit B-5, the model was effectively calibrated for the four trip purposes and the two trip lengths (over and under 80 miles), with reasonable parameters and R^2 and *t* values. All the coefficients have the correct signs such that demand increases or decreases in the correct direction as travel times or costs are increased or decreased, and all the coefficients appear to be reasonable in terms of the size of their impact.

Exhibit B-5: Rail versus Bus Modal Split Model Coefficients (1)

Long-Distance Trips *(longer than 80 miles)*

Business	$\log(P_{Rail}/P_{Bus})$	= 1.163	- 0.009 GC_{Rail} (156)	+	0.013 GC_{Bus} (396)	R^2=0.97
Commuter	$\log(P_{Rail}/P_{Bus})$	= 0.012	- 0.017 GC_{Rail} (268)	+	0.019 GC_{Bus} (660)	R^2=0.98
Tourist	$\log(P_{Rail}/P_{Bus})$	= 2.655	- 0.012 GC_{Rail} (179)	+	0.012 GC_{Bus} (502)	R^2=0.96
Social	$\log(P_{Rail}/P_{Bus})$	= -0.798	- 0.012 GC_{Rail} (220)	+	0.013 GC_{Bus} (479)	R^2=0.97

Short-Distance Trips (*shorter than 80 miles*)

Business	$\log(P_{Rail}/P_{Bus})$	= -0.955	- 0.003 GC_{Rail} (25)	+	0.005 GC_{Bus} (88)	R^2=0.62
Commuter	$\log(P_{Rail}/P_{Bus})$	= -0.168	- 0.012 GC_{Rail} (61)	+	0.009 GC_{Bus} (99)	R^2=0.60
Tourist	$\log(P_{Rail}/P_{Bus})$	= 0.518	- 0.008 GC_{Rail} (57)	+	0.007 GC_{Bus} (147)	R^2=0.76
Social	$\log(P_{Rail}/P_{Bus})$	= -4.031	- 0.010 GC_{Rail} (50)	+	0.018 GC_{Bus} (172)	R^2=0.82

(1) *t-statistics are given in parentheses.*

The constant term in each equation indicates the degree of bias towards one mode or the other. For example, if the constant term is positive, there is a bias towards rail travel that is not explained by the variables (e.g., times, costs, frequencies, reliability) used to model the modes. In considering the bias it is important to recognize that small values indicate little or no bias, and that small values have error ranges that include both positive and negative values. However, large biases may well reflect strong feelings to a modal option due to its innate character or network structure. For example, the short distance social trip purpose includes many shoppers who are sensitive to the access/egress convenience of their modal choice. This frequently leads them to select bus over rail, and for the social purpose to have a negative constant when compared to rail. The reason why the R^2 value for short-distance model is lower than in the long-distance model is due to the fact that some local trips (under 55 miles) were not included as a result of the intercity feature of this study.

For the second level of the hierarchy, the analysis is of the surface modes (i.e., rail and bus) versus air for the three-level model hierarchy only. Accordingly, the utility of the surface modes is obtained by deriving the logsum of the utilities of rail and bus. The Air mode for long distance travel displays a very powerful bias against both rail and bus as it provides a much faster alternative if more expensive. As shown in Exhibit B-6, the model calibrations for both trip purposes are all statistically significant, with good R2 and t values and reasonable parameters.

Exhibit B-6: Surface versus Air Modal Split Model Coefficients [1]

Long-Distance Trips (*longer than 80 miles*)

Business $\log(P_{Surf}/P_{Air}) = -7.537 + 1.092\, V_{Surf} + 0.011\, GC_{Air}$ $R^2=0.98$
(282) (548)

where $V_{Surf} = \log[\exp(1.163 - 0.009\, GC_{Rail}) + \exp(-0.013\, GC_{Bus})]$

Commuter $\log(P_{Surf}/P_{Air}) = -5.068 + 1.045\, V_{Surf} + 0.019\, GC_{Air}$ $R^2=0.98$
(651) (1454)

where $V_{Surf} = \log[\exp(0.012 - 0.017\, GC_{Rail}) + \exp(-0.019\, GC_{Bus})]$

Tourist $\log(P_{Surf}/P_{Air}) = -6.458 + 1.080\, V_{Surf} + 0.012\, GC_{Air}$ $R^2=0.96$
(340) (950)

where $V_{Surf} = \log[\exp(2.655 - 0.012\, GC_{Rail}) + \exp(-0.012\, GC_{Bus})]$

Social $\log(P_{Surf}/P_{Air}) = -5.609 + 1.060\, V_{Surf} + 0.013\, GC_{Air}$ $R^2=0.98$
(992) (1854)

where $V_{Surf} = \log[\exp(-0.798 - 0.012\, GC_{Rail}) + \exp(-0.013\, GC_{Bus})]$

[1] t-statistics are given in parentheses.

The analysis for the top level of the hierarchy is of auto versus the public modes. The utility of the public modes is obtained by deriving the logsum of the utilities of the air, rail and bus modes in the three-level model hierarchy and the by deriving the logsum of the utilities of the rail and bus in the two-level model hierarchy. For Auto versus surface for long distance trips the bias is to air and potentially rail because of their travel time advantage, however, for short distance trips the bias is equally strong towards Auto reflecting the advantage of minimal access and egress times and cost.

As shown in Exhibit B-7, the model calibrations for both trip purposes are all statistically significant, with good R^2 and *t* values and reasonable parameters.

Exhibit B-7: Public versus Auto Hierarchical Modal Split Model Coefficients [1]

Long-Distance Trips (*longer than 80 miles*)

Business $\log(P_{Pub}/P_{Auto}) = 5.406 + 0.898\ V_{Pub} + 0.009\ GC_{Auto}$ $R^2=0.92$
(216) (128)
where $V_{Pub} = \log[\exp(-7.537+1.092\ V_{Surf}) + \exp(-0.011\ GC_{Air})]$

Commuter $\log(P_{Pub}/P_{Auto}) = 3.554 + 0.682\ V_{Pub} + 0.016\ GC_{Auto}$ $R^2=0.88$
(188) (106)
where $V_{Pub} = \log[\exp(-5.068+1.045\ V_{Surf}) + \exp(-0.019\ GC_{Air})]$

Tourist $\log(P_{Pub}/P_{Auto}) = 4.154 + 0.809\ V_{Pub} + 0.007\ GC_{Auto}$ $R^2=0.81$
(174) (58)
where $V_{Pub} = \log[\exp(-6.458+1.080\ V_{Surf}) + \exp(-0.012\ GC_{Air})]$

Social $\log(P_{Pub}/P_{Auto}) = 3.682 + 0.745\ V_{Pub} + 0.012\ GC_{Auto}$ $R^2=0.96$
(315) (174)
where $V_{Pub} = \log[\exp(-5.609 +1.060\ V_{Surf}) + \exp(-0.013\ GC_{Air})]$

Short-Distance Trips (*shorter than 80 miles*)

Business $\log(P_{Pub}/P_{Auto}) = -5.325 + 1.321\ V_{Pub} + 0.032\ GC_{Auto}$ $R^2=0.90$
(76) (190)
where $V_{Pub} = \log[\exp(-0.955 - 0.003\ GC_{Rail}) + \exp(-0.005\ GC_{Bus})]$

Commuter $\log(P_{Pub}/P_{Auto}) = -4.049 + 1.258\ V_{Pub} + 0.035\ GC_{Auto}$ $R^2=0.60$
(99) (86)
where $V_{Pub} = \log[\exp(-0.168 -0.012\ GC_{Rail}) + \exp(-0.009\ GC_{Bus})]$

Tourist $\log(P_{Pub}/P_{Auto}) = -3.199 + 1.010\ V_{Pub} + 0.026\ GC_{Auto}$ $R^2=0.94$
(310) (250)
where $V_{Pub} = \log[\exp(0.518 -0.008\ GC_{Rail}) + \exp(-0.007\ GC_{Bus})]$

Social $\log(P_{Pub}/P_{Auto}) = -3.334 + 0.928\ V_{Pub} + 0.062\ GC_{Auto}$ $R^2=0.96$
(408) (375)
where $V_{Pub} = \log[\exp(-4.031 -0.010\ GC_{Rail}) + \exp(-0.018\ GC_{Bus})]$

[1] t-statistics are given in parentheses.

B.3.4 Incremental Form of the Modal Split Model

Using the same reasoning as previously described, the modal split models are applied incrementally to the base data rather than imposing the model estimated modal shares. Different regions of the corridor may have certain biases toward one form of travel over another and these differences cannot be captured with a single model for the entire system. Using the "pivot point" method, many of these differences can be retained. To apply the modal split models incrementally, the following reformulation of the hierarchical modal split models is used (Equation 7):

Equation 7:

$$\frac{\left(\frac{P_A^f}{P_B^f}\right)}{\left(\frac{P_A^b}{P_B^b}\right)} = e^{\beta(GC_A^f - GC_B^b) + \gamma(GC_B^f - GC_B^b)}$$

For hierarchical modal split models that involve composite utilities instead of generalized costs, the composite utilities would be used in the above formula in place of generalized costs. Once again, the constant term is not used and the drivers for modal shifts are changed in generalized cost from base conditions.

Another consequence of the pivot point method is that it prevents possible extreme modal changes from current trip-making levels as a result of the calibrated modal split model, thus that avoid over- or under- estimating future demand for each mode.

B.4 Induced Demand Model

Induced demand refers to changes in travel demand related to improvements in a transportation system, as opposed to changes in socioeconomic factors that contribute to growth in demand. The quality or utility of the transportation system is measured in terms of total travel time, travel cost, and worth of travel by all modes for a given trip purpose. The induced demand model used the increased utility resulting from system changes to estimate the amount of new (latent) demand that will result from the implementation of the new system adjustments. The model works simultaneously with the mode split model coefficients to determine the magnitude of the modal induced demand based on the total utility changes in the system.

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C Zone and Socioeconomic Data

C.1 Zone Data

Zone	State	County	Centroid Name
1	Colorado	Boulder	"Nederland, Co.,30,"
2	Colorado	Boulder	"Longmont, Co"
3	Colorado	Boulder	"Lyons, Co."
4	Colorado	Boulder	"South Boulder, Colorado"
5	Colorado	Boulder	"Boulder, Co."
6	Colorado	Boulder	"9th Ave & Hover St. Co."
7	Colorado	Jefferson	"Arvada"
8	Colorado	Boulder	"Gunbarrel, Co."
9	Colorado	Jefferson	"Lakewood East, Co."
10	Colorado	Jefferson	"Clement Park, Co."
11	Colorado	Weld	"Frederick, Co."
12	Colorado	Weld	" Ft. Lupton, Co."
13	Colorado	Boulder	"Lafayette, Co."
14	Colorado	Boulder	"Louisville, Co."
15	Colorado	Boulder	"Superior South, Co."
16	Colorado	Broomfield	"Flatiron Circle, Co."
17	Colorado	Jefferson	"Homewood Park (Area), Co."
18	Colorado	Broomfield	"Broomfield, Co."
19	Colorado	Broomfield	"Broomfield East, Co."
20	Colorado	Broomfield	"Baseline Rd., Co."
21	Colorado	Douglas	"Highlands Ranch, Colorado"
22	Colorado	Adams	"Brighten, Co."
23	Colorado	Adams	"Thornton - Todd Creek"
24	Colorado	Adams	"Federal Heights - Sherrelwood, Co."
25	Colorado	Adams	"Northglenn, Co."
26	Colorado	Adams	"Westminster NE - Northglenn, Co."
27	Colorado	Jefferson	"Wallace Village - Westminster, Co."
28	Colorado	Douglas	"Castle Rock, Co."
29	Colorado	Jefferson	"North Arvada, Co."
30	Colorado	Jefferson	"Golden, Colorado"
31	Colorado	Jefferson	"Wah Keeney Park, Co."
32	Colorado	Jefferson	"Wheat Ridge"
33	Colorado	Jefferson	"Edgemont, Co"
34	Colorado	Jefferson	"Lakewood, Co."
35	Colorado	Denver	"Denver, Co."
36	Colorado	Denver	"North Denver, Co."
37	Colorado	Adams	"Twin Lakes - Utah Jct."
38	Colorado	Adams	"Thornton, CO."
39	Colorado	Adams	"Barr Lake, Co."
40	Colorado	Adams	" Bennett, Co."
41	Colorado	Adams	"Commerce City, CO."
42	Colorado	Denver	"Montebello, Co."
43	Colorado	Denver	"Park Hill, CO."
44	Colorado	Denver	"Denver International Airport, Co."
45	Colorado	Denver	"Downtown Denver, Co."
46	Colorado	Adams	"East Monteview Blvd."
47	Colorado	Douglas	"Rt 11 & Rt 83, Co."
48	Colorado	Denver	"North Washington - Dunham Park"
49	Colorado	Arapahoe	"Quincy Resevoir, Co."
50	Colorado	Denver	"Five Points - Denver City Park"
51	Colorado	Arapahoe	" Byers, Co."
52	Colorado	Denver	"Colorado State Capital, Co."
53	Colorado	Denver	"Southmoor, Co."
54	Colorado	Denver	"Capital Hill - Cherry Creek, Co"
55	Colorado	Denver	"University of Denver - Union Station, Co."
56	Colorado	Denver	"Windsor, Co."
57	Colorado	Arapahoe	"Glendale, Co."
58	Colorado	Douglas	"Highland Heritage Park - Lone Tree, Co."
59	Colorado	Arapahoe	"Aurora, Co."
60	Colorado	Arapahoe	"Aurora West, Co."

Zone	State	County	Centroid Name
61	Colorado	Denver	"Virginia Village, Co."
62	Colorado	Arapahoe	"Olympic Park, Co."
63	Colorado	Arapahoe	"Aurora Southeast, Co."
64	Colorado	Arapahoe	"Foxfield North, Co."
65	Colorado	Arapahoe	"Cherry Creek State Park, Colorado"
66	Colorado	Arapahoe	"S. Holly Pl, Co."
67	Colorado	Douglas	"Parker, Co."
68	Colorado	Douglas	"Stonegate, Co."
69	Colorado	Arapahoe	"Centennial East, Co."
70	Colorado	Arapahoe	"East Centennial"
71	Colorado	Arapahoe	"Centennial, Co."
72	Colorado	Arapahoe	"Delmar Park, Co."
73	Colorado	Denver	"University of Denver, Co."
74	Colorado	Arapahoe	"Englewood, Co."
75	Colorado	Arapahoe	"Littleton - Columbine Valley, Co."
76	Colorado	Denver	"South Denver, Co."
77	Colorado	Denver	"Washington Park, Co."
78	Colorado	Denver	"N. Bow Mar Area, Co."
79	Colorado	Arapahoe	"Delaney Farm Park, Co."
80	Colorado	Douglas	"Roxborough State Park, Co."
81	Colorado	Eagle	" Eagle, Co."
82	Colorado	El Paso	" Black Forest, Co."
83	Colorado	El Paso	" Manitou Springs, Co."
84	Colorado	Pueblo	" Pueblo, Colorado"
85	Colorado	Pueblo	" Pueblo West, Colorado"
86	Colorado	Pueblo	" Eden, Colorado"
87	Colorado	Mesa	" Fruita, Co."
88	Colorado	Weld	" Eaton, Co."
89	Colorado	Pueblo	" Blende, Co."
90	Colorado	Pitkin	" Aspen Snowmass Village, Co."
91	Utah	Davis, Salt Lake, Utah, Weber	" Salt Lake City, UT"
92	Utah	Carbon, Morgan, Summit, Uintah, Wasatch	"Heber City, UT"
93	Utah	Emery, Grand	" Castle Dale, UT"
94	Utah	Sanpete, Sevier	" Richfield, UT"
95	Colorado	Moffat	" Maybell, Co."
96	Colorado	Moffat	" Craig, Co."
97	Colorado	Rio Blanco	" Rangely, Co."
98	Colorado	Garfield	" Rt. 139, Co"
99	Colorado	Garfield	" Rifle, Co."
100	Colorado	Routt	" Hayden, Co."
101	Colorado	Routt	" Steamboat Springs, Co"
102	Colorado	Jackson	" Walden, Co."
103	Colorado	Grand	" Kremmling, Co."
104	Colorado	Mesa	" Loma, Co."
105	Colorado	Mesa	" Redlands, Co."
106	Colorado	Mesa	" Orchard Mesa, Co"
107	Colorado	Mesa	" Fruitvale, Co."
108	Colorado	Mesa	" Grand Junction, Co."
109	Colorado	El Paso	" Vindicator Dr. & Rockrimmon Blvd., Co."
110	Colorado	Mesa	" Debeque, Co."
111	Colorado	Delta	" Delta, Co."
112	Colorado	Montrose	" Montrose, Co."
113	Colorado	San Miguel	" Telluride, Co."
114	Colorado	Eagle	" Bond, Colorado"
115	Colorado	Summit	" Copper Mountain Resort, Co."
116	Colorado	Summit	" Silverthorne, Co."
117	Colorado	Eagle	"Vail, Co."
118	Colorado	Larimer	" Drake, Co."
119	Colorado	Larimer	" Ft. Collins, Co."
120	Colorado	Weld	" Greeley, Co."
121	Colorado	Larimer	" Loveland, Co."
122	Colorado	Larimer	" Berthoud, Co."
123	Colorado	Larimer	" Red Feather Lakes, Co"
124	Colorado	Gilpin	" Central City & Black Hawk, Co."
125	Colorado	Park	" Fairplay, Co."
126	Colorado	Garfield	" Glenwood Springs, Co."
127	Colorado	Pitkin	" Snowmass, Co"
128	Colorado	Chaffee, Lake	" Leadville, Co."
129	Colorado	Gunnison	" Gunnison, Co."
130	Colorado	Mineral, Saguache	" Saguache, Co."
131	Colorado	Alamosa, Conejos, Costilla	" Alamosa, Co"
132	Colorado	Archuleta, Hinsdale	" Pagosa Springs, Co."
133	Colorado	La Plata	" Durango, Co."
134	Colorado	Ouray, San Juan	" Ouray, Co."
135	Colorado	Dolores, Montezuma	" Cortez, Co."
136	Colorado	Custer, Huerfano	" Walsenburg, Co."
137	Colorado	Las Animas	" Simpsom Thatcher, Co."
138	Colorado	Fremont	" Canon City, Co."
139	Colorado	Teller	" Divide, Co."
140	Colorado	Pueblo	" Colorado City, CO"

Zone	State	County	Centroid Name
141	Colorado	Pueblo	" East Pueblo, Co."
142	Colorado	El Paso	" Security, Co."
143	Colorado	El Paso	" Colorado Springs, Co"
144	Colorado	El Paso	" Fountain, Colorado"
145	Colorado	El Paso	" Calhan, Co."
146	Colorado	El Paso	" Northeast, Colorado Springs, Co."
147	Colorado	Las Animas	" Trinidad, Co."
148	Colorado	El Paso	" Colorado Springs Municipal Airport, Co."
149	Colorado	Elbert	" Elizabeth, Co."
150	Colorado	Elbert	" Metheson, Co."
151	Colorado	Larimer	" Estes Park, Co."
152	Colorado	Weld	" Johnstown, Co."
153	Colorado	Weld	" Kersey, Co."
154	Colorado	Morgan	" Fort Morgan, Co."
155	Colorado	Logan	" Sterling, Co."
156	Colorado	Philips, Sedgwick	" Holyoke, Co."
157	Colorado	Washington, Yuma	" Yuma, Co."
158	Colorado	Lincoln	" Limon, Co."
159	Colorado	Cheyenne, Kit Carson	" Burlington, Co."
160	Colorado	Baca, Bent, Kiowa, Prowers	" Lamar, Co."
161	Colorado	Crowley, Otero	" Rocky Ford, Co."
162	New Mexico	Bernalillo, Los Alamos, Sandoval, Santa Fe, Velencia	" Albuquerque, NM"
163	New Mexico	Rio Arriba, Taos	" Ranchos De Taos, NM"
164	New Mexico	Colfax	" Raton, NM"
165	New Mexico	Mora, San Miguel	" Las Vegas, NM"
166	Colorado	El Paso	" Gleneagle Neighborhood, Co."
167	Colorado	El Paso	" Monument, Co."
168	Wyoming	Laramie	" Cheyenne, Wyoming"
169	Wyoming	Laramie	" I-25 & Rt. 85, Wyoming"
170	Wyoming	Goshen, Platte	" Torrington, Wyoming"
171	Wyoming	Albany	" Laramie, Wyoming"
172	Wyoming	Carbon	" Rawlings, Wyoming"
173	Wyoming	Converse, Natrona	" Casper, Wyoming"
174	Kansas	Cheyenne, Decatur, Gove, Logan, Rawlins, Sheridan, Sherman, Thomas, Wallace	" Colby, KS"
175	Kansas	Finney, Greeley, Hamilton, Kearny, Lane, Scott, Wichita	" Garden City, KS"
176	Colorado	Clear Creek	" Idaho Springs, CO."
177	Colorado	Teller	" Woodland Park, Co."
178	Colorado	El Paso	" Stratton Meadows, Co."
179	Colorado	Rio Grande	" Monte Vista, Co."
180	Colorado	Summit	" Brekenridge, Co."
181	Colorado	Grand	" Grandby, Co."
182	Colorado	Eagle	" Gypsum, Co."
183	Colorado	Weld	" Grover, Co"
184	Colorado	El Paso	" Rock Creek Park, Co."
185	Colorado	Pueblo	" Boone, Co."
186	Colorado	Eagle	" Avon, Co."
187	Colorado	Clear Creek	" Georgetown, CO"
188	Colorado	Summit	" Keystone, Co"
189	Colorado	Eagle	" Red Cliff, Co."
190	Colorado	Eagle	"Wolcott, CO"
191	Colorado	Routt	" Steamboat Springs Airport, Co."
192	Colorado	Pitkin	" Aspen Pitkin Airport (Sardy Field), Co."
193	Colorado	Mesa	" Grand Jct. Regional Airport, Co."
194	Colorado	Eagle	" Eagle County Regional Airport, Co."

C.2 Central Case Socioeconomic Projections by Zone

Zone	State	Population			Wage and Salary Employment (by place of work)			Average Household Income (in 2007$)		
		2007	2020	2035	2007	2020	2035	2007	2020	2035
1	Colorado	11,916	13,310	15,036	3,017	3,183	3,223	106,392	126,245	142,498
2	Colorado	36,694	45,895	57,057	10,529	12,054	14,959	75,874	90,033	101,624
3	Colorado	5,056	5,787	6,685	2,199	2,317	2,341	108,697	128,981	145,586
4	Colorado	52,014	54,809	58,406	24,148	26,215	28,697	65,294	77,478	87,452
5	Colorado	45,932	49,309	53,573	49,462	51,853	51,546	82,588	97,999	110,615
6	Colorado	47,368	54,377	62,987	26,589	28,673	30,841	76,733	91,052	102,774
7	Colorado	28,736	33,520	38,986	16,479	18,835	19,819	49,947	57,905	61,691
8	Colorado	33,734	45,714	60,154	28,203	30,000	31,094	120,397	142,864	161,257
9	Colorado	50,257	59,186	69,408	24,368	31,123	37,167	80,373	93,178	99,270
10	Colorado	94,327	103,820	114,430	25,999	37,984	51,136	85,900	99,585	106,096
11	Colorado	35,148	58,515	85,079	6,742	13,499	21,121	77,418	90,071	99,931
12	Colorado	30,893	67,750	109,384	8,423	20,367	33,931	67,968	79,077	87,733
13	Colorado	24,172	27,965	32,616	11,616	12,395	12,960	81,943	97,234	109,753
14	Colorado	22,033	23,736	25,880	11,285	12,418	14,066	104,373	123,850	139,795
15	Colorado	11,343	14,037	17,310	8,061	10,205	15,285	122,556	145,426	164,148
16	Colorado	1,733	5,337	9,984	17,087	27,976	36,417	85,744	109,229	124,293
17	Colorado	27,674	36,689	47,140	9,471	11,813	13,765	141,812	164,405	175,154
18	Colorado	24,844	22,680	24,698	12,616	15,917	16,141	96,797	123,310	140,315
19	Colorado	20,330	22,199	28,355	2,410	3,319	3,716	96,797	123,310	140,315
20	Colorado	6,784	15,763	27,920	44	7,158	16,163	102,842	131,010	149,078
21	Colorado	51,333	59,783	77,316	19,376	24,578	26,265	114,637	152,306	177,287
22	Colorado	24,977	34,742	48,288	7,379	9,402	9,115	61,115	70,819	75,450
23	Colorado	44,658	74,181	113,083	8,937	34,620	62,578	89,118	103,269	110,021
24	Colorado	42,206	43,279	47,198	12,996	16,193	15,240	52,241	60,536	64,494
25	Colorado	65,265	71,078	82,273	14,785	20,521	21,993	66,239	76,757	81,775
26	Colorado	56,440	58,718	65,002	14,639	19,920	20,893	74,764	86,637	92,301
27	Colorado	54,341	63,676	74,352	23,713	33,186	43,137	77,210	89,512	95,364
28	Colorado	38,611	58,602	88,746	13,847	19,141	22,357	96,864	128,692	149,800
29	Colorado	61,935	64,541	67,214	13,573	15,170	15,498	76,538	88,732	94,533
30	Colorado	29,399	33,714	38,622	24,469	28,020	29,555	89,673	103,960	110,757
31	Colorado	43,181	54,447	67,461	15,306	18,681	21,260	129,275	149,870	159,670
32	Colorado	30,239	32,556	35,097	15,171	16,883	17,148	52,976	61,416	65,432
33	Colorado	46,531	53,427	61,275	34,135	37,924	38,431	58,702	68,054	72,504
34	Colorado	62,734	70,322	78,884	24,228	26,848	27,110	61,056	70,783	75,411
35	Colorado	68,009	77,656	91,312	42,504	49,631	54,877	47,467	52,141	56,049
36	Colorado	64,973	66,480	70,376	20,210	22,806	24,188	55,843	63,748	68,483
37	Colorado	39,711	47,450	59,438	30,390	43,370	47,846	53,189	61,635	65,664
38	Colorado	46,830	52,149	61,596	15,630	25,498	31,690	53,436	61,921	65,970
39	Colorado	26,100	69,837	124,242	10,229	21,082	30,489	80,416	93,185	99,278
40	Colorado	7,608	17,861	30,761	1,241	4,449	7,896	73,888	85,620	91,218
41	Colorado	23,008	24,785	28,394	25,972	32,870	31,586	46,792	54,222	57,767
42	Colorado	52,019	67,895	88,376	36,294	46,174	55,980	66,066	87,775	102,172
43	Colorado	26,097	27,640	30,319	16,222	18,247	19,273	77,392	102,823	119,687
44	Colorado	446	5,249	10,507	25,930	33,869	42,112	82,956	110,215	128,293
45	Colorado	4,563	6,075	8,012	70,798	83,682	93,841	68,201	90,612	105,474
46	Colorado	45,692	74,947	113,597	22,907	66,574	111,234	45,388	52,596	56,035
47	Colorado	13,881	22,734	35,628	2,077	4,630	7,354	127,063	168,815	196,504
48	Colorado	24,597	33,663	45,182	22,922	30,879	39,484	47,287	62,825	73,130
49	Colorado	38,272	44,095	53,269	5,420	6,532	6,910	73,683	84,617	88,795
50	Colorado	24,671	27,096	30,776	23,371	26,325	27,853	47,506	63,116	73,469

Zone	State	Population			Wage and Salary Employment (by place of work)			Average Household Income (in 2007$)		
		2007	2020	2035	2007	2020	2035	2007	2020	2035
51	Colorado	17,282	99,291	194,883	6,689	14,577	33,118	60,565	69,552	72,986
52	Colorado	7,860	9,894	12,559	30,824	38,134	44,944	37,056	49,233	57,308
53	Colorado	18,289	23,608	30,501	24,176	31,837	39,886	78,192	102,770	118,920
54	Colorado	51,404	51,809	53,954	33,356	36,362	36,846	70,125	93,766	108,232
55	Colorado	5,212	10,634	17,149	15,696	24,368	34,785	118,931	159,026	183,561
56	Colorado	66,392	70,594	77,739	33,164	35,699	35,543	70,462	94,217	108,753
57	Colorado	4,607	4,586	4,812	10,174	11,939	11,757	37,323	42,861	44,978
58	Colorado	63,649	70,344	87,348	24,294	34,520	41,356	130,307	173,124	201,520
59	Colorado	39,104	39,987	43,194	22,394	26,737	27,607	57,430	65,952	69,209
60	Colorado	20,621	22,503	25,920	9,869	11,815	12,288	54,295	62,351	65,430
61	Colorado	48,393	50,869	55,380	27,421	30,979	32,904	60,392	80,752	93,210
62	Colorado	50,103	50,447	53,595	13,680	16,304	16,752	58,849	67,582	70,919
63	Colorado	59,108	72,172	91,278	6,493	9,130	13,202	68,032	78,127	81,984
64	Colorado	49,040	69,362	96,667	9,132	11,906	15,046	124,646	143,142	150,210
65	Colorado	17,397	22,482	29,606	39,363	49,719	58,799	161,779	185,786	194,959
66	Colorado	2,182	2,227	2,401	359	467	589	85,339	98,003	102,841
67	Colorado	49,244	61,965	84,548	13,536	17,636	19,408	111,171	147,701	171,927
68	Colorado	42,563	86,548	146,708	22,544	49,565	78,260	109,294	145,207	169,024
69	Colorado	11,031	14,308	18,889	29,521	36,444	40,915	106,521	122,328	128,368
70	Colorado	53,084	54,443	58,992	18,914	22,161	21,726	124,982	143,528	150,615
71	Colorado	25,625	29,588	35,808	42,611	56,229	72,736	105,604	121,274	127,262
72	Colorado	39,416	42,849	49,180	8,790	11,220	13,572	43,494	49,948	52,414
73	Colorado	29,374	30,918	33,705	18,317	22,579	26,511	74,158	99,158	114,457
74	Colorado	38,424	41,010	46,255	34,546	40,780	40,830	46,861	53,815	56,472
75	Colorado	43,367	43,482	45,984	22,660	26,992	27,699	74,556	85,620	89,847
76	Colorado	51,455	52,268	54,899	15,774	17,808	18,896	55,072	73,639	85,000
77	Colorado	20,163	20,901	22,431	12,427	14,554	16,149	124,731	166,782	192,513
78	Colorado	24,431	25,508	27,579	7,339	8,226	8,649	79,164	122,290	153,132
79	Colorado	36,426	42,672	52,257	20,648	28,005	38,106	45,648	52,421	55,010
80	Colorado	12,835	20,750	32,339	2,022	5,425	9,247	109,226	145,117	168,919
81	Colorado	11,250	17,167	23,983	5,692	7,521	9,742	88,967	118,960	137,314
82	Colorado	30,647	88,642	127,488	4,826	15,095	32,520	95,676	101,465	110,544
83	Colorado	11,634	12,312	14,269	3,874	5,392	7,064	65,192	69,137	75,323
84	Colorado	52,959	59,834	66,693	13,793	17,773	22,210	48,267	51,290	53,251
85	Colorado	20,261	27,441	35,270	2,773	4,592	6,634	60,573	64,367	66,828
86	Colorado	7,526	18,611	30,968	10,682	21,613	33,920	55,969	59,475	61,749
87	Colorado	17,499	27,590	39,320	5,907	9,046	12,767	61,689	64,299	70,953
88	Colorado	24,831	28,827	47,607	7,426	11,333	20,010	74,361	86,514	95,984
89	Colorado	10,780	13,504	16,422	4,605	5,941	7,430	61,143	64,973	67,458
90	Colorado	10,165	14,280	18,716	13,350	17,933	22,269	96,641	108,947	120,900
91	Utah	2,037,161	2,649,370	3,314,119	1,037,606	1,318,513	1,593,625	76,764	84,626	93,648
92	Utah	134,327	197,598	269,162	58,212	78,696	100,663	78,704	93,114	112,996
93	Utah	19,586	23,680	25,060	8,954	9,952	10,865	57,003	60,227	63,410
94	Utah	46,906	55,102	63,895	16,366	19,601	23,375	55,205	60,725	67,092
95	Colorado	1,695	2,164	2,678	705	815	901	65,887	71,646	77,450
96	Colorado	11,953	16,264	21,153	4,999	6,103	7,150	65,810	71,561	77,359
97	Colorado	6,227	7,348	8,749	4,374	5,068	5,486	61,952	65,321	69,210
98	Colorado	6,570	12,877	20,088	3,265	3,818	4,880	53,512	61,768	69,803
99	Colorado	26,907	49,103	74,107	13,374	15,635	19,984	70,816	81,742	92,375
100	Colorado	8,106	11,339	14,949	4,866	6,229	7,896	60,920	79,951	90,584
101	Colorado	14,275	21,148	28,938	11,600	14,851	18,826	80,857	106,116	120,229
102	Colorado	1,381	1,695	2,008	628	840	1,052	50,649	49,421	48,004
103	Colorado	3,105	4,966	6,997	1,125	1,439	1,800	70,387	81,374	92,175
104	Colorado	3,238	6,800	10,926	1,653	1,700	1,782	81,995	85,463	94,307
105	Colorado	14,783	18,237	22,296	1,756	1,680	1,622	107,110	111,641	123,195
106	Colorado	13,471	17,293	21,769	2,290	2,928	3,702	65,234	67,993	75,029
107	Colorado	41,395	54,903	70,696	6,229	10,164	14,808	57,816	60,261	66,498
108	Colorado	41,203	52,326	65,366	41,154	62,135	87,035	61,874	64,491	71,165
109	Colorado	47,458	50,064	51,656	39,912	50,068	55,945	91,983	97,549	106,277
110	Colorado	7,329	14,517	22,847	3,458	4,533	5,830	72,601	75,672	83,503
111	Colorado	30,334	45,174	61,517	9,756	12,429	15,333	46,004	56,647	63,152
112	Colorado	39,527	56,051	75,044	16,686	21,838	26,621	54,863	60,447	65,191
113	Colorado	7,533	10,819	14,504	5,611	9,618	13,012	92,873	112,146	134,383
114	Colorado	983	1,233	1,519	497	657	851	57,113	76,367	88,149
115	Colorado	3,605	5,113	6,772	4,038	5,813	7,513	91,067	112,345	127,972
116	Colorado	7,224	11,114	15,481	2,533	3,647	4,713	84,460	104,195	118,688
117	Colorado	5,197	6,133	7,201	7,288	9,629	12,473	80,465	107,592	124,192
118	Colorado	4,208	6,196	8,490	1,235	1,741	2,214	72,467	84,661	93,807
119	Colorado	161,067	208,561	248,898	94,079	118,408	133,082	67,142	78,439	86,913
120	Colorado	109,306	151,299	195,821	57,986	86,554	114,432	57,880	67,339	74,711

Zone	State	Population			Wage and Salary Employment (by place of work)			Average Household Income (in 2007$)		
		2007	2020	2035	2007	2020	2035	2007	2020	2035
121	Colorado	79,213	109,278	139,854	35,527	63,551	79,892	64,260	75,072	83,182
122	Colorado	14,152	16,533	17,180	3,741	3,938	4,543	87,470	102,188	113,228
123	Colorado	18,156	26,735	36,632	4,586	6,212	7,661	80,991	94,619	104,841
124	Colorado	5,282	7,040	9,485	5,246	8,894	9,506	84,233	98,627	115,235
125	Colorado	17,004	43,743	72,505	2,731	4,418	6,515	86,831	102,974	121,601
126	Colorado	20,154	35,012	51,534	12,439	14,542	18,587	84,137	97,118	109,752
127	Colorado	4,940	7,255	9,810	4,324	5,809	7,213	112,434	126,751	140,658
128	Colorado	24,694	36,773	49,908	9,358	13,294	16,912	59,636	64,309	69,422
129	Colorado	14,973	17,845	21,217	9,331	13,677	15,714	63,979	69,450	75,762
130	Colorado	7,882	8,988	10,238	2,365	3,145	3,503	45,694	49,518	53,963
131	Colorado	26,696	32,331	38,263	10,752	13,257	14,797	45,228	47,673	50,360
132	Colorado	13,410	22,153	32,056	4,402	6,750	9,299	65,288	73,479	82,981
133	Colorado	49,555	66,864	86,351	27,252	38,200	47,108	68,672	76,711	86,119
134	Colorado	4,937	6,242	7,749	2,136	3,621	4,649	70,935	82,142	95,271
135	Colorado	27,135	35,717	45,363	10,627	13,200	15,205	49,489	56,495	60,692
136	Colorado	11,862	16,445	21,466	3,230	5,037	6,703	49,577	55,617	62,616
137	Colorado	897	1,114	1,350	385	403	463	59,412	60,686	68,387
138	Colorado	47,389	61,540	76,940	14,821	19,858	24,584	50,102	58,919	65,122
139	Colorado	12,938	20,108	27,000	3,647	4,726	7,118	68,449	89,874	104,323
140	Colorado	14,128	18,999	24,313	2,682	2,996	3,327	61,091	64,917	67,400
141	Colorado	42,537	47,096	51,505	23,655	29,201	35,344	43,728	46,467	48,244
142	Colorado	56,931	61,968	72,379	13,388	19,296	27,954	52,137	55,292	60,239
143	Colorado	97,142	107,084	111,519	84,081	104,095	120,772	51,633	54,757	59,656
144	Colorado	30,346	49,848	68,370	5,798	8,894	12,580	60,208	63,850	69,563
145	Colorado	19,567	25,414	62,197	8,511	10,555	11,952	58,950	62,517	68,111
146	Colorado	172,887	213,401	257,363	51,555	82,815	114,309	69,312	73,506	80,083
147	Colorado	15,113	19,569	24,533	6,435	6,733	7,739	49,202	50,257	56,634
148	Colorado	2,986	3,724	3,724	13,817	18,175	21,507	51,210	54,309	59,168
149	Colorado	19,869	40,081	60,783	4,063	9,448	14,871	89,986	107,718	125,700
150	Colorado	2,851	3,981	4,945	153	252	309	60,271	72,148	84,191
151	Colorado	10,778	15,870	21,745	3,164	4,458	5,669	86,710	101,300	112,244
152	Colorado	20,923	43,918	65,276	4,210	13,015	25,166	58,965	68,602	76,112
153	Colorado	16,739	25,164	36,857	2,763	5,066	7,452	60,212	70,052	77,721
154	Colorado	27,961	39,877	52,767	11,755	14,647	18,993	50,536	57,764	61,323
155	Colorado	21,055	27,555	34,625	9,620	13,229	16,713	52,401	55,334	58,399
156	Colorado	6,839	7,732	8,596	2,962	3,041	3,144	49,915	51,830	53,995
157	Colorado	14,293	15,816	17,397	5,649	6,304	6,785	54,699	60,078	66,292
158	Colorado	5,326	6,442	7,553	2,318	2,747	3,375	55,179	60,458	66,550
159	Colorado	9,691	10,726	11,715	4,528	4,578	4,709	56,571	60,838	65,775
160	Colorado	24,228	27,369	30,212	8,725	10,447	11,767	48,180	50,490	53,174
161	Colorado	25,497	27,154	29,090	8,412	10,394	11,551	50,214	54,422	59,136
162	New Mexico	980,035	1,353,389	1,705,377	504,323	636,892	778,314	66,618	71,548	77,399
163	New Mexico	72,435	84,219	89,537	24,567	29,944	36,241	47,105	51,520	56,499
164	New Mexico	13,216	15,836	16,720	5,784	6,774	7,476	49,840	53,225	57,132
165	New Mexico	33,724	40,291	42,471	10,757	12,924	15,140	43,636	47,766	52,517
166	Colorado	27,460	47,920	55,743	6,605	18,551	30,023	119,649	126,888	138,242
167	Colorado	8,364	11,260	13,063	3,070	7,042	9,940	86,392	91,620	99,817
168	Wyoming	73,958	80,517	88,834	46,340	52,782	61,172	57,214	59,288	61,682
169	Wyoming	12,395	13,773	15,149	3,583	4,159	4,806	72,050	74,663	77,677
170	Wyoming	20,391	20,470	20,071	8,661	9,752	10,732	50,708	52,412	54,367
171	Wyoming	32,227	31,640	31,619	18,224	21,846	25,487	46,045	43,623	40,829
172	Wyoming	15,486	15,440	15,743	8,499	7,696	7,524	57,063	57,359	57,700
173	Wyoming	84,618	95,560	109,424	47,966	50,738	56,916	57,075	54,889	52,355
174	Kansas	30,801	24,706	18,038	15,027	16,331	16,968	51,739	54,772	58,399
175	Kansas	54,886	47,219	39,904	26,084	33,958	39,481	58,999	61,070	63,457
176	Colorado	6,488	9,468	12,598	1,933	2,520	3,041	87,409	101,613	114,186
177	Colorado	8,886	10,552	10,552	3,658	5,898	6,524	70,874	93,058	108,019
178	Colorado	60,969	66,670	72,572	28,634	35,828	44,130	61,810	65,550	71,416
179	Colorado	11,627	14,074	16,479	5,113	6,456	7,656	51,647	54,530	57,856
180	Colorado	8,206	12,202	16,657	7,715	11,105	14,353	90,659	111,842	127,399
181	Colorado	10,507	17,396	25,007	6,774	8,664	10,837	85,205	98,505	111,579
182	Colorado	14,078	19,610	25,973	7,123	9,412	12,191	73,939	98,866	114,119
183	Colorado	5,910	7,682	10,586	1,612	2,522	3,360	57,433	66,820	74,134
184	Colorado	20,883	24,795	25,106	25,455	38,174	37,690	101,416	107,552	117,175
185	Colorado	6,347	15,311	25,306	3,246	5,076	7,133	54,715	58,142	60,366
186	Colorado	12,793	18,751	25,610	9,197	12,152	15,740	116,522	155,805	179,843
187	Colorado	2,468	3,423	4,380	1,599	2,083	2,515	61,858	71,910	80,809
188	Colorado	7,512	11,355	15,656	5,986	8,617	11,137	73,932	91,206	103,893
189	Colorado	1,432	1,373	1,301	725	957	1,240	64,597	86,375	99,701
190	Colorado	5,625	8,583	11,992	2,846	3,761	4,871	88,967	118,960	137,314
191	Colorado	1	1	1	17	22	28	81,514	106,978	121,205
192	Colorado	1	1	1	404	543	674	155,177	209,108	267,891
193	Colorado	163	178	195	3,390	7,002	11,226	61,874	64,491	71,165
194	Colorado	1	1	1	626	826	1,071	71,776	110,878	138,842

D Stated Preference Survey Forms

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VOT (DIA) Flight#: _______________ Date: __________ Departure Time: __________

Colorado Travel Survey

This survey is part of a transportation study partially funded by a grant from the Colorado Department of Transportation and is being conducted to better understand the travel needs of Colorado residents and visitors to Colorado. Please return this form to our survey staff.

1 Where was the starting point of your trip today?

City/Town _________________________ State/Province ______

2 How often do you make this same trip to the airport?

_____ times per MONTH/YEAR *Enter number and circle month or year*

3 How did you travel to the airport today? *Check only one*

○ Drove own car ○ Dropped Off

○ Taxi ○ Rental Car

○ Bus ○ Other ________________________

4 How many people, including yourself, are in your party? ________

5 What is the primary purpose of your trip today? *Check only one*

○ Business travel ○ Commuting to/from work

○ Vacation/recreation ○ Visit with family/friends

○ Travel to/from school ○ Other _______________________

6 If you're not a Colorado resident, where is your primary residence?

City/Town _________________________ State/Province _______

7 If you're not a Colorado resident, what day and time did you arrive in Colorado?

Monday Tuesday Wednesday Thursday Friday Saturday Sunday

_____ AM/PM *Circle weekday, write in time and circle AM or PM*

8 What is your employment status? *Check only one*

○ Employed full time ○ Employed part time ○ Retired

○ Student ○ Other _________________________

9 What is the combined annual income of everyone in your household? *Check only one*

○ Less than $45,000 ○ $45,000 - 64,999

○ $65,000 - 99,999 ○ $100,000 or more

Imagine you making the SAME TRIP to the airport you indicated in Question #1 and for the SAME PURPOSE you indicated in Question #5. Then imagine you are given a HYPOTHETICAL SCENARIO where:

Your travel time is **1 hour 30 minutes** and the cost of your trip is **$50**.

Travel time is the TOTAL TIME it takes you to travel to the airport (driving, parking, etc.) and the cost of your trip is the TOTAL COST you incur for travel to the airport (gas, tolls, parking, taxi fare, bus fare, etc.). Refer to the ABOVE TIME AND COST SCENARIO when answering the questions below.

For each question, put a checkmark on the ONE circle that best indicates your degree of preference for the alternative travel time and cost scenario given.

10 Compared to the scenario above, would you be willing to take **1 hour longer** traveling if the cost was $30 or **$20 less**?
Check only one

○ Yes ○ Maybe ○ Not Sure ○ Probably Not ○ No

11 Compared to the scenario above, would you spend $60 or **$10 more** if the travel time was **20 minutes less**?
Check only one

○ Yes ○ Maybe ○ Not Sure ○ Probably Not ○ No

12 Compared to the scenario above, would you spend $80 or **$30 more** if the travel time was **45 minutes less**?
Check only one

○ Yes ○ Maybe ○ Not Sure ○ Probably Not ○ No

13 Compared to the scenario above, would you spend $100 or **$50 more** if the travel time was **1 hour less**?
Check only one

○ Yes ○ Maybe ○ Not Sure ○ Probably Not ○ No

14 Compared to the scenario above, would you spend $135 or **$85 more** if the travel time was **1 hour 10 minutes less**?
Check only one

○ Yes ○ Maybe ○ Not Sure ○ Probably Not ○ No

Thank You for Your Time and Cooperation!

Colorado Travel Survey

This survey is part of a transportation study partially funded by a grant from the Colorado Department of Transportation and is being conducted to better understand the travel needs of Colorado residents and visitors to Colorado. Please return this form to our survey staff.

1 What was the starting point of your trip today?

City/Town _________________________ State/Province ______

2 What is your destination?

City/Town _________________________ State/Province ______

3 How often do you make this same trip?

_____ times per MONTH/YEAR *Enter number and circle month or year*

4 What is the primary purpose of your trip today? *Check only one*

○ Business travel ○ Commuting to/from work

○ Vacation/recreation ○ Visit with family/friends

○ Travel to/from school ○ Other _______________________

5 Where is your primary residence?

City/Town _________________________ State/Province ______

6 What is your employment status? *Check only one*

○ Employed full time ○ Employed part time ○ Retired

○ Student ○ Other _________________________

7 What is the combined annual income of everyone in your household? *Check only one*

○ Less than $45,000 ○ $45,000 - 64,999

○ $65,000 - 99,999 ○ $100,000 or more

Imagine you are making the SAME TRIP you indicated in Questions #1 and #2 and for the SAME PURPOSE you indicated in Question #4. Then imagine you are given a HYPOTHETICAL SCENARIO where:

> Your travel time is **1 hour** and the cost of your trip is **$10**.

Travel time is the TOTAL TIME you spend on the bus and cost is the TOTAL COST you incur for a one-way bus fare and for gas, tolls, parking, taxi fare, etc. to travel to the station. Refer to this TIME AND COST SCENARIO when answering the questions below.

For each question, put a checkmark on the ONE circle that best indicates your degree of preference for the alternative travel time and cost scenario given.

8 Compared to the scenario above, would you be willing to spend **1 hour longer** traveling if the cost was $5 or **$5 less**?
Check only one

○ Yes ○ Maybe ○ Not Sure ○ Probably Not ○ No

9 Compared to the scenario above, would you be willing to spend **30 minutes longer** traveling if the cost was $6 or **$4 less**?
Check only one

○ Yes ○ Maybe ○ Not Sure ○ Probably Not ○ No

10 Compared to the scenario above, would you be willing to spend **10 minutes longer** traveling if the cost was $8 or **$2 less**?
Check only one

○ Yes ○ Maybe ○ Not Sure ○ Probably Not ○ No

11 Compared to the scenario above, would you spend $14 or **$4 more** if the travel time was **15 minutes less**?
Check only one

○ Yes ○ Maybe ○ Not Sure ○ Probably Not ○ No

12 Compared to the scenario above, would you spend $25 or **$15 more** if the travel time was **45 minutes less**?
Check only one

○ Yes ○ Maybe ○ Not Sure ○ Probably Not ○ No

Imagine you are making the SAME TRIP you indicated in Questions #1 and #2 and for the SAME PURPOSE you indicated in Question #4. Then imagine you are given a HYPOTHETICAL SCENARIO where:

> The frequency of the service is every **30 minutes** and the cost of your trip is **$10**.

Frequency of service is the time between departures or how long you have to wait for the next bus. Cost is the TOTAL COST you incur for a one-way bus fare and for gas, tolls, parking, taxi fare, etc. to travel to the station. Refer to this TIME AND COST SCENARIO when answering the questions below.

For each question, put a checkmark on the ONE circle that best indicates your degree of preference for the alternative travel time and cost scenario given.

13 Compared to the scenario above, would you be willing to wait **30 minutes longer** if the cost was $8.50 or **$1.50 less**?
Check only one

○ Yes ○ Maybe ○ Not Sure ○ Probably Not ○ No

14 Compared to the scenario above, would you be willing to wait **15 minutes longer** if the cost was $8.75 or **$1.25 less**?
Check only one

○ Yes ○ Maybe ○ Not Sure ○ Probably Not ○ No

15 Compared to the scenario above, would you spend $11.10 or **$1.10 more** if the wait time was **10 minutes less**?
Check only one

○ Yes ○ Maybe ○ Not Sure ○ Probably Not ○ No

16 Compared to the scenario above, would you spend $12 or **$2 more** if the wait time was **15 minutes less**?
Check only one

○ Yes ○ Maybe ○ Not Sure ○ Probably Not ○ No

17 Compared to the scenario above, would you spend $13.75 or **$3.75 more** if the wait time was **23 minutes less**?
Check only one

○ Yes ○ Maybe ○ Not Sure ○ Probably Not ○ No

Thank You for Your Time and Cooperation!

Colorado Travel Survey

This survey is part of a transportation study partially funded by a grant from the Colorado Department of Transportation and is being conducted to better understand the travel needs of Colorado residents and visitors to Colorado. Please return this form to our survey staff.

1 What was the starting point of your trip today?

City/Town _________________________ State/Province ______

2 What is your destination?

City/Town _________________________ State/Province ______

3 How often do you make this same trip?

_____ times per MONTH/YEAR *Enter number and circle month or year*

4 What is the primary purpose of your trip today? *Check only one*

○ Business travel ○ Commuting to/from work

○ Vacation/recreation ○ Visit with family/friends

○ Travel to/from school ○ Other _______________________

5 Where is your primary residence?

City/Town _________________________ State/Province ______

6 What is your employment status? *Check only one*

○ Employed full time ○ Employed part time ○ Retired

○ Student ○ Other _________________________

7 What is the combined annual income of everyone in your household? *Check only one*

○ Less than $45,000 ○ $45,000 - 64,999

○ $65,000 - 99,999 ○ $100,000 or more

Imagine you are making the SAME TRIP you indicated in Questions #1 and #2 and for the SAME PURPOSE you indicated in Question #4. Then imagine you are given a HYPOTHETICAL SCENARIO where:

Your travel time is **4 hours** and the cost of your trip is **$60**.

Travel time is the TOTAL TIME you spend on the train/bus and cost is the TOTAL COST you incur for a one-way rail/bus fare and for gas, tolls, parking, taxi fare, etc. to travel to the station. Refer to this TIME AND COST SCENARIO when answering the questions below.

For each question, put a checkmark on the ONE circle that best indicates your degree of preference for the alternative travel time and cost scenario given.

8 Compared to the scenario above, would you be willing to spend **2 hours 30 minutes longer** traveling if the cost was $35 or **$25 less**? *Check only one*

○ Yes ○ Maybe ○ Not Sure ○ Probably Not ○ No

9 Compared to the scenario above, would you be willing to spend **1 hour longer** traveling if the cost was $45 or **$15 less**? *Check only one*

○ Yes ○ Maybe ○ Not Sure ○ Probably Not ○ No

10 Compared to the scenario above, would you spend $70 or **$10 more** if the travel time was **30 minutes less**? *Check only one*

○ Yes ○ Maybe ○ Not Sure ○ Probably Not ○ No

11 Compared to the scenario above, would you spend $85 or **$25 more** if the travel time was **1 hour less**? *Check only one*

○ Yes ○ Maybe ○ Not Sure ○ Probably Not ○ No

12 Compared to the scenario above, would you spend $105 or **$45 more** if the travel time was **1 hour 30 minutes less**? *Check only one*

○ Yes ○ Maybe ○ Not Sure ○ Probably Not ○ No

Imagine you are making the SAME TRIP you indicated in Questions #1 and #2 and for the SAME PURPOSE you indicated in Question #4. Then imagine you are given a HYPOTHETICAL SCENARIO where:

The frequency of the service is every **2 hours** and the cost of your trip is **$60**.

Frequency of service is the time between departures or how long you have to wait for the next train/bus. Cost is the TOTAL COST you incur for a one-way rail/bus fare and for gas, tolls, parking, taxi fare, etc. to travel to the station. Refer to this TIME AND COST SCENARIO when answering the questions below.

For each question, put a checkmark on the ONE circle that best indicates your degree of preference for the alternative travel time and cost scenario given.

13 Compared to the scenario above, would you be willing to wait **1 hours 30 minutes longer** if the cost was $52 or **$8 less**? *Check only one*

○ Yes ○ Maybe ○ Not Sure ○ Probably Not ○ No

14 Compared to the scenario above, would you be willing to wait **30 minutes longer** if the cost was $56 or **$4 less**? *Check only one*

○ Yes ○ Maybe ○ Not Sure ○ Probably Not ○ No

15 Compared to the scenario above, would you spend $63 or **$3 more** if the wait time was **15 minutes less**? *Check only one*

○ Yes ○ Maybe ○ Not Sure ○ Probably Not ○ No

16 Compared to the scenario above, would you spend $68 or **$8 more** if the wait time was **30 minutes less**? *Check only one*

○ Yes ○ Maybe ○ Not Sure ○ Probably Not ○ No

17 Compared to the scenario above, would you spend $105 or **$45 more** if the wait time was **1 hour 30 minutes less**? *Check only one*

○ Yes ○ Maybe ○ Not Sure ○ Probably Not ○ No

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Colorado Travel Survey

This survey is part of a transportation study partially funded by a grant from the Colorado Department of Transportation and is being conducted to better understand the travel needs of Colorado residents and visitors to Colorado. Please return this form to our survey staff.

For the questions below, recall a RECENT INTERCITY AUTO TRIP of 50 miles or more that you made in Colorado.

1 What was the starting point of this INTERCITY auto trip?

City/Town ______________________ State/Province ______

2 What was your destination for this INTERCITY auto trip?

City/Town _______________________ State/Province ______

3 How often do you make this same INTERCITY auto trip?

_____ times per MONTH/YEAR *Enter number and circle month or year*

4 What day of the week and approximate time did you start this INTERCITY auto trip?

Monday Tuesday Wednesday Thursday Friday Saturday Sunday

_____ AM/PM *Circle weekday, write in time and circle AM or PM*

5 How many people, including yourself, were in your party on this INTERCITY auto trip? ______

6 What was the primary purpose of this INTERCITY auto trip? *Check only one*

○ Business travel ○ Commuting to/from work

○ Vacation/recreation ○ Visit with family/friends

○ Travel to/from school ○ Other ______________________

7 Where is your primary residence?

City/Town ________________________ State/Province _______

8 What is your employment status? *Check only one*

○ Employed full time ○ Employed part time ○ Retired

○ Student ○ Other ________________________

9 What is the combined annual income of everyone in your household? *Check only one*

○ Less than $45,000 ○ $45,000 - 64,999

○ $65,000 - 99,999 ○ $100,000 or more

Imagine you are making the same INTERCITY auto trip you indicated in Questions #1 and #2 and for the same purpose you indicated in Question #6. Then imagine you are given a HYPOTHETICAL SCENARIO where:

Your travel time is **3 hours** and the cost of your trip is **$45**.

Travel time is the TOTAL TIME you actually spend driving and does not include stops for gas or meals, etc. The cost of your trip is the TOTAL COST you incur for gas, tolls, parking, etc. Refer to the ABOVE TIME AND COST SCENARIO when answering the questions below.

For each question, put a checkmark on the ONE circle that best indicates your degree of preference for the alternative travel time and cost scenario given.

10 Compared to the scenario above, would you be willing to spend **2 hours 30 minutes longer** traveling if the cost was $20 or **$25 less**? *Check only one*

○ Yes ○ Maybe ○ Not Sure ○ Probably Not ○ No

11 Compared to the scenario above, would you be willing to spend **1 hour longer** traveling if the cost was $30 or **$15 less**? *Check only one*

○ Yes ○ Maybe ○ Not Sure ○ Probably Not ○ No

12 Compared to the scenario above, would you spend $55 or **$10 more** if the travel time was **30 minutes less**? *Check only one*

○ Yes ○ Maybe ○ Not Sure ○ Probably Not ○ No

13 Compared to the scenario above, would you spend $70 or **$25 more** if the travel time was **1 hour less**? *Check only one*

○ Yes ○ Maybe ○ Not Sure ○ Probably Not ○ No

14 Compared to the scenario above, would you spend $90 or **$45 more** if the travel time was **1 hour 30 minutes less**? *Check only one*

○ Yes ○ Maybe ○ Not Sure ○ Probably Not ○ No

Thank You for Your Time and Cooperation!

E Capital Cost Detailed Segment Schematics and Data

E.1 Capital Cost Detailed Segment Schematics

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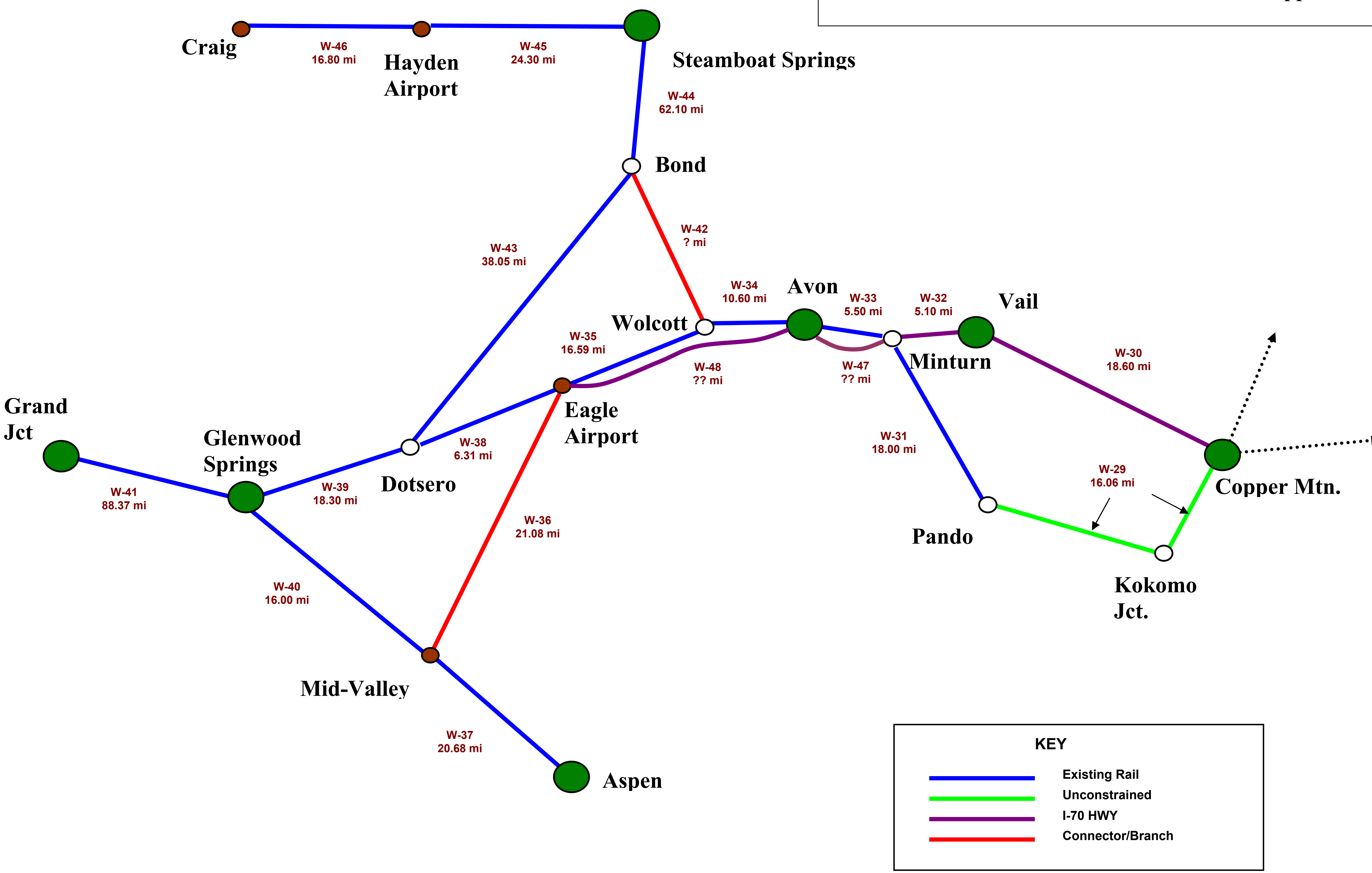
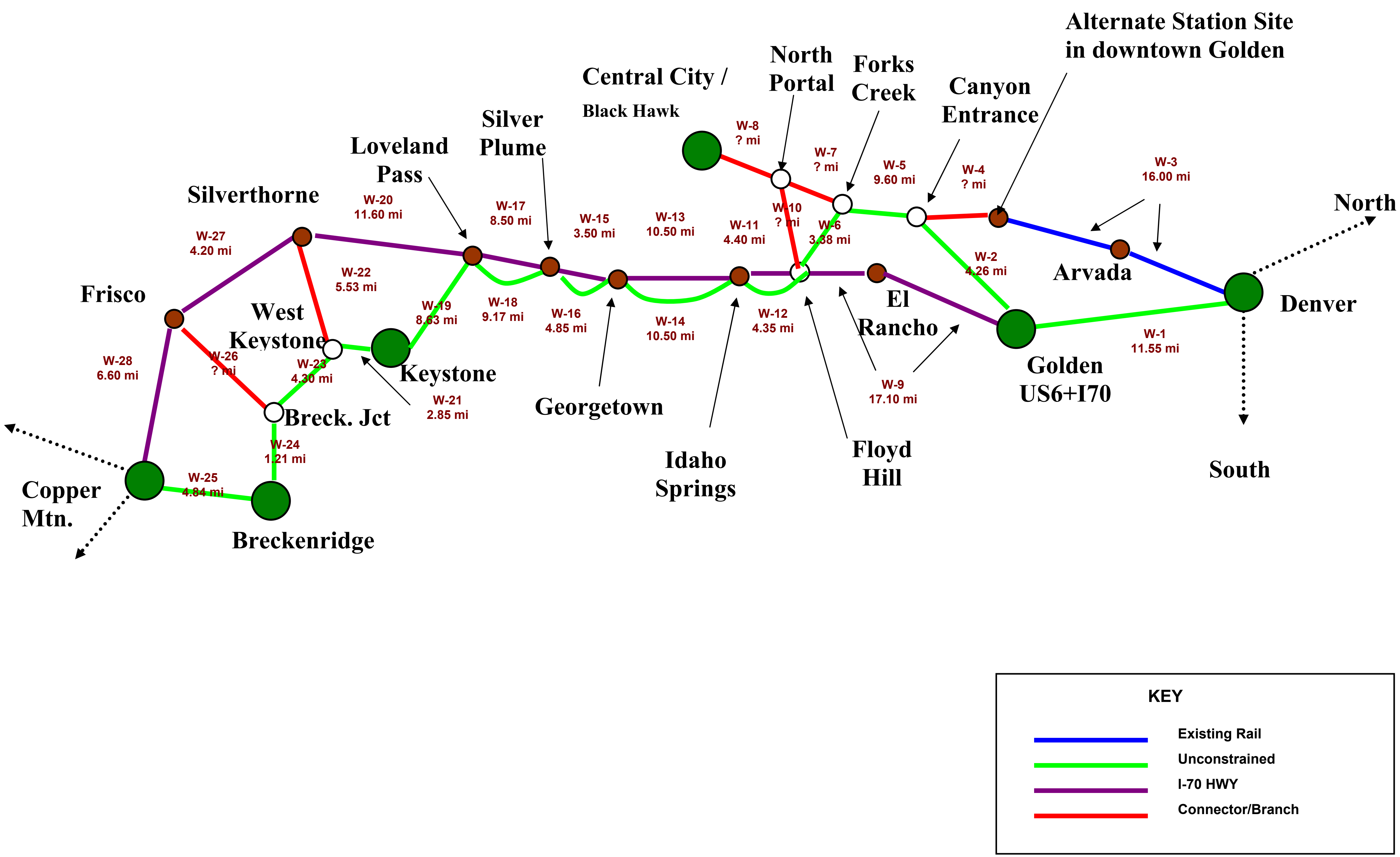
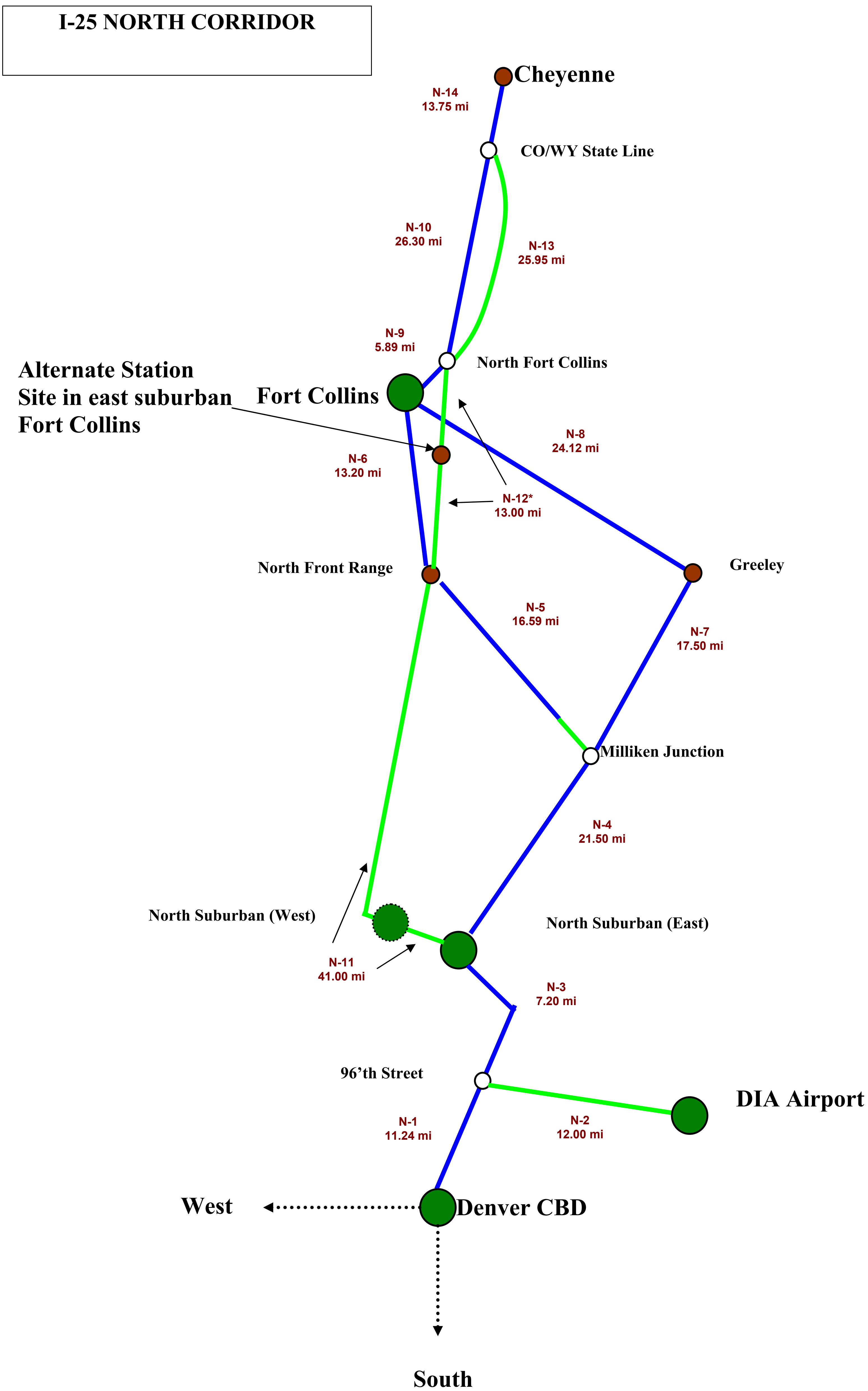
I-70 WEST CORRIDOR – West of Copper

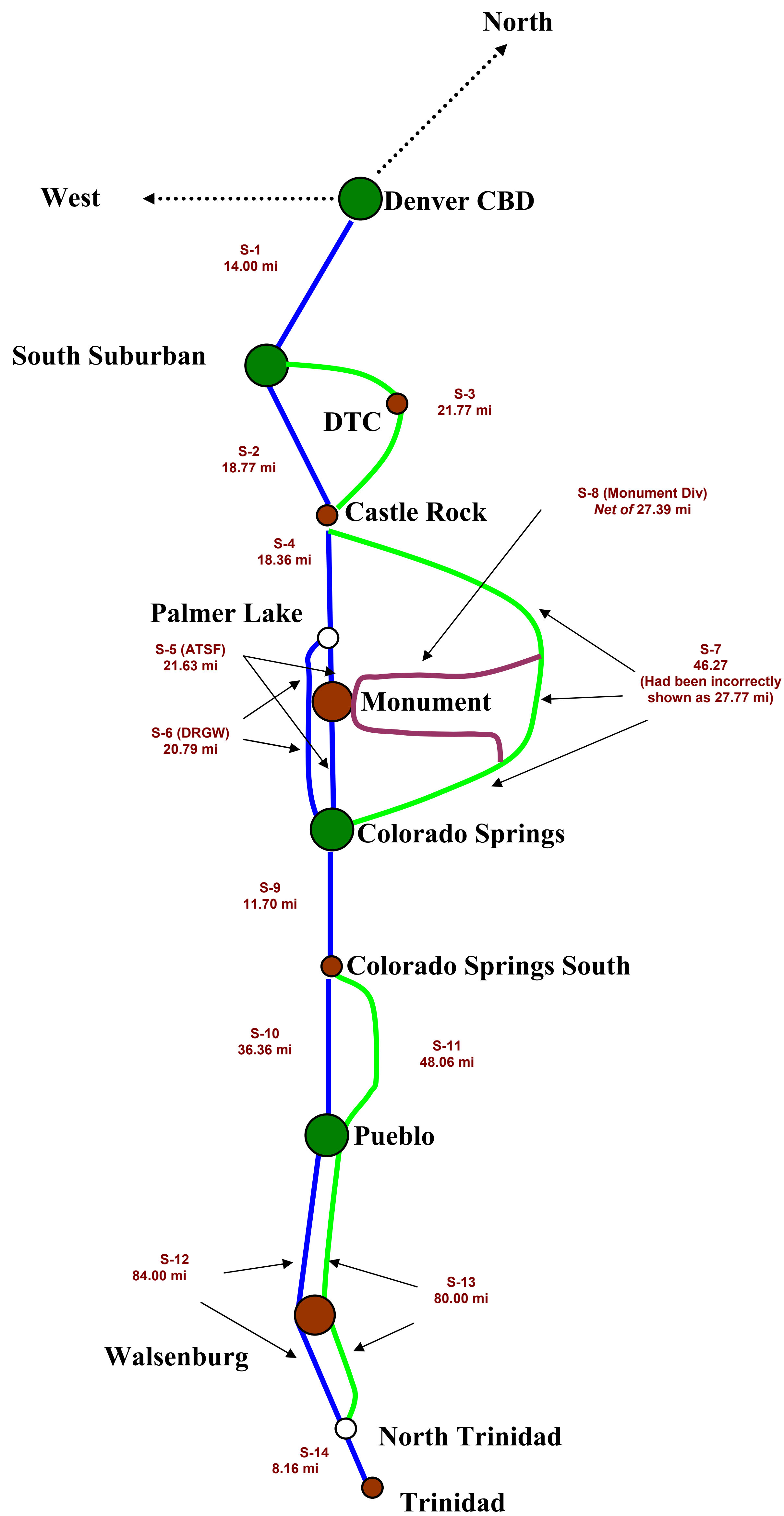


I-70 WEST CORRIDOR – East of Copper




I-25 NORTH CORRIDOR
Cheyenne
N-14
13.75 mi
CO/WY State Line
N-10
26.30 mi
N-13
25.95 mi
N-9
5.89 mi
North Fort Collins
Alternate Station
Site in east suburban
Fort Collins
Fort Collins
N-8
24.12 mi
N-6
13.20 mi
N-12*
13.00 mi
North Front Range
Greeley
N-5
16.59 mi
N-7
17.50 mi
Milliken Junction
N-4
21.50 mi
North Suburban (West)
North Suburban (East)
N-11
41.00 mi
N-3
7.20 mi
96'th Street
DIA Airport
N-1
11.24 mi
N-2
12.00 mi
West
Denver CBD
South

I-25 SOUTH CORRIDOR



E.2 I-70 Rail

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			Segment No.	Segment W1		Segment W2		Segment W3		Segment W4		Segment W5		Segment W6		Segment W7		Segment W8		Segment W9		Segment W10		Segment W11		Segment W12	
			From - To	Denver to US6/I70 Junction via US6		US6/I70 Junction to entrance to Clear Creek Canyon		Denver to Downtown Golden via Arvada		Downtown Golden to entrance to Clear Creek Canyon		Clear Creek Canyon entrance to Forks Creek via US6		Forks Creek to Floyds Hill via US6		Forks Creek to Black Hawk Tunnel N Portal		Black Hawk Tunnel N Portal to Central City/Black Hawk		US6/I70 Junction to Floyds Hill via El Rancho on I70		Floyds Hill to Blackhawk Tunnel N Portal		Floyds Hill to Idaho Springs via I70		Floyds Hill to Idaho Springs via Unconstrained	
			Host Carrier																								
			Mileposts																								
			Track Miles	11.6 miles		4.3 miles		16.0 miles				9.6 miles		3.4 miles		2.7 miles		5.0 miles		17.3 miles		1.0 miles		4.4 miles		4.4 miles	
			Maximum Authorized Speed																								
		Unit	2009 Unit Cost	Quantity	Amount	Quantity	Amount	Quantity	Amount	Quantity	Amount	Quantity	Amount	Quantity	Amount	Quantity	Amount	Quantity	Amount	Quantity	Amount	Quantity	Amount	Quantity	Amount	Quantity	Amount
Trackwork																											
1.1	HSR on Existing Roadbed	per mile	$ 1,175		$ -		$ -		$ -		$ -		$ -		$ -	0	$ -	0	$ -		$ -		$ -		$ -		$ -
1.2	HSR on Existing Roadbed (Double Track)	per mile	$ 2,350	10.6	$ 24,910	2.6	$ 6,110	7.2	$ 16,920	0.5	$ 1,175	9.6	$ 22,560	3.4	$ 7,990	2.3	$ 5,405	8.2	$ 19,270	17.3	$ 40,655	1	$ 2,350	4.4	$ 10,340	3.5	$ 8,225
1.3	HSR on New Roadbed & New Embankment	per mile	$ 1,765		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -
1.4	HSR on New Roadbed & New Embankment (Double Track)	per mile	$ 3,164	1	$ 3,164		$ -	1.6	$ 5,062		$ -		$ -		$ -	0.4	$ 1,266	0.8	$ 2,531		$ -		$ -		$ -		$ -
1.5	HSR Double Track on 15' Retained Earth Fill	per mile	$ 16,711	**0**	$ -	1.7	$ 28,409	7.2	$ 120,321	0.4	$ 6,685		$ -		$ -		$ -		$ -		$ -		$ -		$ -	0.9	$ 15,040
1.6	Timber & Surface w/ 33% Tie replacement	per mile	$ 263		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -
1.7	Timber & Surface w/ 66% Tie Replacement	per mile	$ 392		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -
1.8	Relay Track w/ 136# CWR	per mile	$ 419		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -
1.9	Freight Siding	per mile	$ 1,079		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -
1.10	Passenger Siding	per mile	$ 1,628		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -
1.11	NCHRP Class 6 Barrier (on tangent)	lineal ft	$ 1		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -
1.12	NCHRP Class 5 Barrier (on curves)	lineal ft	$ 0		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -
1.13	Fencing, 4 ft Woven Wire (both sides)	per mile	$ 60		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -
1.14	Fencing, 6 ft Chain Link (both sides)	per mile	$ 181	10.6	$ 1,919	1.7	$ 308	1.6	$ 290	0.9	$ 163		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -
1.15	Fencing, 10 ft Chain Link (both sides)	per mile	$ 207	0.5	$ 104		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -
1.16	Decorative Fencing (both sides)	per mile	$ 466	0.5	$ 233		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -
1.17	Drainage Improvements (cross country)	per mile	$ 78	11.6	$ 906	4.3	$ 336		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -	4.4	$ 344
1.18	Drainage Improvements in Median or along highway	per mile	$ 625		$ -		$ -	16	$ 9,995	0.9	$ 562	9.6	$ 5,997	3.4	$ 2,124	2.7	$ 1,687	5	$ 3,124	17.3	$ 10,807	1	$ 625	4.4	$ 2,749		$ -
1.19	Land Acquisition Urban	per mile	$ 387	11.6	$ 4,488	4.3	$ 1,664	16	$ 6,190		$ -		$ -		$ -	0	$ -	1	$ 387		$ -		$ -		$ -		$ -
1.20	Land Acquisition Rural	per mile	$ 129		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -
1.21	#33 High Speed Turnout	each	$ 672		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -
1.22	#24 High Speed Turnout	each	$ 532	2	$ 1,065		$ -		$ -		$ -	2	$ 1,065		$ -		$ -		$ -		$ -	2	$ 1,065		$ -		$ -
1.23	#20 Turnout Timber	each	$ 147		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -
1.24	#10 Turnout Timber	each	$ 82		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -
1.25	#20 Turnout Concrete	each	$ 295		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -
1.26	#10 Turnout Concrete	each	$ 140		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -
1.27	#33 Crossover	each	$ 1,344		$ -		$ -	1	$ 1,344		$ -	1	$ 1,344		$ -		$ -		$ -		$ -		$ -		$ -		$ -
1.28	#20 Crossover	each	$ 590	1	$ 590		$ -		$ -		$ -		$ -		$ -	1	$ 590	1	$ 590	1	$ 590		$ -		$ -		$ -
1.29	Elevate & Surface Curves	per mile	$ 69		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -
1.30	Curvature Reduction	per mile	$ 465		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -
1.31	Elastic Fasteners	per mile	$ 97		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -
1.32	Realign Track for Curves (See Table G6 for Costs)	lump sum	$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -
	Sub-total Trackwork (A)				$ 37,378		$ 36,826		$ 160,123		$ 8,585		$ 30,966		$ 10,114		$ 8,947		$ 25,902		$ 52,052		$ 4,040		$ 13,089		$ 23,609
Structures																											
	Bridges-under																										
2.1	Four Lane Urban Expressway	each	$ 5,721		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -
2.2	Four Lane Rural Expressway	each	$ 4,762		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -
2.3	Two Lane Highway	each	$ 3,614		$ -	2	$ 7,227		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -
2.4	Rail	each	$ 3,614		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -
2.5	Minor river	each	$ 958		$ -	1	$ 958		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -
2.6	Major River	each	$ 9,582		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -
2.7	Double Track High (50') Level Bridge	per LF	$ 14	7300	$ 105,120	0	$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -	2000	$ 28,800	2000	$ 28,800
2.8	Rehab for 110	per LF	$ 17		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -
2.9	Convert open deck bridge to ballast deck (single track)	per LF	$ 6		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -
2.10	Convert open deck bridge to ballast deck (double track)	per LF	$ 11		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -
2.11	Single Track on Flyover/Elevated Structure	per LF	$ 5		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -
2.12	Single Track on Approach Embankment w/ Retaining Wall	per LF	$ 4		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -
2.13	Double Track on Flyover/Elevated Structure	per LF	$ 8	38720	$ 321,376	0	$ -	35000	$ 290,500	2500	$ 20,750	29425	$ 244,228	13914	$ 115,486	12000	$ 99,600	22000	$ 182,600	91344	$ 758,155		$ -	17232	$ 143,026	11537	$ 95,757
2.14	Double Track on Approach Embankment w/ Retaining Wall	per LF	$ 7	2640	$ 17,160	12500	$ 81,250		$ -		$ -	0	$ -	0	$ -	0	$ -	0	$ -	0	$ -		$ -	4000	$ 26,000	4000	$ 26,000
2.15	Ballasted Concrete Deck Replacement Bridge	per LF	$ 3		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -
2.16	Land Bridges	per LF	$ 3		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -
	Bridges-over																										
2.17	Four Lane Urban Expressway	each	$ 2,469		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -
2.18	Four Lane Rural Expressway	each	$ 3,466		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -
2.19	Two Lane Highway	each	$ 2,252		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -
2.20	Rail	each	$ 7,229		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -
	Tunnels																										
2.21	Two Bore Long Tunnel	route ft	$ 44		$ -		$ -		$ -		$ -	21263	$ 935,572	4038	$ 177,672		$ -		$ -		$ -	5280	$ 232,320		$ -		$ -
2.22	Single Bore Short Tunnel	lineal ft	$ 25		$ -		$ -	3000	$ 75,000		$ -		$ -		$ -		$ -		$ -		$ -		$ -	750	$ 18,750	750	$ 18,750
	Sub-total Structures (B)				$ 443,656		$ 89,435		$ 365,500		$ 20,750		$ 1,179,800		$ 293,158		$ 99,600		$ 182,600		$ 758,155		$ 232,320		$ 216,576		$ 169,307
Systems																											
3.1	Signals for Siding w/ High Speed Turnout	each	$ 1,500		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -
3.2	Install CTC System (Single Track)	per mile	$ 217		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -
3.3	Install CTC System (Double Track)	per mile	$ 355		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -
3.4	Install PTC System	per mile	$ 171		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -
3.5	Electric Lock for Industry Turnout	each	$ 122		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -
3.6	Signals for Crossover	each	$ 828	1	$ 828		$ -	1	$ 828		$ -	1	$ 828		$ -	1	$ 828	1	$ 828	1	$ 828		$ -		$ -		$ -
3.7	Signals for Turnout	each	$ 473	2	$ 947		$ -		$ -		$ -	2	$ 947		$ -		$ -		$ -		$ -	2	$ 947	0	$ -		$ -
3.8	Signals, Communications & Dispatch	per mile	$ 1,540		$ -		$ -	16	$ 24,635	0.9	$ 1,386	9.6	$ 14,781	3.4	$ 5,235	2.7	$ 4,157	5	$ 7,699	17.3	$ 26,637	1	$ 1,540	4.4	$ 6,775	4.4	$ 6,775
3.9	Electrification (Double Track)	per mile	$ 3,080	11.6	$ 35,722	4.3	$ 13,242	16	$ 49,272	0.9	$ 2,772	9.6	$ 29,563	3.4	$ 10,470	2.7	$ 8,315	5	$ 15,398	17.3	$ 53,275	1	$ 3,080	4.4	$ 13,550	4.4	$ 13,550
3.10	Electrification (Single Track)	per mile	$ 1,540	11.6	$ 17,861	4.3	$ 6,621		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -
	Sub-total Systems (C)				$ 55,358		$ 19,863		$ 74,735		$ 4,157		$ 46,119		$ 15,705		$ 13,300		$ 23,924		$ 80,740		$ 5,566		$ 20,324		$ 20,324
Crossings																											
4.1	Private Closure	each	$ 98		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -
4.2	Four Quadrant Gates w/ Trapped Vehicle Detector	each	$ 582	3	$ 1,746		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -
4.3	Four Quadrant Gates	each	$ 341		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -

4.4	Convert Dual Gates to Quad Gates	each	$ 178		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -
4.5	Conventional Gates single mainline track	each	$ 196		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -
4.6	Conventional Gates double mainline track	each	$ 243		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -
4.7	Convert Flashers Only to Dual Gate	each	$ 59		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -
4.8	Single Gate with Median Barrier	each	$ 213		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -
4.9	Convert Single Gate to Extended Arm	each	$ 18		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -
4.10	Precast Panels without Rdway Improvements	each	$ 95		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -
4.11	Precast Panels with Rdway Improvements	each	$ 178	3	$ 533		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -
	Sub-total Crossings (D)				$ 2,279		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -
Station/Maintenance Facilities																											
5.1	Full Service - New - Low Volume - 500 Surface Park	each	$ 5,000		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -
5.2	Full Service - Renovated - Low Volume- 500 Surface Park	each	$ 4,000		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -
5.3	Terminal - New - Low Volume - 500 Surface Park	each	$ 7,500		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -	1	$ 7,500	1	$ 7,500
5.4	Terminal - Renovated - Low Volume - 500 Surface Park	each	$ 6,000		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -
5.5	Full Service - New- High Volume - Dual Platform - 1000 Surface Park	each	$ 10,000		$ -	1	$ 10,000	1	$ 10,000		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -
5.6	Terminal - New- High Volume - Dual Platform - 1000 Surface Park	each	$ 15,000	1	$ 15,000		$ -		$ -		$ -		$ -		$ -	0	$ -	1	$ 15,000		$ -		$ -		$ -		$ -
5.7	Maintenance Facility (non-electrified track)	each	$ 80,000		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -
5.8	Maintenance Facility (electrified track)	each	$ 100,000		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -
5.9	Layover Facility	lump sum	$ 10,000		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -
	Sub-total Station/Maintenance Facilities (E)				$ 15,000		$ 10,000		$ 10,000		$ -		$ -		$ -		$ -		$ 15,000		$ -		$ -		$ 7,500		$ 7,500
Allocations for Special Elements																											
		lump sum			$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -
		lump sum			$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -
		lump sum			$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -
		lump sum			$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -
		lump sum			$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -
	Sub-Total Allocations for Special Elements (F)				$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -
	Sub-total Construction Elements (A+B+C+D+E+F)				$ 553,670		$ 156,124		$ 610,358		$ 33,492		$ 1,256,885		$ 318,977		$ 121,847		$ 247,426		$ 890,948		$ 241,925		$ 257,489		$ 220,740
Contingency																											
	Design and Construction Contingency		30%		$ 166,101		$ 46,837		$ 183,107		$ 10,048		$ 377,065		$ 95,693		$ 36,554		$ 74,228		$ 267,284		$ 72,578		$ 77,247		$ 66,222
	Sub-total Construction Elements Including Contingency (G)				$ 719,771		$ 202,962		$ 793,466		$ 43,540		$ 1,633,950		$ 414,671		$ 158,401		$ 321,653		$ 1,158,232		$ 314,503		$ 334,735		$ 286,963
Professional Services and Environmental																											
	Design Engineering	10%																									
	Insurance and Bonding	2%																									
	Program Management	4%																									
	Construction Management & Inspection	6%																									
	Engineering Services During Construction	2%																									
	Integrated Testing and Commissioning	2%																									
	Erosion Control and Water Quality Management	2%																									
	Sub-total Professional Services and Environmental (H)		28%		$ 201,536		$ 56,829		$ 222,170		$ 12,191		$ 457,506		$ 116,108		$ 44,352		$ 90,063		$ 324,305		$ 88,061		$ 93,726		$ 80,350
	Total Segment Cost (G)+(H)				$ 921,307		$ 259,791		$ 1,015,636		$ 55,731		$ 2,091,456		$ 530,778		$ 202,754		$ 411,716		$ 1,482,537		$ 402,564		$ 428,461		$ 367,312

Segment W13		Segment W14		Segment W15		Segment W16		Segment W17		Segment W18		Segment W19		Segment W20		Segment W21		Segment W22		Segment W23		Segment W24		Segment W25		Segment W26		Segment W27		Segment W28		Segment W29	
Idaho Springs to Georgetown via I70		Idaho Springs to Georgetown via Unconstrained		Georgetown to Silver Plume via I70		Georgetown to Silver Plume via Unconstrained		Silver Plume to Loveland Pass via I70		Silver Plume to Loveland Pass via Unconstrained		Loveland Pass to Keystone via North Fork Tunnel		Loveland Pass to Silverthorne via EJMT		Keystone to West Keystone via US6		West Keystone to Silverthorne via US6		West Keystone to Breckenridge Junction		Breckenridge Junction to Breckenridge		Breckenridge to Copper Mtn via Tunnel		Breckenridge Junction to Friso		Silverthorne to Frisco via I70		Frisco to Copper Mtn via I70		Copper Mtn to Pando via Greenfield	
10.5 miles		10.5 miles		4.9 miles		4.9 miles		8.6 miles		8.6 miles		8.6 miles		9.9 miles		2.9 miles		4.2 miles		4.3 miles		1.2 miles		4.8 miles		5.3 miles		4.6 miles		6.3 miles		16.1 miles	
Quantity	Amount	Quantity	Amount	Quantity	Amount	Quantity	Amount	Quantity	Amount	Quantity	Amount	Quantity	Amount	Quantity	Amount	Quantity	Amount	Quantity	Amount	Quantity	Amount	Quantity	Amount	Quantity	Amount	Quantity	Amount	Quantity	Amount	Quantity	Amount	Quantity	Amount
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10.5	$ 24,675	5.8	$ 13,630	4.9	$ 11,515	3.8	$ 8,930	8.6	$ 20,210	3.1	$ 7,285	5.7	$ 13,395	9.9	$ 23,265	0.8	$ 1,880	2.3	$ 5,405	2.3	$ 5,405	0.6	$ 1,410	4.2	$ 9,870	4.1	$ 9,635	4.6	$ 10,810	6.3	$ 14,805	4.6	$ 10,810
	$ -		$ -		$ -		$ -		$ -		$ -	0.8	$ 1,412		$ -	1	$ 1,765		$ -		$ -		$ -		$ -	1	$ 1,765		$ -		$ -		$ -
	$ -	2.3	$ 7,277		$ -		$ -		$ -	2.7	$ 8,543		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -	6	$ 18,983
	$ -	2.4	$ 40,107		$ -	1.1	$ 18,382		$ -	2.8	$ 46,792	1.4	$ 23,396		$ -	1.1	$ 18,382	1.9	$ 31,751	2	$ 33,423	0.6	$ 10,027	0.7	$ 11,698	0.2	$ 3,342		$ -		$ -	5.5	$ 91,912
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	$ -	10.5	$ 820		$ -		$ -		$ -	8.6	$ 672		$ -		$ -		$ -		$ -		$ -		$ -		$ -	2	$ 156		$ -		$ -	16.1	$ 1,257
10.5	$ 6,559		$ -	4.9	$ 3,061		$ -	8.6	$ 5,372		$ -		$ -	9.9	$ 6,185	2.9	$ 1,812	4.2	$ 2,624	4.3	$ 2,686	1.2	$ 750	0.7	$ 437	3.3	$ 2,062	4.6	$ 2,874	6.3	$ 3,936		$ -
	$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -	2.9	$ 1,122	4.2	$ 1,625	4.3	$ 1,664	1.2	$ 464		$ -	3.3	$ 1,277		$ -		$ -		$ -
	$ -		$ -		$ -		$ -		$ -	8.6	$ 1,109	8.6	$ 1,109		$ -		$ -		$ -		$ -		$ -		$ -	2	$ 258		$ -		$ -	16.1	$ 2,077
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	$ 31,234		$ 61,834		$ 14,576		$ 27,312		$ 26,927		$ 65,744		$ 39,312		$ 30,794		$ 25,375		$ 42,077		$ 43,177		$ 12,832		$ 22,005		$ 18,495		$ 13,684		$ 20,085		$ 126,384
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300	$ 4,320	300	$ 4,320		$ -		$ -	300	$ 4,320	700	$ 10,080		$ -		$ -		$ -	676	$ 9,734		$ -		$ -		$ -	500	$ 7,200		$ -		$ -	16000	$ 230,400
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55140	$ 457,662	25000	$ 207,500	25872	$ 214,738		$ -	45108	$ 374,396		$ -	4000	$ 33,200	42272	$ 350,858	4000	$ 33,200	11500	$ 95,450		$ -		$ -		$ -	15984	$ 132,667	24288	$ 201,590	33264	$ 276,091	4224	$ 35,059
	$ -	4400	$ 28,600		$ -		$ -		$ -	16000	$ 104,000		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -	3853	$ 25,045
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	$ -		$ -		$ -	14000	$ 616,000		$ -		$ -	30000	$ 1,320,000	10000	$ 440,000		$ -		$ -	12000	$ 528,000		$ -	22000	$ 968,000	6000	$ 264,000		$ -		$ -		$ -
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	$ 461,982		$ 240,420		$ 214,738		$ 616,000		$ 378,716		$ 114,080		$ 1,353,200		$ 790,858		$ 33,200		$ 105,184		$ 528,000		$ -		$ 968,000		$ 403,867		$ 201,590		$ 276,091		$ 290,504
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	$ -		$ -		$ -		$ -	1	$ 828		$ -		$ -	1	$ 828		$ -		$ -		$ -		$ -		$ -		$ -		$ -	1	$ 828	1	$ 828
	$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -	1	$ 473		$ -		$ -		$ -		$ -		$ -		$ -		$ -
10.5	$ 16,167	10.5	$ 16,167	4.9	$ 7,545	4.9	$ 7,545	8.6	$ 13,241	8.6	$ 13,241	8.6	$ 13,241	9.9	$ 15,243	2.9	$ 4,465	4.2	$ 6,467	4.3	$ 6,621	1.2	$ 1,848	4.8	$ 7,391	5.3	$ 8,160	4.6	$ 7,083	6.3	$ 9,700	16.1	$ 24,789
10.5	$ 32,335	10.5	$ 32,335	4.9	$ 15,090	4.9	$ 15,090	8.6	$ 26,484	8.6	$ 26,484	8.6	$ 26,484	9.9	$ 30,487	2.9	$ 8,931	4.2	$ 12,934	4.3	$ 13,242	1.2	$ 3,695	4.8	$ 14,782	5.3	$ 16,321	4.6	$ 14,166	6.3	$ 19,401	16.1	$ 49,580
	$ -		$ -	0	$ -	0	$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -
	$ 48,502		$ 48,502		$ 22,634		$ 22,634		$ 40,553		$ 39,725		$ 39,725		$ 46,558		$ 13,396		$ 19,874		$ 19,863		$ 5,543		$ 22,172		$ 24,482		$ 21,248		$ 29,929		$ 75,197
	$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -
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1	$ 5,000	1	$ 5,000		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -
	$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -
	$ -		$ -		$ -		$ -	1	$ 7,500	1	$ 7,500		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -
	$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -
	$ -		$ -		$ -		$ -		$ -		$ -	1	$ 10,000	1	$ 10,000	1	$ 10,000	1	$ 10,000		$ -	1	$ 10,000	1	$ 10,000		$ -		$ -	1	$ 10,000		$ -
	$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -
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	$ 5,000		$ 5,000		$ -		$ -		$ 7,500		$ 7,500		$ 10,000		$ 10,000		$ 10,000		$ 10,000		$ -		$ 10,000		$ 10,000		$ -		$ -		$ 10,000		$ -
	$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -
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	$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -
	$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -
	$ 546,718		$ 355,756		$ 251,948		$ 665,947		$ 453,696		$ 227,049		$ 1,442,238		$ 878,210		$ 81,971		$ 177,136		$ 591,040		$ 28,375		$ 1,022,177		$ 446,844		$ 236,522		$ 336,105		$ 492,085
	$ 164,015		$ 106,727		$ 75,584		$ 199,784		$ 136,109		$ 68,115		$ 432,671		$ 263,463		$ 24,591		$ 53,141		$ 177,312		$ 8,512		$ 306,653		$ 134,053		$ 70,957		$ 100,832		$ 147,625
	$ 710,733		$ 462,482		$ 327,532		$ 865,730		$ 589,805		$ 295,164		$ 1,874,909		$ 1,141,672		$ 106,562		$ 230,276		$ 768,352		$ 36,887		$ 1,328,831		$ 580,897		$ 307,479		$ 436,937		$ 639,710
	$ 199,005		$ 129,495		$ 91,709		$ 242,405		$ 165,145		$ 82,646		$ 524,974		$ 319,668		$ 29,837		$ 64,477		$ 215,139		$ 10,328		$ 372,073		$ 162,651		$ 86,094		$ 122,342		$ 179,119
	$ 909,739		$ 591,978		$ 419,241		$ 1,108,135		$ 754,951		$ 377,810		$ 2,399,883		$ 1,461,341		$ 136,400		$ 294,754		$ 983,491		$ 47,216		$ 1,700,903		$ 743,548		$ 393,573		$ 559,279		$ 818,829

Segment W30		Segment W31		Segment W32		Segment W33		Segment W34	
Copper Mtn to Vail via I70		Pando to Minturn via existing Rail		Vail to Minturn via I70		Minturn to Avon		Avon to Wolcott	
21.1 miles		18.0 miles		2.9 miles		5.5 miles		10.6 miles	
Quantity	Amount	Quantity	Amount	Quantity	Amount	Quantity	Amount	Quantity	Amount
	$ -		$ -		$ -		$ -		$ -
21.1	$ 49,585	5.8	$ 13,630	2.9	$ 6,815	1.4	$ 3,290	3	$ 7,050
	$ -		$ -		$ -		$ -		$ -
	$ -	4.2	$ 13,288		$ -	1.8	$ 5,695	3.4	$ 10,757
	$ -	8	$ 133,690		$ -	2.3	$ 38,436	4.1	$ 68,516
	$ -		$ -		$ -		$ -		$ -
	$ -		$ -		$ -		$ -		$ -
	$ -		$ -		$ -		$ -		$ -
	$ -		$ -		$ -		$ -		$ -
	$ -		$ -		$ -		$ -		$ -
	$ -		$ -		$ -		$ -		$ -
	$ -		$ -		$ -		$ -		$ -
	$ -		$ -		$ -		$ -		$ -
	$ -	17	$ 3,077		$ -	5.5	$ 996	6.5	$ 1,177
	$ -		$ -		$ -		$ -		$ -
	$ -	1	$ 466		$ -		$ -		$ -
	$ -	18	$ 1,406		$ -	5.5	$ 430	10.6	$ 828
21.1	$ 13,181		$ -	2.9	$ 1,812	0	$ -		$ -
	$ -		$ -		$ -		$ -		$ -
	$ -	18	$ 2,322		$ -	5.5	$ 710		$ -
	$ -		$ -	1	$ 672		$ -		$ -
	$ -		$ -		$ -		$ -		$ -
	$ -		$ -		$ -		$ -		$ -
	$ -		$ -		$ -		$ -		$ -
	$ -		$ -		$ -		$ -		$ -
	$ -		$ -		$ -		$ -		$ -
1	$ 1,344	1	$ 1,344		$ -		$ -		$ -
	$ -		$ -		$ -		$ -		$ -
	$ -		$ -		$ -		$ -		$ -
	$ -		$ -		$ -		$ -		$ -
	$ -		$ -		$ -		$ -		$ -
	$ -		$ -		$ -		$ -		$ -
	$ 64,110		$ 169,224		$ 9,299		$ 49,556		$ 88,328
	$ -		$ -		$ -		$ -		$ -
	$ -		$ -		$ -		$ -		$ -
	$ -	6	$ 21,681		$ -	4	$ 14,454	12	$ 43,362
	$ -		$ -		$ -		$ -		$ -
	$ -	6	$ 5,750		$ -	4	$ 3,834	2	$ 1,917
	$ -	2	$ 19,163		$ -		$ -		$ -
	$ -	1000	$ 14,400		$ -		$ -		$ -
	$ -		$ -		$ -		$ -		$ -
	$ -		$ -		$ -		$ -		$ -
	$ -		$ -		$ -		$ -		$ -
	$ -		$ -		$ -		$ -		$ -
	$ -		$ -		$ -		$ -		$ -
111408	$ 924,686	25000	$ 207,500	15312	$ 127,090	6000	$ 49,800	14000	$ 116,200
	$ -	1000	$ 6,500		$ -		$ -		$ -
	$ -		$ -		$ -		$ -		$ -
	$ -		$ -		$ -		$ -		$ -
	$ -		$ -		$ -		$ -		$ -
	$ -		$ -		$ -		$ -		$ -
	$ -	2	$ 4,503		$ -		$ -		$ -
	$ -		$ -		$ -		$ -		$ -
	$ -		$ -		$ -		$ -		$ -
	$ -	600	$ 15,000		$ -		$ -		$ -
	$ 924,686		$ 294,498		$ 127,090		$ 68,088		$ 161,479
	$ -		$ -		$ -		$ -		$ -
	$ -		$ -		$ -		$ -		$ -
	$ -		$ -		$ -		$ -		$ -
	$ -		$ -		$ -		$ -		$ -
	$ -		$ -		$ -		$ -		$ -
1	$ 828	1	$ 828		$ -		$ -		$ -
	$ -		$ -	1	$ 473		$ -		$ -
21.1	$ 32,488	18	$ 27,715	2.9	$ 4,465	5.5	$ 8,468	10.6	$ 16,321
21.1	$ 64,977	18	$ 55,431	2.9	$ 8,931	5.5	$ 16,937	10.6	$ 32,643
	$ -		$ -		$ -		$ -		$ -
	$ 98,293		$ 83,974		$ 13,869		$ 25,406		$ 48,964
	$ -		$ -		$ -		$ -		$ -
	$ -		$ -		$ -		$ -		$ -
	$ -		$ -		$ -		$ -		$ -

Segment W35		Segment W36		Segment W37		Segment W38		Segment W39	
Wolcott to Eagle Airport		Eagle Airport to Mid-Valley (Basalt) via Tunnel		Mid-Valley (Basalt) to Aspen Airport		Eagle Airport to Dotsero		Dotsero to Glenwood Springs via Canyon	
16.6 miles		21.1 miles		20.7 miles		6.3 miles		18.3 miles	
Quantity	Amount	Quantity	Amount	Quantity	Amount	Quantity	Amount	Quantity	Amount
	$ -		$ -		$ -	1.2	$ 1,410	7.3	$ 8,577
3.1	$ 7,285	11.7	$ 27,495	2.6	$ 6,110		$ -		$ -
	$ -		$ -		$ -	3.1	$ 5,472	4.1	$ 7,238
6.3	$ 19,933	4.1	$ 12,972	7.3	$ 23,096		$ -		$ -
7.2	$ 120,321	5.2	$ 86,899	10.8	$ 180,482	2	$ 33,423	6.5	$ 108,623
	$ -		$ -		$ -		$ -		$ -
	$ -		$ -		$ -		$ -		$ -
	$ -		$ -		$ -		$ -		$ -
	$ -		$ -		$ -		$ -		$ -
	$ -		$ -		$ -		$ -	5	$ 8,141
	$ -		$ -		$ -		$ -		$ -
	$ -		$ -		$ -		$ -		$ -
	$ -		$ -		$ -		$ -		$ -
9.4	$ 1,701	8	$ 1,448	19	$ 3,439	6.3	$ 1,140		$ -
	$ -		$ -	2.7	$ 559		$ -		$ -
	$ -		$ -		$ -		$ -		$ -
16.6	$ 1,296	11	$ 859	20.7	$ 1,617	6.3	$ 492	18.3	$ 1,429
	$ -		$ -		$ -		$ -		$ -
4.6	$ 1,780	11	$ 4,256	20.7	$ 8,009		$ -		$ -
12	$ 1,548		$ -	1	$ 129		$ -	18.3	$ 2,361
	$ -		$ -		$ -		$ -		$ -
	$ -		$ -		$ -		$ -	2	$ 1,065
	$ -		$ -		$ -		$ -		$ -
	$ -		$ -		$ -		$ -		$ -
	$ -		$ -		$ -	1	$ 295		$ -
	$ -		$ -		$ -		$ -		$ -
	$ -	1	$ 1,344	1	$ 1,344		$ -		$ -
	$ -		$ -		$ -		$ -		$ -
	$ -		$ -		$ -		$ -		$ -
	$ -		$ -		$ -		$ -		$ -
	$ -		$ -		$ -		$ -		$ -
	$ -		$ -		$ -		$ -		$ -
	$ 153,865		$ 135,273		$ 224,785		$ 42,232		$ 137,433
	$ -		$ -		$ -		$ -		$ -
	$ -		$ -	1	$ 4,762	1	$ 4,762		$ -
8	$ 28,908		$ -	16	$ 57,816	1	$ 3,614	1	$ 3,614
	$ -		$ -		$ -		$ -		$ -
8	$ 7,667		$ -		$ -		$ -	7	$ 6,709
	$ -		$ -		$ -		$ -		$ -
	$ -	584	$ 8,410		$ -		$ -		$ -
	$ -		$ -		$ -		$ -		$ -
	$ -		$ -		$ -		$ -		$ -
	$ -		$ -		$ -		$ -		$ -
	$ -		$ -		$ -	6000	$ 28,200	36000	$ 169,200
	$ -		$ -		$ -		$ -		$ -
15000	$ 124,500	10315	$ 85,615	12000	$ 99,600		$ -		$ -
	$ -		$ -		$ -		$ -		$ -
	$ -		$ -		$ -		$ -		$ -
	$ -		$ -		$ -		$ -		$ -
	$ -		$ -		$ -		$ -		$ -
	$ -		$ -		$ -		$ -		$ -
	$ -		$ -		$ -		$ -		$ -
	$ -		$ -		$ -		$ -		$ -
	$ -	51000	$ 2,244,000		$ -		$ -		$ -
	$ -		$ -		$ -		$ -	2000	$ 50,000
	$ 161,075		$ 2,338,024		$ 162,178		$ 36,576		$ 229,522
	$ -		$ -		$ -		$ -	0	$ -
	$ -		$ -		$ -	6.3	$ 1,364	18.3	$ 3,962
	$ -		$ -		$ -		$ -		$ -
	$ -		$ -		$ -		$ -		$ -
	$ -		$ -		$ -		$ -		$ -
	$ -	1	$ 828	1	$ 828		$ -		$ -
	$ -		$ -		$ -		$ -	2	$ 947
16.6	$ 25,559	21.1	$ 32,488	20.7	$ 31,872		$ -		$ -
16.6	$ 51,120	21.1	$ 64,977	20.7	$ 63,746	0	$ -		$ -
	$ -		$ -		$ -	6.3	$ 9,700	18.3	$ 28,177
	$ 76,679		$ 98,293		$ 96,446		$ 11,064		$ 33,085
	$ -		$ -		$ -		$ -		$ -
	$ -		$ -		$ -		$ -		$ -
	$ -		$ -		$ -		$ -		$ -

Segment W40		Segment W41		Segment W42		Segment W43	
Glenwood Springs to Mid-Valley (Basalt)		Glenwood Springs to Grand Junction		Wolcott to Bond via RT131		Dotsero to Bond via DRGW Existing Rail	
16.0 miles		88.4 miles		14.2 miles		38.1 miles	
Quantity	Amount	Quantity	Amount	Quantity	Amount	Quantity	Amount
0.4	$ 470	15.9	$ 18,681	11.7	$ 13,746	7.9	$ 9,282
	$ -		$ -		$ -		$ -
5	$ 8,827	36.1	$ 63,727	0.6	$ 1,059	9.3	$ 16,417
	$ -		$ -		$ -		$ -
10.6	$ 177,140	36.4	$ 608,291	1.9	$ 31,751	19	$ 317,515
	$ -	0	$ -		$ -		$ -
	$ -		$ -		$ -		$ -
	$ -		$ -		$ -		$ -
	$ -	16	$ 17,266		$ -	5	$ 5,396
	$ -	20.1	$ 32,725		$ -	5	$ 8,141
	$ -		$ -		$ -		$ -
	$ -		$ -		$ -		$ -
	$ -		$ -		$ -		$ -
14	$ 2,534	40	$ 7,240	0.6	$ 109		$ -
	$ -		$ -		$ -		$ -
2	$ 932		$ -		$ -		$ -
16	$ 1,250	88.4	$ 6,904	14.2	$ 1,109		$ -
	$ -		$ -		$ -		$ -
	$ -		$ -		$ -		$ -
16	$ 2,064	88.4	$ 11,404	14.2	$ 1,832		$ -
	$ -		$ -		$ -		$ -
2	$ 1,065		$ -		$ -		$ -
	$ -		$ -		$ -		$ -
	$ -		$ -		$ -		$ -
	$ -	4	$ 1,178	1	$ 295	4	$ 1,178
	$ -		$ -		$ -		$ -
	$ -		$ -		$ -		$ -
	$ -	2	$ 1,180		$ -		$ -
	$ -		$ -		$ -		$ -
	$ -		$ -		$ -		$ -
	$ -		$ -		$ -		$ -
	$ -		$ -		$ -		$ -
	$ 194,281		$ 768,596		$ 49,901		$ 357,928
	$ -		$ -		$ -		$ -
4	$ 19,050		$ -		$ -	1	$ 4,762
16	$ 57,816	6	$ 21,681		$ -	4	$ 14,454
	$ -		$ -		$ -		$ -
	$ -	10	$ 9,584		$ -	12	$ 11,501
1	$ 9,582	1	$ 9,582		$ -	1	$ 9,582
	$ -		$ -	30000	$ 432,000		$ -
	$ -		$ -		$ -		$ -
	$ -		$ -		$ -		$ -
	$ -		$ -		$ -		$ -
	$ -		$ -	26000	$ 122,200	39000	$ 183,300
	$ -		$ -		$ -		$ -
	$ -	80000	$ 664,000	0	$ -		$ -
	$ -		$ -		$ -		$ -
	$ -		$ -		$ -		$ -
	$ -		$ -		$ -		$ -
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	$ -		$ -	6000	$ 264,000	0	$ -
	$ -	2000	$ 50,000	0	$ -	1000	$ 25,000
	$ 86,447		$ 754,847		$ 818,200		$ 248,599
	$ -		$ -		$ -		$ -
	$ -	88.4	$ 19,139	14.2	$ 3,074	38.1	$ 8,249
	$ -		$ -		$ -		$ -
	$ -		$ -		$ -		$ -
	$ -		$ -		$ -		$ -
	$ -	2	$ 1,656	1	$ 828		$ -
2	$ 947	4	$ 1,893	2	$ 947	4	$ 1,893
16	$ 24,635		$ -		$ -		$ -
16	$ 49,272		$ -		$ -		$ -
	$ -	88.4	$ 136,109	14.2	$ 21,864	38.1	$ 58,663
	$ 74,854		$ 158,798		$ 26,713		$ 68,804
	$ -	15	$ 1,473		$ -	6	$ 589
	$ -		$ -		$ -		$ -
	$ -	47	$ 16,018		$ -	8	$ 2,726

Segment W44		Segment W45		Segment W46	
Bond to Steamboat Springs		Steamboat Springs to Hayden Airport		Hayden Airport to Craig	
62.1 miles		24.3 miles		16.8 miles	
Quantity	Amount	Quantity	Amount	Quantity	Amount
6.3	$ 7,402	2.6	$ 3,055	1.7	$ 1,997
	$ -		$ -		$ -
36.6	$ 64,610	14.8	$ 26,126	9.8	$ 17,300
	$ -	0	$ -		$ -
19.2	$ 320,857	7	$ 116,979	5.3	$ 88,570
	$ -		$ -		$ -
	$ -		$ -		$ -
	$ -		$ -		$ -
20	$ 21,582	5	$ 5,396	5	$ 5,396
15	$ 24,422	7	$ 11,397	5	$ 8,141
	$ -		$ -		$ -
	$ -		$ -		$ -
	$ -		$ -		$ -
62.1	$ 11,240	22	$ 3,982	15	$ 2,715
	$ -		$ -		$ -
	$ -	2.3	$ 1,072	1.8	$ 839
62.1	$ 4,850	24.3	$ 1,898	16.8	$ 1,312
	$ -		$ -		$ -
50	$ 19,345		$ -		$ -
12.1	$ 1,561	24.3	$ 3,135	16.8	$ 2,167
0	$ -		$ -		$ -
4	$ 2,130	4	$ 2,130	2	$ 1,065
	$ -		$ -		$ -
	$ -		$ -		$ -
10	$ 2,946	6	$ 1,768	4	$ 1,178
	$ -		$ -		$ -
	$ -		$ -		$ -
2	$ 1,180	1	$ 590	1	$ 590
	$ -		$ -		$ -
	$ -		$ -		$ -
	$ -		$ -		$ -
	$ -		$ -		$ -
	$ 482,124		$ 177,526		$ 131,270
	$ -		$ -		$ -
	$ -		$ -		$ -
5	$ 18,068	0	$ -	1	$ 3,614
	$ -		$ -		$ -
10	$ 9,584	5	$ 4,792	3	$ 2,875
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	$ -		$ -		$ -
32000	$ 150,400	13000	$ 61,100	8800	$ 41,360
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	$ -		$ -		$ -
2500	$ 110,000		$ -		$ -
5500	$ 137,500		$ -		$ -
	$ 425,552		$ 65,892		$ 47,849
	$ -		$ -		$ -
62.1	$ 13,445	24.3	$ 5,261	16.8	$ 3,637
	$ -		$ -		$ -
	$ -		$ -		$ -
	$ -		$ -		$ -
2	$ 1,656	1	$ 828	1	$ 828
14	$ 6,626	6	$ 2,840	6	$ 2,840
	$ -		$ -		$ -
	$ -		$ -		$ -
62.1	$ 95,615	24.3	$ 37,415	16.8	$ 25,867
	$ 117,343		$ 46,344		$ 33,172
10	$ 982	10	$ 982	6	$ 589
	$ -		$ -		$ -
56	$ 19,085	42	$ 14,314	28	$ 9,542

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	$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ 25,833		$ -		$ 4,736		$ 30,007		$ 22,751		$ 15,102
	$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -	0	$ -		$ -		$ -	1	$ 5,000	1	$ 5,000	1	$ 5,000
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	$ 1,087,090		$ 547,695		$ 165,257		$ 143,049		$ 298,770		$ 401,618		$ 2,571,590		$ 483,409		$ 89,872		$ 404,041		$ 355,582		$ 1,712,073		$ 894,814		$ 680,067		$ 1,060,025		$ 317,513		$ 232,392
	$ 326,127		$ 164,309		$ 49,577		$ 42,915		$ 89,631		$ 120,486		$ 771,477		$ 145,023		$ 26,962		$ 121,212		$ 106,675		$ 513,622		$ 268,444		$ 204,020		$ 318,007		$ 95,254		$ 69,718
	$ 1,413,217		$ 712,004		$ 214,834		$ 185,963		$ 388,401		$ 522,104		$ 3,343,067		$ 628,432		$ 116,833		$ 525,253		$ 462,257		$ 2,225,695		$ 1,163,258		$ 884,087		$ 1,378,032		$ 412,767		$ 302,110
	$ 395,701		$ 199,361		$ 60,154		$ 52,070		$ 108,752		$ 146,189		$ 936,059		$ 175,961		$ 32,713		$ 147,071		$ 129,432		$ 623,195		$ 325,712		$ 247,544		$ 385,849		$ 115,575		$ 84,591
	$ 1,808,918		$ 911,365		$ 274,988		$ 238,033		$ 497,154		$ 668,293		$ 4,279,126		$ 804,393		$ 149,547		$ 672,323		$ 591,689		$ 2,848,890		$ 1,488,970		$ 1,131,631		$ 1,763,881		$ 528,341		$ 386,701

E.3 I-25 Rail

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RMRA: I-25 North Capital Cost Summary 110 mph	Segment N1	Segment N2	Segment N3	Segment N4	Segment N5	Segment N6	Segment N7
From - To	Denver to 96 St via Brush Line	96th St to DIA greenfield	96th St to E470/US85	E470/US85 to Milliken Jct via Greeley Line	Milliken Junction to North Front Range via Milliken Line	North Front Range to Fort Collins via Milliken Line	Milliken Junction to Greeley via Greeley Line
Host Carrier	BNSF	N/A	BNSF	UP/Greenfield (GF)	UP/GF	UP	UP
Mileposts	MP 542.5-MP 531.3	MP 0 to MP 9	MP 531.3	MP 15.0- MP 36.5	GF 0 - MKN 18.9	Mkn 18.9 - Mkn 33	Gre 36.5-Gre 51.9
Track Miles	11.2 miles	9.0 miles	8.7 miles	21.5 miles	17.1 miles	13.2 miles	15.4 miles
Maximum Authorized Speed	110 mph	110 mph	110 mph	110 mph	110 mph	110 mph	110 mph
Costs in $1,000							
Trackwork	$ 24,931	$ 37,058	$ 28,873	$ 44,619	$ 50,618	$ 28,683	$ 47,989
Structures	$ 14,273	$ 21,208	$ 41,641	$ 8,626	$ 36,249	$ 11,061	$ 40,026
Systems	$ 23,408	$ 35,881	$ 26,903	$ 41,435	$ 51,238	$ 25,439	$ 47,962
Crossings	$ 2,171	$ 4,665	$ 1,135	$ 20,186	$ 15,200	$ 5,898	$ 12,537
Stations/Maintenance Facilities	$ -	$ 15,000	$ 10,000	$ -	$ 5,000	$ 10,000	$ 5,000
Allocation for Special Elements	$ 150,000	$ -	$ -	$ 8,000	$ 4,000	$ -	$ -
Total of Construction Elements	$ 214,783	$ 113,812	$ 108,551	$ 122,866	$ 162,305	$ 81,081	$ 153,514
Contingency	$ 64,435	$ 34,144	$ 32,565	$ 36,860	$ 48,691	$ 24,324	$ 46,054
Other Costs	$ 78,181	$ 41,428	$ 39,513	$ 44,723	$ 59,079	$ 29,513	$ 55,879
Total Segment Costs	$ 357,399	$ 189,383	$ 180,629	$ 204,449	$ 270,075	$ 134,918	$ 255,447
Cost Per Mile	$ 31,911	$ 21,043	$ 20,762	$ 9,509	$ 15,794	$ 10,221	$ 16,587

Segment N8 Greeley to Fort Collins via GWRCO GWR GWR 98.7-GWR 74.6 24.1 miles 110 mph	Segment N9 Fort Collins to North Fort Collins via BNSF BNSF FR 74.6-FR 80.5 5.9 miles 110 mph	Segment N10 North Fort Collins to StateLine via BNSF BNSF FR 80.5-FR 106.8 27.1 miles 110 mph	Segment N11 E470/US85 to North Front Range via I25 GF GF 18 - GF59 41.0 miles 110 mph	Segment N12 North Front Range to North Fort Collins via I25 GF GF 59 - GF72 13.0 miles 110 mph	Segment N13 North Fort Collins to StateLine via I25 GF GF 72 - GF98 26.0 miles 110 mph	Segment N14 StateLine to Cheyenne Union via BNSF BNSF FR106.8- UD 12.6 miles 110 mph
$ 66,302	$ 3,420	$ 40,710	$ 268,198	$ 111,864	$ 218,432	$ 10,531
$ 60,204	$ -	$ 4,792	$ 207,047	$ 39,591	$ 88,432	$ 958
$ 64,729	$ 11,370	$ 74,181	$ 190,215	$ 60,878	$ 120,927	$ 20,347
$ 28,845	$ 5,379	$ 8,811	$ -	$ -	$ -	$ 2,592
$ 10,000	$ -	$ -	$ 10,000	$ 10,000	$ -	$ 16,000
$ -	$ 10,000	$ -	$ -	$ -	$ -	$ 100,000
$ 230,079	$ 30,169	$ 128,495	$ 675,460	$ 222,333	$ 427,791	$ 150,427
$ 69,024	$ 9,051	$ 38,548	$ 202,638	$ 66,700	$ 128,337	$ 45,128
$ 83,749	$ 10,982	$ 46,772	$ 245,868	$ 80,929	$ 155,716	$ 54,756
$ 382,852	$ 50,202	$ 213,815	$ 1,123,966	$ 369,962	$ 711,845	$ 250,311
$ 15,886	$ 8,523	$ 7,890	$ 27,414	$ 28,459	$ 27,431	$ 19,866

RMRA: I-25 South Capital Cost Summary 110 mph							
Segment No.	Segment S1	Segment S2	Segment S3	Segment S4	Segment S5	Segment S6	Segment S7
From - To	Denver to Suburban South via Joint Line	Suburban South to Castle Rock via Joint Line	Suburban South to Castle Rock via Greenfield	Castle Rock to Palmer Lake via Joint Line	Palmer Lake to Colorado Springs via restored ATSF and I25 segment	Palmer Lake to Colorado Springs via double track DRGW	Castle Rock to Colorado Springs via Greenfield (no Diversion)
Host Carrier	BNSF/UP	BNSF/UP	GF	BNSF/UP	BNSF/UP	BNSF/UP	BNSF/UP/GF
Mileposts	JL 14-JL 0	JL 32.8-JL 14	GF 190.2-GF212	JL 51.2-JL 32.8	JL 73-ATSF 686.3	JL 72.8 - JL52	JL 72.8-GF 190.2
Track Miles	14.0 miles	18.8 miles	21.8 miles	18.4 miles	21.6 miles	20.8 miles	27.8 miles
Maximum Authorized Speed							
Costs in $1,000							
Trackwork	$ 5,609	$ 33,556	$ 152,837	$ 15,688	$ -	$ 215,333	$ 292,663
Structures	$ -	$ 34,065	$ 412,435	$ 12,980	$ -	$ 76,740	$ 117,008
Systems	$ 23,950	$ 43,695	$ 95,522	$ 41,337	$ -	$ 41,979	$ 129,242
Crossings	$ 4,665	$ 8,658	$ -	$ 5,898	$ -	$ 3,208	$ -
Stations/Maintenance Facilities	$ 25,000	$ 105,000	$ 25,000	$ -	$ -	$ 10,000	$ 10,000
Allocation for Special Elements	$ -	$ 6,000	$ 27,000	$ 6,000	$ -	$ 6,000	$ -
Total of Construction Elements	$ 59,223	$ 230,974	$ 712,793	$ 81,903	$ -	$ 353,261	$ 548,913
Contingency	$ 17,767	$ 69,292	$ 213,838	$ 24,571	$ -	$ 105,978	$ 164,674
Other Costs	$ 21,557	$ 84,074	$ 259,457	$ 29,813	$ -	$ 128,587	$ 199,804
Total Segment Costs	$ 98,547	$ 384,340	$ 1,186,088	$ 136,286	$ -	$ 587,826	$ 913,392
Cost Per Mile	$ 7,039	$ 20,476	$ 54,483	$ 7,423	$ -	$ 28,274	$ 32,891

Segment S8 Greenfield Monument Diversion - Placeholder, net of 15.03 Straight Line miles GF GF 144.4-GF 171.7 27.8 miles	Segment S9 Colorado Springs to Fountain BNSF/UP JL 84.5-JL 73 11.5 miles	Segment S10 Fountain to Pueblo via Joint Line BNSF/UP ATSF618.4-JL 84.5 36.4 miles	Segment S11 Fountain to Pueblo via Greenfield BNSF/UP/GF GF 80- JL 84.4 48.1 miles	Segment S12 Pueblo to North Trinidad via Spanish Peaks Sub BNSF ATSF 618.4-SP204 84.0 miles	Segment S13 Pueblo to North Trinidad via Greenfield GF GF 0-GF 80 80.0 miles	Segment S14 North Trinidad to downtown Trinidad BNSF Transcon- SP 204 8.2 miles
$ -	$ 9,195	$ 32,491	$ 479,709	$ 125,128	$ 835,792	$ 4,806
$ -	$ 11,063	$ 19,168	$ 200,000	$ 26,835	$ 336,000	$ -
$ -	$ 25,599	$ 83,317	$ 223,012	$ 164,885	$ 371,192	$ 3,178
$ -	$ 5,183	$ 11,375	$ -	$ 15,904	$ -	$ 374
$ -	$ 10,000	$ 15,000	$ 10,000	$ 20,000	$ 10,000	$ 7,500
$ -	$ 6,000	$ 6,000	$ -	$ 6,000	$ -	$ 6,000
$ -	$ 67,041	$ 167,351	$ 912,721	$ 358,752	$ 1,552,985	$ 21,857
$ -	$ 20,112	$ 50,205	$ 273,816	$ 107,626	$ 465,895	$ 6,557
$ -	$ 24,403	$ 60,916	$ 332,230	$ 130,586	$ 565,286	$ 7,956
$ -	$ 111,556	$ 278,473	$ 1,518,768	$ 596,963	$ 2,584,167	$ 36,371
$ -	$ 9,700	$ 7,659	$ 31,601	$ 7,107	$ 32,302	$ 4,457

RMRA: I-25 North Capital Cost Estimate

		Unit	2008 Unit Cost	Segment N1		Segment N2		Segment N3		Segment N4		Segment N5		Segment N6		Segment N7	
			From - To	Denver to 96 St via Brush Line		96th St to DIA greenfield		96th St to E470/US85		E470/US85 to Milliken Jct via Greeley Line		Milliken Junction to North Front Range via Milliken Line		North Front Range to Fort Collins via Milliken Line		Milliken Junction to Greeley via Greeley Line	
			Host Carrier	BNSF		N/A		BNSF		UP/Greenfield (GF)		UP/GF		UP		UP	
			Mileposts	MP 542.5-MP 531.3		MP 0 to MP 9		MP 531.3		MP 15.0- MP 36.5		GF 0 - MKN 18.9		Mkn 18.9 - Mkn 33		Gre 36.5-Gre 51.9	
			Track Miles	11.2 miles		9.0 miles		8.7 miles		21.5 miles		17.1 miles		13.2 miles		15.4 miles	
			Maximum Authorized Speed	110 mph		110 mph		110 mph		110 mph		110 mph		110 mph		110 mph	
		Unit	2008 Unit Cost	Quantity	Amount	Quantity	Amount	Quantity	Amount	Quantity	Amount	Quantity	Amount	Quantity	Amount	Quantity	Amount
Trackwork																	
1.1	HSR on Existing Roadbed	per mile	$ 1,175		$ -		$ -	1.5	$ 1,762		$ -	1	$ 1,175		$ -	1	$ 1,175
1.2	HSR on Existing Roadbed (Double Track)	per mile	$ 2,350		$ -	0.5	$ 1,175		$ -		$ -		$ -		$ -		$ -
1.3	HSR on New Roadbed & New Embankment	per mile	$ 1,765		$ -		$ -	2.5	$ 4,413	21.5	$ 37,954	6.1	$ 10,768	13.2	$ 23,302	4.4	$ 7,767
1.4	HSR on New Roadbed & New Embankment (Double Track)	per mile	$ 3,164	6	$ 18,983	8.5	$ 26,893	4.7	$ 14,870		$ -	10	$ 31,639		$ -	10	$ 31,639
1.5	HSR Double Track on 15' Retained Earth Fill	per mile	$ 16,711		$ -		$ -		$ -		$ -		$ -		$ -		$ -
1.6	Timber & Surface w/ 33% Tie replacement	per mile	$ 263		$ -		$ -		$ -		$ -		$ -		$ -		$ -
1.7	Timber & Surface w/ 66% Tie Replacement	per mile	$ 392		$ -		$ -		$ -		$ -		$ -		$ -		$ -
1.8	Relay Track w/ 136# CWR	per mile	$ 419		$ -		$ -		$ -		$ -		$ -		$ -		$ -
1.9	Freight Siding	per mile	$ 1,079		$ -		$ -		$ -		$ -		$ -		$ -		$ -
1.10	Passenger Siding	per mile	$ 1,628		$ -		$ -		$ -		$ -		$ -		$ -		$ -
1.11	NCHRP Class 6 Barrier (on curves)	lineal ft	$ 1		$ -		$ -		$ -		$ -		$ -		$ -		$ -
1.12	NCHRP Class 5 Barrier (on tangent)	lineal ft	$ 0		$ -		$ -		$ -		$ -		$ -		$ -		$ -
1.13	Fencing, 4 ft Woven Wire (both sides)	per mile	$ 60		$ -		$ -		$ -		$ -		$ -		$ -		$ -
1.14	Fencing, 6 ft Chain Link (both sides)	per mile	$ 181		$ -	18	$ 3,258	17.4	$ 3,149	21.5	$ 3,892	17.1	$ 3,095	13.2	$ 2,389	15.4	$ 2,787
1.15	Fencing, 10 ft Chain Link (both sides)	per mile	$ 207	12	$ 2,485		$ -		$ -		$ -		$ -		$ -		$ -
1.16	Decorative Fencing (both sides)	per mile	$ 466		$ -		$ -		$ -		$ -		$ -		$ -		$ -
1.17	Drainage Improvements (cross country)	per mile	$ 78		$ -	9	$ 703	2.5	$ 195		$ -	5	$ 391		$ -		$ -
1.18	Drainage Improvements in Median or along highway	per mile	$ 625		$ -		$ -		$ -		$ -		$ -		$ -		$ -
1.19	Land Acquisition Urban	per mile	$ 387		$ -		$ -		$ -		$ -		$ -	5	$ 1,935	5	$ 1,935
1.20	Land Acquisition Rural	per mile	$ 129	6	$ 774	9	$ 1,161	8.7	$ 1,122	21.5	$ 2,774	17.1	$ 2,206	8.2	$ 1,058	10.4	$ 1,342
1.21	#33 High Speed Turnout	each	$ 672	2	$ 1,344	2	$ 1,344	3	$ 2,016		$ -	2	$ 1,344		$ -	2	$ 1,344
1.22	#24 High Speed Turnout	each	$ 532		$ -		$ -		$ -		$ -		$ -		$ -		$ -
1.23	#20 Turnout Timber	each	$ 147		$ -		$ -		$ -		$ -		$ -		$ -		$ -
1.24	#10 Turnout Timber	each	$ 82		$ -		$ -		$ -		$ -		$ -		$ -		$ -
1.25	#20 Turnout Concrete	each	$ 295		$ -		$ -		$ -		$ -		$ -		$ -		$ -
1.26	#10 Turnout Concrete	each	$ 140		$ -		$ -		$ -		$ -		$ -		$ -		$ -
1.27	#33 Crossover	each	$ 1,344	1	$ 1,344	1	$ 1,344	1	$ 1,344		$ -		$ -		$ -		$ -
1.28	#20 Crossover	each	$ 590		$ -	2	$ 1,180		$ -		$ -		$ -		$ -		$ -
1.29	Elevate & Surface Curves	per mile	$ 69		$ -		$ -		$ -		$ -		$ -		$ -		$ -
1.30	Curvature Reduction	per mile	$ 465		$ -		$ -		$ -		$ -		$ -		$ -		$ -
1.31	Elastic Fasteners	per mile	$ 97		$ -		$ -		$ -		$ -		$ -		$ -		$ -
1.32	Realign Track for Curves (See Table G6 for Costs)	lump sum	$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -
	Sub-total Trackwork (A)				$ 24,931		$ 37,058		$ 28,873		$ 44,619		$ 50,618		$ 28,683		$ 47,989
Structures																	
	Bridges-under																
2.1	Four Lane Urban Expressway	each	$ 5,721	1	$ 5,721		$ -		$ -		$ -		$ -		$ -	2	$ 11,442
2.2	Four Lane Rural Expressway	each	$ 4,762		$ -		$ -	1	$ 4,762		$ -		$ -		$ -		$ -
2.3	Two Lane Highway	each	$ 3,614	1	$ 3,614		$ -		$ -		$ -		$ -	2	$ 7,227		$ -
2.4	Rail	each	$ 3,614		$ -		$ -		$ -		$ -		$ -		$ -		$ -
2.5	Minor river	each	$ 958		$ -	1	$ 958	3	$ 2,875	9	$ 8,626	8	$ 7,667	4	$ 3,834	10	$ 9,584
2.6	Major River	each	$ 9,582		$ -		$ -		$ -		$ -	1	$ 9,582		$ -		$ -
2.7	Double Track High (50') Level Bridge	per LF	$ 14		$ -		$ -		$ -		$ -		$ -		$ -		$ -
2.8	Rehab for 110	per LF	$ 17		$ -		$ -		$ -		$ -		$ -		$ -		$ -
2.9	Convert open deck bridge to ballast deck (single track)	per LF	$ 6		$ -		$ -		$ -		$ -		$ -		$ -		$ -
2.10	Convert open deck bridge to ballast deck (double track)	per LF	$ 11		$ -		$ -		$ -		$ -		$ -		$ -		$ -
2.11	Single Track on Flyover/Elevated Structure	per LF	$ 5		$ -		$ -	1000	$ 5,000		$ -	1000	$ 5,000		$ -	1000	$ 5,000
2.12	Single Track on Approach Embankment w/ Retaining Wall	per LF	$ 4		$ -		$ -	7000	$ 24,500		$ -	4000	$ 14,000		$ -	4000	$ 14,000
2.13	Double Track on Flyover/Elevated Structure	per LF	$ 8		$ -	500	$ 4,000		$ -		$ -		$ -		$ -		$ -
2.14	Double Track on Approach Embankment w/ Retaining Wall	per LF	$ 7		$ -	2500	$ 16,250		$ -		$ -		$ -		$ -		$ -
2.15	Ballasted Concrete Deck Replacement Bridge	per LF	$ 3		$ -		$ -		$ -		$ -		$ -		$ -		$ -
2.16	Land Bridges	per LF	$ 3		$ -		$ -		$ -		$ -		$ -		$ -		$ -
	Bridges-over																
2.17	Four Lane Urban Expressway	each	$ 2,469	2	$ 4,939		$ -		$ -		$ -		$ -		$ -		$ -
2.18	Four Lane Rural Expressway	each	$ 3,466		$ -		$ -		$ -		$ -		$ -		$ -		$ -
2.19	Two Lane Highway	each	$ 2,252		$ -		$ -	2	$ 4,503		$ -		$ -		$ -		$ -
2.20	Rail	each	$ 7,229		$ -		$ -		$ -		$ -		$ -		$ -		$ -
	Tunnels																
2.21	Two Bore Long Tunnel	route ft	$ 44		$ -		$ -		$ -		$ -		$ -		$ -		$ -
2.22	Single Bore Short Tunnel	lineal ft	$ 25		$ -		$ -		$ -		$ -		$ -		$ -		$ -
	Sub-total Structures (B)				$ 14,273		$ 21,208		$ 41,641		$ 8,626		$ 36,249		$ 11,061		$ 40,026
Systems																	
3.1	Signals for Siding w/ High Speed Turnout	each	$ 1,500		$ -		$ -		$ -		$ -	1	$ 1,500		$ -	1	$ 1,500
3.2	Install CTC System (Single Track)	per mile	$ 217		$ -		$ -	4	$ 866	21.5	$ 4,655	7.1	$ 1,537	13.2	$ 2,858	5.4	$ 1,169
3.3	Install CTC System (Double Track)	per mile	$ 355	6	$ 2,130	9	$ 3,195	4.7	$ 1,669		$ -	10	$ 3,550		$ -	10	$ 3,550
3.4	Install PTC System	per mile	$ 171	6	$ 1,026	9	$ 1,539	8.7	$ 1,488	21.5	$ 3,677	17.1	$ 2,924	13.2	$ 2,257	15.4	$ 2,633
3.5	Electric Lock for Industry Turnout	each	$ 122		$ -		$ -		$ -		$ -		$ -		$ -		$ -
3.6	Signals for Crossover	each	$ 828	1	$ 828	3	$ 2,485	1	$ 828		$ -		$ -		$ -		$ -
3.7	Signals for Turnout	each	$ 473	2	$ 947	2	$ 947	3	$ 1,420		$ -		$ -		$ -		$ -
3.8	Signals, Communications & Dispatch	per mile	$ 1,540		$ -		$ -		$ -		$ -		$ -		$ -		$ -
3.9	Electrification (Double Track)	per mile	$ 3,080	6	$ 18,477	9	$ 27,716	4.7	$ 14,474		$ -	10	$ 30,795		$ -	10	$ 30,795
3.10	Electrification (Single Track)	per mile	$ 1,540		$ -		$ -	4	$ 6,159	21.5	$ 33,104	7.1	$ 10,932	13.2	$ 20,324	5.4	$ 8,314
	Sub-total Systems (C)				$ 23,408		$ 35,881		$ 26,903		$ 41,435		$ 51,238		$ 25,439		$ 47,962
Crossings																	
4.1	Private Closure	each	$ 98	1	$ 98		$ -	1	$ 98	5	$ 491	7	$ 687	2	$ 196	1	$ 98
4.2	Four Quadrant Gates w/ Trapped Vehicle Detector	each	$ 582		$ -		$ -		$ -		$ -		$ -		$ -		$ -
4.3	Four Quadrant Gates	each	$ 341	4	$ 1,363	9	$ 3,067	2	$ 682	38	$ 12,950	28	$ 9,542	11	$ 3,749	24	$ 8,179
4.4	Convert Dual Gates to Quad Gates	each	$ 178		$ -		$ -		$ -		$ -		$ -		$ -		$ -
4.5	Conventional Gates single mainline track	each	$ 196		$ -		$ -		$ -		$ -		$ -		$ -		$ -
4.6	Conventional Gates double mainline track	each	$ 243		$ -		$ -		$ -		$ -		$ -		$ -		$ -
4.7	Convert Flashers Only to Dual Gate	each	$ 59		$ -		$ -		$ -		$ -		$ -		$ -		$ -
4.8	Single Gate with Median Barrier	each	$ 213		$ -		$ -		$ -		$ -		$ -		$ -		$ -
4.9	Convert Single Gate to Extended Arm	each	$ 18		$ -		$ -		$ -		$ -		$ -		$ -		$ -
4.10	Precast Panels without Rdway Improvements	each	$ 95		$ -		$ -		$ -		$ -		$ -		$ -		$ -
4.11	Precast Panels with Rdway Improvements	each	$ 178	4	$ 710	9	$ 1,598	2	$ 355	38	$ 6,745	28	$ 4,970	11	$ 1,953	24	$ 4,260
	Sub-total Crossings (D)				$ 2,171		$ 4,665		$ 1,135		$ 20,186		$ 15,200		$ 5,898		$ 12,537
Station/Maintenance Facilities																	

		Segment N8		Segment N9		Segment N10		Segment N11		Segment N12		Segment N13		Segment N14	
	From - To	Greeley to Fort Collins via GWRCO		Fort Collins to North Fort Collins via BNSF		North Fort Collins to StateLine via BNSF		E470/US85 to North Front Range via I25		North Front Range to North Fort Collins via I25		North Fort Collins to StateLine via I25		StateLine to Cheyenne Union via BNSF	
	Host Carrier	GWR		BNSF		BNSF		GF		GF		GF		BNSF	
	Mileposts	GWR 98.7-GWR 74.6		FR 74.6-FR 80.5		FR 80.5-FR 106.8		GF 18 - GF59		GF 59 - GF72		GF 72 - GF98		FR106.8- UD	
	Track Miles	24.1 miles		5.9 miles		27.1 miles		41.0 miles		13.0 miles		26.0 miles		12.6 miles	
	Maximum Authorized Speed	110 mph		110 mph		110 mph		110 mph		110 mph		110 mph		110 mph	
		Quantity	Amount	Quantity	Amount	Quantity	Amount	Quantity	Amount	Quantity	Amount	Quantity	Amount	Quantity	Amount
Trackwork															
1.1	HSR on Existing Roadbed	1	$ 1,175		$ -		$ -		$ -		$ -		$ -		$ -
1.2	HSR on Existing Roadbed (Double Track)		$ -		$ -		$ -	4.1	$ 9,635	0.4	$ 940	1.2	$ 2,820		$ -
1.3	HSR on New Roadbed & New Embankment	13.1	$ 23,125		$ -	10	$ 17,653		$ -		$ -		$ -		$ -
1.4	HSR on New Roadbed & New Embankment (Double Track)	10	$ 31,639		$ -		$ -	29.4	$ 93,019	10	$ 31,639	19.8	$ 62,645		$ -
1.5	HSR Double Track on 15' Retained Earth Fill		$ -		$ -		$ -	4.1	$ 68,516	2.7	$ 45,121	4.9	$ 81,885		$ -
1.6	Timber & Surface w/ 33% Tie replacement		$ -		$ -		$ -		$ -		$ -		$ -		$ -
1.7	Timber & Surface w/ 66% Tie Replacement		$ -	5.9	$ 2,310	27.1	$ 10,612		$ -		$ -		$ -	12.6	$ 4,934
1.8	Relay Track w/ 136# CWR		$ -		$ -		$ -		$ -		$ -		$ -		$ -
1.9	Freight Siding		$ -		$ -	6	$ 6,475		$ -		$ -		$ -	2	$ 2,158
1.10	Passenger Siding		$ -		$ -		$ -		$ -		$ -		$ -		$ -
1.11	NCHRP Class 6 Barrier (on curves)		$ -		$ -		$ -	31080	$ 40,404	11000	$ 14,300	28516	$ 37,071		$ -
1.12	NCHRP Class 5 Barrier (on tangent)		$ -		$ -		$ -	124000	$ 24,800	41640	$ 8,328	64000	$ 12,800		$ -
1.13	Fencing, 4 ft Woven Wire (both sides)		$ -		$ -		$ -		$ -		$ -		$ -		$ -
1.14	Fencing, 6 ft Chain Link (both sides)	24.1	$ 4,362	5.9	$ 1,068	27.1	$ 4,905		$ -		$ -		$ -	12.6	$ 2,281
1.15	Fencing, 10 ft Chain Link (both sides)		$ -		$ -		$ -	23.5	$ 4,867	10	$ 2,071	17.5	$ 3,624		$ -
1.16	Decorative Fencing (both sides)		$ -		$ -		$ -		$ -		$ -		$ -		$ -
1.17	Drainage Improvements (cross country)		$ -		$ -		$ -		$ -		$ -		$ -		$ -
1.18	Drainage Improvements in Median or along highway		$ -		$ -		$ -	41	$ 25,613	13	$ 8,121	26	$ 16,242		$ -
1.19	Land Acquisition Urban	6	$ 2,321		$ -		$ -		$ -		$ -		$ -		$ -
1.20	Land Acquisition Rural	18.1	$ 2,335		$ -		$ -		$ -		$ -		$ -		$ -
1.21	#33 High Speed Turnout	2	$ 1,344		$ -		$ -		$ -		$ -		$ -		$ -
1.22	#24 High Speed Turnout		$ -		$ -		$ -		$ -		$ -		$ -		$ -
1.23	#20 Turnout Timber		$ -		$ -	6	$ 880		$ -		$ -		$ -	2	$ 293
1.24	#10 Turnout Timber		$ -		$ -		$ -		$ -		$ -		$ -		$ -
1.25	#20 Turnout Concrete		$ -		$ -		$ -		$ -		$ -		$ -		$ -
1.26	#10 Turnout Concrete		$ -		$ -		$ -		$ -		$ -		$ -		$ -
1.27	#33 Crossover		$ -		$ -		$ -	1	$ 1,344	1	$ 1,344	1	$ 1,344		$ -
1.28	#20 Crossover		$ -		$ -		$ -		$ -		$ -		$ -		$ -
1.29	Elevate & Surface Curves		$ -	0.6	$ 41	2.7	$ 185		$ -		$ -		$ -	12.6	$ 864
1.30	Curvature Reduction		$ -		$ -		$ -		$ -		$ -		$ -		$ -
1.31	Elastic Fasteners		$ -		$ -		$ -		$ -		$ -		$ -		$ -
1.32	Realign Track for Curves (See Table G6 for Costs)		$ -		$ -		$ -		$ -		$ -		$ -		$ -
	Sub-total Trackwork (A)		$ 66,302		$ 3,420		$ 40,710		$ 268,198		$ 111,864		$ 218,432		$ 10,531
Structures															
	Bridges-under														
2.1	Four Lane Urban Expressway		$ -		$ -		$ -		$ -		$ -		$ -		$ -
2.2	Four Lane Rural Expressway		$ -		$ -		$ -	9	$ 42,862	5	$ 23,812	5	$ 23,812		$ -
2.3	Two Lane Highway		$ -		$ -		$ -		$ -		$ -		$ -		$ -
2.4	Rail		$ -		$ -		$ -		$ -		$ -		$ -		$ -
2.5	Minor river	13	$ 12,459		$ -	5	$ 4,792	5	$ 4,792	2	$ 1,917	5	$ 4,792	1	$ 958
2.6	Major River	3	$ 28,745		$ -		$ -		$ -		$ -		$ -		$ -
2.7	Double Track High (50') Level Bridge		$ -		$ -		$ -	1500	$ 21,600		$ -		$ -		$ -
2.8	Rehab for 110		$ -		$ -		$ -		$ -		$ -		$ -		$ -
2.9	Convert open deck bridge to ballast deck (single track)		$ -		$ -		$ -		$ -		$ -		$ -		$ -
2.10	Convert open deck bridge to ballast deck (double track)		$ -		$ -		$ -		$ -		$ -		$ -		$ -
2.11	Single Track on Flyover/Elevated Structure	1000	$ 5,000		$ -		$ -		$ -		$ -	500	$ 2,500		$ -
2.12	Single Track on Approach Embankment w/ Retaining Wall	4000	$ 14,000		$ -		$ -		$ -		$ -		$ -		$ -
2.13	Double Track on Flyover/Elevated Structure		$ -		$ -		$ -		$ -		$ -	5000	$ 40,000		$ -
2.14	Double Track on Approach Embankment w/ Retaining Wall		$ -		$ -		$ -	18000	$ 117,000		$ -		$ -		$ -
2.15	Ballasted Concrete Deck Replacement Bridge		$ -		$ -		$ -		$ -		$ -		$ -		$ -
2.16	Land Bridges		$ -		$ -		$ -		$ -		$ -		$ -		$ -
	Bridges-over														
2.17	Four Lane Urban Expressway		$ -		$ -		$ -		$ -		$ -		$ -		$ -
2.18	Four Lane Rural Expressway		$ -		$ -		$ -	6	$ 20,794	4	$ 13,862	5	$ 17,328		$ -
2.19	Two Lane Highway		$ -		$ -		$ -		$ -		$ -		$ -		$ -
2.20	Rail		$ -		$ -		$ -		$ -		$ -		$ -		$ -
	Tunnels														
2.21	Two Bore Long Tunnel		$ -		$ -		$ -		$ -		$ -		$ -		$ -
2.22	Single Bore Short Tunnel		$ -		$ -		$ -		$ -		$ -		$ -		$ -
	Sub-total Structures (B)		$ 60,204		$ -		$ 4,792		$ 207,047		$ 39,591		$ 88,432		$ 958
Systems															
3.1	Signals for Siding w/ High Speed Turnout	1	$ 1,500		$ -	1	$ 1,500		$ -		$ -		$ -		$ -
3.2	Install CTC System (Single Track)	14.1	$ 3,053	5.9	$ 1,277	11.1	$ 2,403		$ -		$ -		$ -		$ -
3.3	Install CTC System (Double Track)	10	$ 3,550		$ -	16	$ 5,680		$ -		$ -		$ -		$ -
3.4	Install PTC System	24.1	$ 4,121	5.9	$ 1,009	27.1	$ 4,634		$ -		$ -		$ -		$ -
3.5	Electric Lock for Industry Turnout		$ -		$ -		$ -		$ -		$ -		$ -		$ -
3.6	Signals for Crossover		$ -		$ -		$ -	1	$ 828	1	$ 828	1	$ 828		$ -
3.7	Signals for Turnout		$ -		$ -	6	$ 2,840		$ -		$ -		$ -	2	$ 947
3.8	Signals, Communications & Dispatch		$ -		$ -		$ -	41	$ 63,128	13	$ 20,016	26	$ 40,032		$ -
3.9	Electrification (Double Track)	10	$ 30,795		$ -	10	$ 30,795	41	$ 126,260	13	$ 40,034	26	$ 80,067		$ -
3.10	Electrification (Single Track)	14.1	$ 21,710	5.9	$ 9,084	17.1	$ 26,329		$ -		$ -		$ -	12.6	$ 19,400
	Sub-total Systems (C)		$ 64,729		$ 11,370		$ 74,181		$ 190,215		$ 60,878		$ 120,927		$ 20,347
Crossings															
4.1	Private Closure	14	$ 1,375	2	$ 196		$ -		$ -		$ -		$ -		$ -
4.2	Four Quadrant Gates w/ Trapped Vehicle Detector		$ -		$ -		$ -		$ -		$ -		$ -		$ -
4.3	Four Quadrant Gates	53	$ 18,062	10	$ 3,408	17	$ 5,794		$ -		$ -		$ -	5	$ 1,704
4.4	Convert Dual Gates to Quad Gates		$ -		$ -		$ -		$ -		$ -		$ -		$ -
4.5	Conventional Gates single mainline track		$ -		$ -		$ -		$ -		$ -		$ -		$ -
4.6	Conventional Gates double mainline track		$ -		$ -		$ -		$ -		$ -		$ -		$ -
4.7	Convert Flashers Only to Dual Gate		$ -		$ -		$ -		$ -		$ -		$ -		$ -
4.8	Single Gate with Median Barrier		$ -		$ -		$ -		$ -		$ -		$ -		$ -
4.9	Convert Single Gate to Extended Arm		$ -		$ -		$ -		$ -		$ -		$ -		$ -
4.10	Precast Panels without Rdway Improvements		$ -		$ -		$ -		$ -		$ -		$ -		$ -
4.11	Precast Panels with Rdway Improvements	53	$ 9,408	10	$ 1,775	17	$ 3,018		$ -		$ -		$ -	5	$ 888
	Sub-total Crossings (D)		$ 28,845		$ 5,379		$ 8,811		$ -		$ -		$ -		$ 2,592
Station/Maintenance Facilities															

5.1	Full Service - New - Low Volume - 500 Surface Park	each	$ 5,000		$ -		$ -		$ -		$ -	1	$ 5,000		$ -	1	$ 5,000
5.2	Full Service - Renovated - Low Volume- 500 Surface Park	each	$ 4,000		$ -		$ -		$ -		$ -		$ -		$ -		$ -
5.3	Terminal - New - Low Volume - 500 Surface Park	each	$ 7,500		$ -		$ -		$ -		$ -		$ -		$ -		$ -
5.4	Terminal - Renovated - Low Volume - 500 Surface Park	each	$ 6,000		$ -		$ -		$ -		$ -		$ -		$ -		$ -
5.5	Full Service - New- High Volume - Dual Platform - 1000 Surface Park	each	$ 10,000		$ -		$ -	1	$ 10,000		$ -		$ -	1	$ 10,000		$ -
5.6	Terminal - New- High Volume - Dual Platform - 1000 Surface Park	each	$ 15,000		$ -	1	$ 15,000		$ -		$ -		$ -		$ -		$ -
5.7	Maintenance Facility (non-electrified track)	each	$ 80,000		$ -		$ -		$ -		$ -		$ -		$ -		$ -
5.8	Maintenance Facility (electrified track)	each	$ 100,000		$ -		$ -		$ -		$ -		$ -		$ -		$ -
5.9	Layover Facility	lump sum	$ 10,000		$ -		$ -		$ -		$ -		$ -		$ -		$ -
	Sub-total Station/Maintenance Facilities (E)				$ -		$ 15,000		$ 10,000		$ -		$ 5,000		$ 10,000		$ 5,000
Allocations for Special Elements																	
	North Denver Infrastructure Improvements	lump sum	$ 150,000	1	$ 150,000		$ -		$ -		$ -		$ -		$ -		$ -
	Business Relocations	lump sum	$ 4,000		$ -		$ -		$ -	2	$ 8,000	1	$ 4,000		$ -		$ -
	Freight facility reconstruction at North Yard	lump sum	$ 10,000		$ -		$ -		$ -		$ -		$ -		$ -		$ -
	Cheyenne Infrastructure Improvements	lump sum	$ 100,000		$ -		$ -		$ -		$ -		$ -		$ -		$ -
		lump sum			$ -		$ -		$ -		$ -		$ -		$ -		$ -
	Sub-Total Allocations for Special Elements (F)				$ 150,000		$ -		$ -		$ 8,000		$ 4,000		$ -		$ -
	Sub-total Construction Elements (A+B+C+D+E+F)				$ 214,783		$ 113,812		$ 108,551		$ 122,866		$ 162,305		$ 81,081		$ 153,514
Contingency																	
	Design and Construction Contingency		30%		$ 64,435		$ 34,144		$ 32,565		$ 36,860		$ 48,691		$ 24,324		$ 46,054
	Sub-total Construction Elements Including Contingency (G)				$ 279,218		$ 147,956		$ 141,117		$ 159,725		$ 210,996		$ 105,405		$ 199,568
Professional Services and Environmental																	
	Design Engineering	10%															
	Insurance and Bonding	2%															
	Program Management	4%															
	Construction Management & Inspection	6%															
	Engineering Services During Construction	2%															
	Integrated Testing and Commissioning	2%															
	Erosion Control and Water Quality Management	2%															
	Sub-total Professional Services and Environmental (H)		28%		$ 78,181		$ 41,428		$ 39,513		$ 44,723		$ 59,079		$ 29,513		$ 55,879
	Total Segment Cost (G)+(H)				$ 357,399		$ 189,383		$ 180,629		$ 204,449		$ 270,075		$ 134,918		$ 255,447

5.1	Full Service - New - Low Volume - 500 Surface Park		$ -		$ -		$ -		$ -		$ -		$ -		$ -
5.2	Full Service - Renovated - Low Volume- 500 Surface Park		$ -		$ -		$ -		$ -		$ -		$ -		$ -
5.3	Terminal - New - Low Volume - 500 Surface Park		$ -		$ -		$ -		$ -		$ -		$ -		$ -
5.4	Terminal - Renovated - Low Volume - 500 Surface Park		$ -		$ -		$ -		$ -		$ -		$ -	1	$ 6,000
5.5	Full Service - New- High Volume - Dual Platform - 1000 Surface Park	1	$ 10,000		$ -		$ -	1	$ 10,000	1	$ 10,000		$ -		$ -
5.6	Terminal - New- High Volume - Dual Platform - 1000 Surface Park		$ -		$ -		$ -		$ -		$ -		$ -		$ -
5.7	Maintenance Facility (non-electrified track)		$ -		$ -		$ -		$ -		$ -		$ -		$ -
5.8	Maintenance Facility (electrified track)		$ -		$ -		$ -		$ -		$ -		$ -		$ -
5.9	Layover Facility		$ -		$ -		$ -		$ -		$ -		$ -	1	$ 10,000
	Sub-total Station/Maintenance Facilities (E)		$ 10,000		$ -		$ -		$ 10,000		$ 10,000		$ -		$ 16,000
Allocations for Special Elements															
	North Denver Infrastructure Improvements		$ -		$ -		$ -		$ -		$ -		$ -		$ -
	Business Relocations		$ -		$ -		$ -		$ -		$ -		$ -		$ -
	Freight facility reconstruction at North Yard		$ -	1	$ 10,000		$ -		$ -		$ -		$ -		$ -
	Cheyenne Infrastructure Improvements		$ -		$ -		$ -		$ -		$ -		$ -	1	$ 100,000
			$ -		$ -		$ -		$ -		$ -		$ -		$ -
	Sub-Total Allocations for Special Elements (F)		$ -		$ 10,000		$ -		$ -		$ -		$ -		$ 100,000
	Sub-total Construction Elements (A+B+C+D+E+F)		$ 230,079		$ 30,169		$ 128,495		$ 675,460		$ 222,333		$ 427,791		$ 150,427
Contingency															
	Design and Construction Contingency		$ 69,024		$ 9,051		$ 38,548		$ 202,638		$ 66,700		$ 128,337		$ 45,128
	Sub-total Construction Elements Including Contingency (G)		$ 299,103		$ 39,220		$ 167,043		$ 878,098		$ 289,033		$ 556,129		$ 195,556
Professional Services and Environmental															
	Design Engineering														
	Insurance and Bonding														
	Program Management														
	Construction Management & Inspection														
	Engineering Services During Construction														
	Integrated Testing and Commissioning														
	Erosion Control and Water Quality Management														
	Sub-total Professional Services and Environmental (H)		$ 83,749		$ 10,982		$ 46,772		$ 245,868		$ 80,929		$ 155,716		$ 54,756
	Total Segment Cost (G)+(H)		$ 382,852		$ 50,202		$ 213,815		$ 1,123,966		$ 369,962		$ 711,845		$ 250,311

	RMRA: I-25 South Capital Cost Estimate		Segment No.	Segment S1		Segment S2		Segment S3		Segment S4		Segment S5		Segment S6		Segment S7		Segment S8		Segment S9		Segment S10		Segment S11		Segment S12		Segment S13		Segment S14	
			From - To	Denver to Suburban South via Joint Line		Suburban South to Castle Rock via Joint Line		Suburban South to Castle Rock via Greenfield		Castle Rock to Palmer Lake via Joint Line		Palmer Lake to Colorado Springs via restored ATSF and I25 segment		Palmer Lake to Colorado Springs via double track DRGW		Castle Rock to Colorado Springs via Greenfield (no Diversion)		Greenfield Monument Diversion - Placeholder, net of 15.03 Straight Line miles		Colorado Springs to Fountain		Fountain to Pueblo via Joint Line		Fountain to Pueblo via Greenfield		Pueblo to North Trinidad via Spanish Peaks Sub		Pueblo to North Trinidad via Greenfield		North Trinidad to downtown Trinidad	
			Host Carrier	BNSF/UP		BNSF/UP		GF		BNSF/UP		BNSF/UP		BNSF/UP		BNSF/UP/GF		GF		BNSF/UP		BNSF/UP		BNSF/UP/GF		BNSF		GF		BNSF	
			Mileposts	JL 14-JL 0		JL 32.8-JL 14		GF 190.2-GF212		JL 51.2-JL 32.8		JL 73-ATSF 686.3		JL 72.8 - JL52		JL 72.8-GF 190.2		GF 144.4-GF 171.7		JL 84.5-JL 73		ATSF618.4-JL 84.5		GF 80- JL 84.4		ATSF 618.4-SP204		GF 0-GF 80		Transcon- SP 204	
			Track Miles	14.0 miles		18.8 miles		21.8 miles		18.4 miles		21.6 miles		20.8 miles		27.8 miles		27.8 miles		11.5 miles		36.4 miles		48.1 miles		84.0 miles		80.0 miles		8.2 miles	
			Maximum Authorized Speed																												
		Unit	2008 Unit Cost	Quantity	Amount	Quantity	Amount	Quantity	Amount	Quantity	Amount	Quantity	Amount	Quantity	Amount	Quantity	Amount	Quantity	Amount	Quantity	Amount	Quantity	Amount	Quantity	Amount	Quantity	Amount	Quantity	Amount	Quantity	Amount
Trackwork																															
1.1	HSR on Existing Roadbed	per mile	$ 1,175		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -	52	$ 61,095		$ -		$ -
1.2	HSR on Existing Roadbed (Double Track)	per mile	$ 2,350		$ -		$ -	9.2	$ 21,620		$ -		$ -	10	$ 23,500	2.8	$ 6,580		$ -		$ -		$ -	4.7	$ 11,045		$ -	8	$ 18,800		$ -
1.3	HSR on New Roadbed & New Embankment	per mile	$ 1,765		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -
1.4	HSR on New Roadbed & New Embankment (Double Track)	per mile	$ 3,164		$ -		$ -	6.1	$ 19,300		$ -		$ -		$ -	11.2	$ 35,436		$ -		$ -		$ -	15.5	$ 49,040		$ -	31.4	$ 99,346		$ -
1.5	HSR Double Track on 15' Retained Earth Fill	per mile	$ 16,711		$ -		$ -	5.3	$ 88,570		$ -		$ -	10.8	$ 180,482	13.8	$ 230,616		$ -		$ -		$ -	23.9	$ 399,400		$ -	40.6	$ 678,479		$ -
1.6	Timber & Surface w/ 33% Tie replacement	per mile	$ 263		$ -	18.8	$ 4,939		$ -	18.4	$ 4,834		$ -		$ -		$ -		$ -	11.5	$ 3,021	36.4	$ 9,562		$ -	32	$ 8,406	0	$ -	8.2	$ 2,154
1.7	Timber & Surface w/ 66% Tie Replacement	per mile	$ 392		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -
1.8	Relay Track w/ 136# CWR	per mile	$ 419		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -
1.9	Freight Siding	per mile	$ 1,079		$ -	4	$ 4,316		$ -	4	$ 4,316		$ -	4	$ 4,316		$ -		$ -	2	$ 2,158	8	$ 8,633		$ -		$ -		$ -		$ -
1.10	Passenger Siding	per mile	$ 1,628		$ -	10	$ 16,281		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -	20	$ 32,562		$ -		$ -
1.11	NCHRP Class 6 Barrier (on curves)	lineal ft	$ 1.3		$ -		$ -	1	$ 1.3		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -
1.12	NCHRP Class 5 Barrier (on tangent)	lineal ft	$ 0.2		$ -		$ -	2	$ 0.4		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -
1.13	Fencing, 4 ft Woven Wire (both sides)	per mile	$ 60		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -
1.14	Fencing, 6 ft Chain Link (both sides)	per mile	$ 181		$ -	18.8	$ 3,403		$ -	18.4	$ 3,330		$ -	20.8	$ 3,765	20	$ 3,620		$ -	11.5	$ 2,082	36.4	$ 6,588	45	$ 8,145	84	$ 15,204	70	$ 12,670	8.2	$ 1,484
1.15	Fencing, 10 ft Chain Link (both sides)	per mile	$ 207		$ -		$ -	6.1	$ 1,263		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -
1.16	Decorative Fencing (both sides)	per mile	$ 466		$ -		$ -		$ -		$ -		$ -		$ -	7.8	$ 3,636		$ -		$ -		$ -	3.1	$ 1,445		$ -	10	$ 4,662		$ -
1.17	Drainage Improvements (cross country)	per mile	$ 78		$ -		$ -	0	$ -		$ -		$ -		$ -	27.8	$ 2,171		$ -		$ -		$ -	48.1	$ 3,757		$ -	80	$ 6,248		$ -
1.18	Drainage Improvements in Median or along highway	per mile	$ 625		$ -		$ -	20.5	$ 12,806		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -
1.19	Land Acquisition Urban	per mile	$ 387	14	$ 5,417		$ -	20.5	$ 7,931		$ -		$ -		$ -	22	$ 8,512		$ -		$ -		$ -		$ -		$ -	10	$ 3,869		$ -
1.20	Land Acquisition Rural	per mile	$ 129		$ -	18.8	$ 2,425	0	$ -	18.4	$ 2,374		$ -	20.8	$ 2,683	5.8	$ 748		$ -	11.5	$ 1,484	36.4	$ 4,696	48.1	$ 6,205	52	$ 6,708	70	$ 9,030	8.2	$ 1,058
1.21	#33 High Speed Turnout	each	$ 672		$ -	2	$ 1,344		$ -		$ -		$ -		$ -		$ -		$ -		$ -	2	$ 1,344	1	$ 672		$ -		$ -		$ -
1.22	#24 High Speed Turnout	each	$ 532		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -
1.23	#20 Turnout Timber	each	$ 147		$ -	4	$ 587		$ -	4	$ 587		$ -	4	$ 587		$ -		$ -	2	$ 293	8	$ 1,174		$ -		$ -		$ -		$ -
1.24	#10 Turnout Timber	each	$ 82		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -
1.25	#20 Turnout Concrete	each	$ 295		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -
1.26	#10 Turnout Concrete	each	$ 140		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -
1.27	#33 Crossover	each	$ 1,344		$ -		$ -	1	$ 1,344		$ -		$ -		$ -	1	$ 1,344		$ -		$ -		$ -		$ -		$ -	2	$ 2,688		$ -
1.28	#20 Crossover	each	$ 590		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -
1.29	Elevate & Surface Curves	per mile	$ 69	2.8	$ 192	3.8	$ 261		$ -	3.6	$ 247		$ -		$ -		$ -		$ -	2.3	$ 158	7.2	$ 494		$ -	16.8	$ 1,152		$ -	1.6	$ 110
1.30	Curvature Reduction	per mile	$ 465		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -
1.31	Elastic Fasteners	per mile	$ 97		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -
1.32	Realign Track for Curves (See Table G6 for Costs)	lump sum	$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -
	Sub-total Trackwork (A)				$ 5,609		$ 33,556		$ 152,837		$ 15,688		$ -		$ 215,333		$ 292,663		$ -		$ 9,195		$ 32,491		$ 479,709		$ 125,128		$ 835,792		$ 4,806
Structures																															
	Bridges-under																														
2.1	Four Lane Urban Expressway	each	$ 5,721		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -
2.2	Four Lane Rural Expressway	each	$ 4,762		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -
2.3	Two Lane Highway	each	$ 3,614		$ -		$ -		$ -		$ -		$ -	4	$ 14,454		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -
2.4	Rail	each	$ 3,614		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -
2.5	Minor river	each	$ 958		$ -	28	$ 26,835		$ -	6	$ 5,750		$ -	25	$ 23,960		$ -		$ -	4	$ 3,834	20	$ 19,168		$ -	28	$ 26,835		$ -		$ -
2.6	Major River	each	$ 9,582		$ -		$ -		$ -		$ -		$ -	4	$ 38,326		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -
2.7	Double Track High (50') Level Bridge	per LF	$ 14		$ -		$ -	7150	$ 102,960		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -
2.8	Rehab for 110	per LF	$ 17		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -
2.9	Convert open deck bridge to ballast deck (single track)	per LF	$ 6		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -
2.10	Convert open deck bridge to ballast deck (double track)	per LF	$ 11		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -
2.11	Single Track on Flyover/Elevated Structure	per LF	$ 5		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -
2.12	Single Track on Approach Embankment w/ Retaining Wall	per LF	$ 4		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -
2.13	Double Track on Flyover/Elevated Structure	per LF	$ 8		$ -		$ -	27350	$ 218,800		$ -		$ -		$ -	14626	$ 117,008		$ -		$ -		$ -	25000	$ 200,000		$ -	42000	$ 336,000		$ -
2.14	Double Track on Approach Embankment w/ Retaining Wall	per LF	$ 7		$ -		$ -	13950	$ 90,675		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -
2.15	Ballasted Concrete Deck Replacement Bridge	per LF	$ 3		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -
2.16	Land Bridges	per LF	$ 3		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -
	Bridges-over																														
2.17	Four Lane Urban Expressway	each	$ 2,469		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -
2.18	Four Lane Rural Expressway	each	$ 3,466		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -
2.19	Two Lane Highway	each	$ 2,252		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -
2.20	Rail	each	$ 7,229		$ -	1	$ 7,229		$ -	1	$ 7,229		$ -		$ -		$ -		$ -	1	$ 7,229		$ -		$ -		$ -		$ -		$ -
	Tunnels																														
2.21	Two Bore Long Tunnel	route ft	$ 44		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -
2.22	Single Bore Short Tunnel	lineal ft	$ 25		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -
	Sub-total Structures (B)				$ -		$ 34,065		$ 412,435		$ 12,980		$ -		$ 76,740		$ 117,008		$ -		$ 11,063		$ 19,168		$ 200,000		$ 26,835		$ 336,000		$ -
Systems																															
3.1	Signals for Siding w/ High Speed Turnout	each	$ 1,500		$ -	1	$ 1,500		$ -		$ -		$ -		$ -		$ -		$ -		$ -	1	$ 1,500		$ -	2	$ 3,001		$ -		$ -
3.2	Install CTC System (Single Track)	per mile	$ 217		$ -	37.6	$ 8,140		$ -	36.8	$ 7,967		$ -	20.8	$ 4,503		$ -		$ -	23	$ 4,980	72.8	$ 15,761		$ -	84	$ 18,186		$ -	8.2	$ 1,775
3.3	Install CTC System (Double Track)	per mile	$ 355		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -
3.4	Install PTC System	per mile	$ 171	14	$ 2,394	18.8	$ 3,215		$ -	18.4	$ 3,146		$ -	20.8	$ 3,557		$ -		$ -	11.5	$ 1,967	36.4	$ 6,224		$ -	84	$ 14,364		$ -	8.2	$ 1,402
3.5	Electric Lock for Industry Turnout	each	$ 122		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -
3.6	Signals for Crossover	each	$ 828		$ -		$ -	1	$ 828		$ -		$ -		$ -	1	$ 828		$ -		$ -		$ -	1	$ 828		$ -	2	$ 1,656		$ -
3.7	Signals for Turnout	each	$ 473		$ -	4	$ 1,893		$ -	4	$ 1,893		$ -	4	$ 1,893		$ -		$ -	2	$ 947	8	$ 3,786		$ -		$ -		$ -		$ -
3.8	Signals, Communications & Dispatch	per mile	$ 1,540		$ -		$ -	20.5	$ 31,564		$ -		$ -		$ -	27.8	$ 42,804		$ -		$ -		$ -	48.1	$ 74,060		$ -		$ -		$ -
3.9	Electrification (Double Track)	per mile	$ 3,080		$ -		$ -	20.5	$ 63,130		$ -		$ -		$ -	27.8	$ 85,610		$ -		$ -		$ -	48.1	$ 148,124		$ -	80	$ 246,360		$ -
3.10	Electrification (Single Track)	per mile	$ 1,540	14	$ 21,556	18.8	$ 28,946		$ -	18.4	$ 28,330		$ -	20.8	$ 32,026		$ -		$ -	11.5	$ 17,707	36.4	$ 56,045		$ -	84	$ 129,335	80	$ 123,176		$ -
	Sub-total Systems (C)				$ 23,950		$ 43,695		$ 95,522		$ 41,337		$ -		$ 41,979		$ 129,242		$ -		$ 25,599		$ 83,317		$ 223,012		$ 164,885		$ 371,192		$ 3,178
Crossings																															
4.1	Private Closure	each	$ 98		$ -	9	$ 884		$ -	2	$ 196		$ -	1	$ 98		$ -		$ -		$ -	5	$ 491		$ -		$ -		$ -		$ -
4.2	Four Quadrant Gates w/ Trapped Vehicle Detector	each	$ 582		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -
4.3	Four Quadrant Gates	each	$ 341	9	$ 3,067	15	$ 5,112		$ -	11	$ 3,749		$ -	6	$ 2,045		$ -		$ -	10	$ 3,408	21	$ 7,157		$ -	21	$ 7,157		$ -		$ -
4.4	Convert Dual Gates to Quad Gates	each	$ 178		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -
4.5	Conventional Gates single mainline track	each	$ 196		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -	12	$ 2,357		$ -	1	$ 196
4.6	Conventional Gates double mainline track	each	$ 243		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -
4.7	Convert Flashers Only to Dual Gate	each	$ 59		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -
4.8	Single Gate with Median Barrier	each	$ 213		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -
4.9	Convert Single Gate to Extended Arm	each	$ 18		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -
4.10	Precast Panels without Rdway Improvements	each	$ 95		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -
4.11	Precast Panels with Rdway Improvements	each	$ 178	9	$ 1,598	15	$ 2,663		$ -	11	$ 1,953		$ -	6	$ 1,065		$ -		$ -	10	$ 1,775	21	$ 3,728		$ -	36	$ 6,390		$ -	1	$ 178
	Sub-total Crossings (D)				$ 4,665		$ 8,658		$ -		$ 5,898		$ -		$ 3,208		$ -		$ -		$ 5,183		$ 11,375		$ -		$ 15,904		$ -		$ 374

Station/Maintenance Facilities																															
5.1	Full Service - New - Low Volume - 500 Surface Park	each	$ 5,000		$ -	1	$ 5,000		$ -		$ -		$ -		$ -		$ -		$ -		$ -	1	$ 5,000		$ -		$ -		$ -		$ -
5.2	Full Service - Renovated - Low Volume- 500 Surface Park	each	$ 4,000		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -
5.3	Terminal - New - Low Volume - 500 Surface Park	each	$ 7,500		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -	1	$ 7,500
5.4	Terminal - Renovated - Low Volume - 500 Surface Park	each	$ 6,000		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -
5.5	Full Service - New- High Volume - Dual Platform - 1000 Surface Park	each	$ 10,000	1	$ 10,000		$ -	1	$ 10,000		$ -		$ -	1	$ 10,000	1	$ 10,000		$ -	1	$ 10,000	1	$ 10,000	1	$ 10,000	1	$ 10,000	1	$ 10,000		$ -
5.6	Terminal - New- High Volume - Dual Platform - 1000 Surface Park	each	$ 15,000	1	$ 15,000		$ -	1	$ 15,000		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -
5.7	Maintenance Facility (non-electrified track)	each	$ 80,000		$ -	0	$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -
5.8	Maintenance Facility (electrified track)	each	$ 100,000		$ -	1	$ 100,000		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -
5.9	Layover Facility	lump sum	$ 10,000		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -	1	$ 10,000		$ -		$ -
	Sub-total Station/Maintenance Facilities (E)				$ 25,000		$ 105,000		$ 25,000		$ -		$ -		$ 10,000		$ 10,000		$ -		$ 10,000		$ 15,000		$ 10,000		$ 20,000		$ 10,000		$ 7,500
Allocations for Special Elements																															
	Curve Reduction in Rugged Terrain	lump sum	$ 6,000		$ -	1	$ 6,000		$ -	1	$ 6,000		$ -	1	$ 6,000		$ -		$ -	1	$ 6,000	1	$ 6,000		$ -	1	$ 6,000		$ -	1	$ 6,000
	Construction in 470 from CML to I-25 ($3M per mile)	lump sum	$ 27,000		$ -	0	$ -	1	$ 27,000		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -
		lump sum			$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -
		lump sum			$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -
		lump sum			$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -
	Sub-Total Allocations for Special Elements (F)				$ -		$ 6,000		$ 27,000		$ 6,000		$ -		$ 6,000		$ -		$ -		$ 6,000		$ 6,000		$ -		$ 6,000		$ -		$ 6,000
	Sub-total Construction Elements (A+B+C+D+E+F)				$ 59,223		$ 230,974		$ 712,793		$ 81,903		$ -		$ 353,261		$ 548,913		$ -		$ 67,041		$ 167,351		$ 912,721		$ 358,752		$ 1,552,985		$ 21,857
Contingency																															
	Design and Construction Contingency		30%		$ 17,767		$ 69,292		$ 213,838		$ 24,571		$ -		$ 105,978		$ 164,674		$ -		$ 20,112		$ 50,205		$ 273,816		$ 107,626		$ 465,895		$ 6,557
	Sub-total Construction Elements Including Contingency (G)				$ 76,990		$ 300,266		$ 926,631		$ 106,473		$ -		$ 459,239		$ 713,587		$ -		$ 87,153		$ 217,557		$ 1,186,537		$ 466,377		$ 2,018,880		$ 28,414
Professional Services and Environmental																															
	Design Engineering	10%																													
	Insurance and Bonding	2%																													
	Program Management	4%																													
	Construction Management & Inspection	6%																													
	Engineering Services During Construction	2%																													
	Integrated Testing and Commissioning	2%																													
	Erosion Control and Water Quality Management	2%																													
	Sub-total Professional Services and Environmental (H)		28%		$ 21,557		$ 84,074		$ 259,457		$ 29,813		$ -		$ 128,587		$ 199,804		$ -		$ 24,403		$ 60,916		$ 332,230		$ 130,586		$ 565,286		$ 7,956
	Total Segment Cost (G)+(H)				$ 98,547		$ 384,340		$ 1,186,088		$ 136,286		$ -		$ 587,826		$ 913,392		$ -		$ 111,556		$ 278,473		$ 1,518,768		$ 596,963		$ 2,584,167		$ 36,371

E.4 Maglev

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		Segment No.	Segment W1		Segment W2		Segment W3		Segment W4		Segment W5		Segment W6		Segment W7		Segment W8	
CAPITAL COST ESTIMATE		From - To	Denver to US6/I70 Junction via US6		US6/I70 Junction to entrance to Clear Creek Canyon		Denver to Downtown Golden via Arvada		Downtown Golden to entrance to Clear Creek Canyon		Clear Creek Canyon entrance to Forks Creek via US6		Forks Creek to Floyds Hill via US6		Forks Creek to Black Hawk Tunnel N Portal		Black Hawk Tunnel N Portal to Central City/Black Hawk	
Cost in thousands		Host Carrier																
		Mileposts																
		Track Miles	11.6		4.3		16.0		0.9		9.6		3.4		2.9		4.0	
		Lineal Feet		60,984		22,493		84,480		4,752		50,688		17,846		15,312		21,120
Cost Elements	Unit	Unit Cost	Quantity	Amount	Quantity	Amount	Quantity	Amount	Quantity	Amount	Quantity	Amount	Quantity	Amount	Quantity	Amount	Quantity	Amount
Right of Way																		
Land Acquisition Rural	Mile	$ 129.0			4.3	$ 555												
Land Acquisition Urban	Mile	$ 387.0	11.6	$ 4,489														
Sub Right of Way				$4,489		$555		$0		$0		$0		$0		$0		$0
Guideway & Track																		
At Grade Guideway	LF	$ 3.4	22,000	$ 73,920	19,000	$ 63,840	34,480	$ 115,853		$ -	25,000	$ 84,000.0	6,000	$ 20,160		$ -		$ -
Aerial Guideway Type A	LF	$ 6.6	28,984	$ 192,176	1,493	$ 9,899	50,000	$ 331,520	4,752	$ 31,508	25,688	$ 170,322	11,846	$ 78,544	15,312	$ 101,525	21,120	$ 140,034
Aerial Guideway Type B	LF	$ 8.8	6,000	$ 52,550	2,000	$ 17,517		$ -		$ -		$ -		$ -		$ -		$ -
Bridge	LF	$ 25.8	4,000	$ 103,040		$ -		$ -		$ -		$ -		$ -		$ -		$ -
Tunnel Type A	LF	$ 33.6		$ -			-	$ -		$ -	25,000	$ 840,000.0	6,000	$ 201,600		$ -		$ -
Tunnel Type B	LF	$ 44.8		$ -				$ -		$ -	-	$ -		$ -		$ -		$ -
Sub Guideway & Track			60,984	$ 421,686	22,493	$ 91,256	84,480	$ 447,373		$ 31,508		$ 1,094,322		$ 300,304		$ 101,525		$ 140,034
Systems																		
Propulsion, C& C Systems	Mile	$ 18,368	11.6	$ 213,069	4.3	$ 78,982	16.0	$ 293,888	0.9	$ 16,531.2	9.6	$ 176,332.8	3.4	$ 62,451	2.9	$ 53,267	4	$ 73,472
Power Distribution	Mile	$ 1,389	11.6	$ 16,110	4.3	$ 5,972	16.0	$ 22,221	0.9	$ 1,250	9.6	$ 13,332.5	3.4	$ 4,722	2.9	$ 4,028	4	$ 5,555
Sub Systems				$ 229,179		$ 84,954		$ 316,109		$ 17,781		$ 189,665		$ 67,173		$ 57,295		$ 79,027
Maintenance Facilities																		
Maintenance Facilities	Sections	$ 3,080																
Stations & Parking																		
Full Service - New - Low Volume - 500 Surface Park		$ 5,000		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -
Full Service - Renovated - Low Volume- 500 Surface Park		$ 4,000		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -
Terminal - New - Low Volume - 500 Surface Park		$ 7,500		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -
Terminal - Renovated - Low Volume - 500 Surface Park		$ 6,000		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -
Full Service - New- High Volume - Dual Platform - 1000 Surface Park		$ 10,000	1	$ 10,000		$ -	1	$ 10,000		$ -		$ -		$ -		$ -	1	$ 10,000
Terminal - New- High Volume - Dual Platform - 1000 Surface Park		$ 15,000	1	$ 15,000		$ -		$ -		$ -		$ -		$ -		$ -		$ -
Stations & Parking				$ 25,000		$ -		$ 10,000		$ -		$ -		$ -		$ -		$ 10,000
Sub Construction Costs				$ 680,354		$ 176,765		$ 773,482		$ 49,289		$ 1,283,987		$ 367,477		$ 158,819		$ 229,061
Contingency	30%			$ 204,106		$ 53,029		$ 232,044		$ 14,787		$ 385,196		$ 110,243		$ 47,646		$ 68,718
Other Costs																		
Design Engineering	10%			$ 88,446		$ 22,979		$ 100,553		$ 6,408		$ 166,918		$ 47,772		$ 20,647		$ 29,778
Insurance and Bonding	2%			$ 17,689		$ 4,596		$ 20,111		$ 1,282		$ 33,384		$ 9,554		$ 4,129		$ 5,956
Program Management	4%			$ 35,378		$ 9,192		$ 40,221		$ 2,563		$ 66,767		$ 19,109		$ 8,259		$ 11,911
Const Mgt & Insp	6%			$ 53,068		$ 13,788		$ 60,332		$ 3,845		$ 100,151		$ 28,663		$ 12,388		$ 17,867
Eng During Construction	2%			$ 17,689		$ 4,596		$ 20,111		$ 1,282		$ 33,384		$ 9,554		$ 4,129		$ 5,956
Integrated Testing & Com	2%			$ 17,689		$ 4,596		$ 20,111		$ 1,282		$ 33,384		$ 9,554		$ 4,129		$ 5,956
Erosion Control & Water Mgt	2%			$ 17,689		$ 4,596		$ 20,111		$ 1,282		$ 33,384		$ 9,554		$ 4,129		$ 5,956
Sub Other Costs				$ 247,649		$ 64,342		$ 281,547		$ 17,941		$ 467,371		$ 133,762		$ 57,810		$ 83,378
Total Infrastructure Costs VHS Maglev				$ 1,132,109		$ 294,137		$ 1,287,073		$ 82,017		$ 2,136,554		$ 611,481		$ 264,275		$ 381,158
Cost Per Mile				$ 98,018		$ 69,046		$ 80,442		$ 91,129		$ 222,558		$ 180,912		$ 91,129		$ 95,289
Systems Cost for VHS Maglev																		
Propulsion, C& C Systems	Mile	$ 18,368																
Power Distribution	Mile	$ 1,389																
Sub Systems	Mile	$ 19,757																
System Cost for Urban Maglev	Mile	$ 7,742																
Difference in Base Cost per Mile	Mile	$ 12,014		$ 12,014		$ 12,014		$ 12,014		$ 12,014		$ 12,014		$ 12,014		$ 12,014		$ 12,014
Cost per Mile Urban Maglev				$ 86,004		$ 57,032		$ 68,428		$ 79,115		$ 210,543		$ 168,897		$ 79,115		$ 83,275
Cost per Segment Urban Maglev				$ 993,343		$ 242,956		$ 1,094,844		$ 71,204		$ 2,021,217		$ 570,873		$ 229,434		$ 333,101

Segment W9		Segment W10		Segment W11		Segment W12		Segment W13		Segment W14	
US6/I70 Junction to Floyds Hill via El Rancho on I70		Floyds Hill to Blackhawk Tunnel N Portal		Floyds Hill to Idaho Springs via I70		Floyds Hill to Idaho Springs via Unconstrained		Idaho Springs to Georgetown via I70		Idaho Springs to Georgetown via Unconstrained	
17.3		1.0		4.4		4.4		10.5		10.5	
	91,080		5,280		22,968		22,968		55,440		55,440
Quantity	Amount	Quantity	Amount	Quantity	Amount	Quantity	Amount	Quantity	Amount	Quantity	Amount
						4.4	$ 568			10.5	$ 1,355
	$0		$0		$0		$568		$0		$1,355
18,000	$ 60,480	5280	$ 17,741	8,900	$ 29,904	11,500	$ 38,640	22,176	$ 74,511	27,720	$ 93,139
54,000	$ 358,042			11,500	$ 76,250	11,468	$ 76,037	27,720	$ 183,795	27,720	$ 183,795
19,080	$ 167,110			2,568	$ 22,492		$ -	5,544	$ 48,557		$ -
	$ -				$ -		$ -		$ -		$ -
	$ -			740	$ 24,864	740	$ 24,864		$ -		$ -
	$ -	5280	$ 236,544		$ -		$ -		$ -		$ -
	$ 585,632		$ 254,285		$ 153,509		$ 139,541		$ 306,863		$ 276,934
17.3	$ 317,766	1	$ 18,368	4.4	$ 80,819	4.4	$ 80,819	10.5	$ 192,864	10.5	$ 192,864
17.3	$ 24,026			4.4	$ 6,111	4.4	$ 6,111	10.5	$ 14,582	10.5	$ 14,582
	$ 341,793		$ 18,368		$ 86,930		$ 86,930		$ 207,446		$ 207,446
	$ -		$ -		$ -		$ -		$ -		$ -
	$ -		$ -		$ -		$ -		$ -		$ -
	$ -		$ -		$ -		$ -		$ -		$ -
	$ -		$ -		$ -		$ -		$ -		$ -
	$ -		$ -	1	$ 10,000	1	$ 10,000	1	$ 10,000	1	$ 10,000
	$ -		$ -		$ -		$ -		$ -		$ -
	$ -		$ -		$ 10,000		$ 10,000		$ 10,000		$ 10,000
	$ 927,425		$ 272,653		$ 250,439		$ 237,039		$ 524,309		$ 495,735
	$ 278,227		$ 81,796		$ 75,132		$ 71,112		$ 157,293		$ 148,720
	$ 120,565		$ 35,445		$ 32,557		$ 30,815		$ 68,160		$ 64,446
	$ 24,113		$ 7,089		$ 6,511		$ 6,163		$ 13,632		$ 12,889
	$ 48,226		$ 14,178		$ 13,023		$ 12,326		$ 27,264		$ 25,778
	$ 72,339		$ 21,267		$ 19,534		$ 18,489		$ 40,896		$ 38,667
	$ 24,113		$ 7,089		$ 6,511		$ 6,163		$ 13,632		$ 12,889
	$ 24,113		$ 7,089		$ 6,511		$ 6,163		$ 13,632		$ 12,889
	$ 24,113		$ 7,089		$ 6,511		$ 6,163		$ 13,632		$ 12,889
	$ 337,583		$ 99,246		$ 91,160		$ 86,282		$ 190,848		$ 180,447
	$ 1,543,234		$ 453,694		$ 416,731		$ 394,433		$ 872,450		$ 824,903
	$ 89,463		$ 453,694		$ 95,800		$ 90,674		$ 83,090		$ 78,562
	$ 12,014		$ 12,014		$ 12,014		$ 12,014		$ 12,014		$ 12,014
	$ 77,449		$ 441,680		$ 83,786		$ 78,660		$ 71,076		$ 66,548
	$ 1,335,987		$ 441,680		$ 364,468		$ 342,170		$ 746,300		$ 698,752

Segment W15		Segment W16		Segment W17		Segment W18		Segment W19		Segment W20		Segment W
Georgetown to Silver Plume via I70		Georgetown to Silver Plume via Unconstrained		Silver Plume to Loveland Pass via I70		Silver Plume to Loveland Pass via Unconstrained		Loveland Pass to Keystone via North Fork Tunnel		Loveland Pass to Silverthorne via EJMT		Keyston Keyston
4.9		4.9		8.6		9.2		8.6		9.9		2
	25,872		25608.0 LF		45,408		48,418		45,566		52,272	
Quantity	Amount	Quantity	Amount	Quantity	Amount	Quantity	Amount	Quantity	Amount	Quantity	Amount	Quantity
		4.9	$ 632			9.2	$ 1,187	4.3	$ 555			0.9
								4.3	$ 1,664			2
	$0		$632		$0		$1,187		$2,219		$0	
5,000	$ 16,800	12,804	$ 43,021	18,163	$ 61,028	24,209	$ 81,342	30,000	$ 100,800	20,909	$ 70,254	
7,936	$ 52,619	12,804	$ 84,896	22,704	$ 150,537	24,209	$ 160,514	15,566	$ 103,209	26,136	$ 173,292	15048
12,936	$ 113,299		$ -	4,541	$ 39,770		$ -		$ -	5,227	$ 45,782	
	$ -		$ -		$ -		$ -		$ -		$ -	
	$ -		$ -		$ -		$ -		$ -		$ -	
-	$ -	14,000	$ 627,200		$ -		$ -	30,000	$ 1,344,000	10000	$ 448,000	
25,872	$ 182,718		$ 755,117		$ 251,335		$ 241,856		$ 1,548,009		$ 737,328	
4.9	$ 90,003	4.9	$ 90,003	8.6	$ 157,965	9.2	$ 168,986	8.6	$ 157,965	9.9	$ 181,843	2.9
4.9	$ 6,805	4.9	$ 6,805	8.6	$ 11,944	9.2	$ 12,777	8.6	$ 11,944	9.9	$ 13,749	2.9
	$ 96,808		$ 96,808		$ 169,908		$ 181,763		$ 169,908		$ 195,592	
	$ -		$ -		$ -		$ -		$ -		$ -	
	$ -		$ -		$ -		$ -		$ -		$ -	
	$ -		$ -		$ -		$ -		$ -		$ -	
	$ -		$ -		$ -		$ -		$ -		$ -	
	$ -		$ -	1	$ 10,000	1	$ 10,000		$ -	1	$ 10,000	1
	$ -		$ -		$ -		$ -		$ -		$ -	
	$ -		$ -		$ 10,000		$ 10,000		$ -		$ 10,000	
	$ 279,526		$ 852,558		$ 431,244		$ 434,805		$ 1,720,136		$ 942,920	
	$ 83,858		$ 255,767		$ 129,373		$ 130,441		$ 516,041		$ 282,876	
	$ 36,338		$ 110,832		$ 56,062		$ 56,525		$ 223,618		$ 122,580	
	$ 7,268		$ 22,166		$ 11,212		$ 11,305		$ 44,724		$ 24,516	
	$ 14,535		$ 44,333		$ 22,425		$ 22,610		$ 89,447		$ 49,032	
	$ 21,803		$ 66,499		$ 33,637		$ 33,915		$ 134,171		$ 73,548	
	$ 7,268		$ 22,166		$ 11,212		$ 11,305		$ 44,724		$ 24,516	
	$ 7,268		$ 22,166		$ 11,212		$ 11,305		$ 44,724		$ 24,516	
	$ 7,268		$ 22,166		$ 11,212		$ 11,305		$ 44,724		$ 24,516	
	$ 101,747		$ 310,331		$ 156,973		$ 158,269		$ 626,130		$ 343,223	
	$ 465,131		$ 1,418,656		$ 717,589		$ 723,515		$ 2,862,306		$ 1,569,019	
	$ 94,925		$ 292,506		$ 83,441		$ 78,900		$ 331,669		$ 158,487	
	$ 12,014		$ 12,014		$ 12,014		$ 12,014		$ 12,014		$ 12,014	
	$ 82,910		$ 280,492		$ 71,426		$ 66,886		$ 319,655		$ 146,472	
	$ 406,261		$ 1,360,386		$ 614,266		$ 613,344		$ 2,758,623		$ 1,450,077	

/21	Segment W22		Segment W23		Segment W24		Segment W25		Segment W26		Segment W27	
e to West e via US6	West Keystone to Silverthorne via US6		West Keystone to Breckenridge Junction		Breckenridge Junction to Breckenridge		Breckenridge to Copper Mtn via Tunnel		Breckenridge Junction to Friso		Silverthorne to Frisco via I70	
2.9	4.2		4.3		1.2		4.8		5.3		4.6	
15,048		22,176		22,704		6,389		25,555		27984.0 LF		24288.0 LF
Amount	Quantity	Amount	Quantity	Amount	Quantity	Amount	Quantity	Amount	Quantity	Amount	Quantity	Amount
$ 116	2	$ 258	4.3	$ 555			4.8	$ 619	2	$ 258	4.6	$ 593
$ 774	2.2	$ 851		$ -	1.2	$ 464			3.3	$ 1,277		$ -
$890		$1,109		$555		$464		$619		$1,535		$593
$ -	12000	$ 40,320	16000	$ 53,760	3000	$ 10,080	23000	$ 77,280	12000	$ 40,320	9,715	$ 32,643
$ 99,774	10176	$ 67,471	6704	$ 44,450	3389	$ 22,470	2555	$ 16,941	15984	$ 105,980	12,144	$ 80,520
$ -		$ -		$ -		$ -		$ -		$ -	2,429	$ 21,272
$ -		$ -		$ -		$ -		$ -		$ -		$ -
$ -		$ -		$ -		$ -		$ -		$ -		$ -
$ -		$ -	12000	$ 537,600		$ -	22000	$ 985,600	6000	$ 268,800		$ -
$ 99,774		$ 107,791		$ 635,810		$ 32,550		$ 1,079,821		$ 415,100		$ 134,435
$ 53,267	4.2	$ 77,146	4.3	$ 78,982	1.2	$ 22,042	4.8	$ 88,166	5.3	$ 97,350	4.6	$ 84,493
$ 4,028	4.2	$ 5,833	4.3	$ 5,972	1.2	$ 1,667	4.8	$ 6,666	5.3	$ 7,361	4.6	$ 6,388
$ 57,295		$ 82,979		$ 84,954		$ 23,708		$ 94,833		$ 104,711		$ 90,881
$ -		$ -		$ -		$ -		$ -		$ -		$ -
$ -		$ -		$ -		$ -		$ -		$ -		$ -
$ -		$ -		$ -		$ -		$ -		$ -		$ -
$ -		$ -		$ -		$ -		$ -		$ -		$ -
$ 10,000		$ -		$ -	1	$ 10,000	1	$ 10,000		$ -	1	$ 10,000
$ -		$ -		$ -		$ -		$ -		$ -		$ -
$ 10,000		$ -		$ -		$ 10,000		$ 10,000		$ -		$ 10,000
$ 167,959		$ 191,879		$ 721,319		$ 66,723		$ 1,185,273		$ 521,346		$ 235,910
$ 50,388		$ 57,564		$ 216,396		$ 20,017		$ 355,582		$ 156,404		$ 70,773
$ 21,835		$ 24,944		$ 93,771		$ 8,674		$ 154,085		$ 67,775		$ 30,668
$ 4,367		$ 4,989		$ 18,754		$ 1,735		$ 30,817		$ 13,555		$ 6,134
$ 8,734		$ 9,978		$ 37,509		$ 3,470		$ 61,634		$ 27,110		$ 12,267
$ 13,101		$ 14,967		$ 56,263		$ 5,204		$ 92,451		$ 40,665		$ 18,401
$ 4,367		$ 4,989		$ 18,754		$ 1,735		$ 30,817		$ 13,555		$ 6,134
$ 4,367		$ 4,989		$ 18,754		$ 1,735		$ 30,817		$ 13,555		$ 6,134
$ 4,367		$ 4,989		$ 18,754		$ 1,735		$ 30,817		$ 13,555		$ 6,134
$ 61,137		$ 69,844		$ 262,560		$ 24,287		$ 431,439		$ 189,770		$ 85,871
$ 279,484		$ 319,287		$ 1,200,275		$ 111,027		$ 1,972,293		$ 867,520		$ 392,554
$ 98,065		$ 76,021		$ 279,134		$ 91,758		$ 407,499		$ 163,683		$ 85,338
$ 12,014		$ 12,014		$ 12,014		$ 12,014		$ 12,014		$ 12,014		$ 12,014
$ 86,050		$ 64,006		$ 267,119		$ 79,744		$ 395,484		$ 151,669		$ 73,323
$ 245,243		$ 268,826		$ 1,148,613		$ 96,490		$ 1,914,144		$ 803,845		$ 337,288

Segment W28		Segment W29		Segment W30		Segment W31		Segment W32		Segment W33		Segment W34	
Frisco to Copper Mtn via I70		Copper Mtn to Pando via Greenfield		Copper Mtn to Vail via I70		Pando to Minturn via existing Rail ROW		Vail to Minturn via I70		Minturn to Avon		Avon to Wolcott	
6.3		16.1		21.1		18.0		2.9		5.5		10.6	
	33,264		84,797		111,408		95,040		15,312		29,040		55,968
Quantity	Amount	Quantity	Amount	Quantity	Amount	Quantity	Amount	Quantity	Amount	Quantity	Amount	Quantity	Amount
6.3	$ 813	16.1	$ 2,077	21.1	$ 2,722	18	$ 2,322	2.9	$ 374	5.5	$ 710	10.6	$ 1,367
	$ -		$ -		$ -		$ -		$ -		$ -		$ -
	$813		$2,077		$2,722		$2,322		$374		$710		$1,367
13,306	$ 44,707	20000	$ 67,200	44,563	$ 149,732	45040	$ 151,334	3,125	$ 10,500	12000	$ 40,320	30000	$ 100,800
16,632	$ 110,277	42000	$ 278,477	55,704	$ 369,340	50000	$ 331,520	7,656	$ 50,762	17040	$ 112,982	25968	$ 172,178
3,326	$ 29,134	0	$ -	11,141	$ 97,576		$ -	4,531	$ 39,684		$ -		$ -
	$ -	22797	$ 587,251		$ -		$ -		$ -		$ -		$ -
	$ -		$ -		$ -		$ -		$ -		$ -		$ -
	$ -		$ -		$ -		$ -		$ -		$ -		$ -
	$ 184,118		$ 932,928		$ 616,648		$ 482,854	15,312	$ 100,947		$ 153,302		$ 272,978
6.3	$ 115,718	16.1	$ 295,725	21.1	$ 387,565	18	$ 330,624	2.9	$ 53,267	5.5	$ 101,024	10.6	$ 194,701
6.3	$ 8,749	16.1	$ 22,360	21.1	$ 29,304	18	$ 24,998	2.9	$ 4,028	5.5	$ 7,638	10.6	$ 14,721
	$ 124,468		$ 318,084		$ 416,868		$ 355,622		$ 57,295		$ 108,662		$ 209,422
	$ -		$ -		$ -		$ -		$ -		$ -		$ -
	$ -		$ -		$ -		$ -		$ -		$ -		$ -
	$ -		$ -		$ -		$ -		$ -		$ -		$ -
	$ -		$ -		$ -		$ -		$ -		$ -		$ -
1	$ 10,000		$ -	1	$ 10,000		$ -	1	$ 10,000		$ -		$ -
	$ -		$ -		$ -		$ -		$ -		$ -		$ -
	$ 10,000		$ -		$ 10,000		$ -		$ 10,000		$ -		$ -
	$ 319,398		$ 1,253,089		$ 1,046,238		$ 840,799		$ 168,615		$ 262,674		$ 483,768
	$ 95,819		$ 375,927		$ 313,871		$ 252,240		$ 50,585		$ 78,802		$ 145,130
	$ 41,522		$ 162,902		$ 136,011		$ 109,304		$ 21,920		$ 34,148		$ 62,890
	$ 8,304		$ 32,580		$ 27,202		$ 21,861		$ 4,384		$ 6,830		$ 12,578
	$ 16,609		$ 65,161		$ 54,404		$ 43,722		$ 8,768		$ 13,659		$ 25,156
	$ 24,913		$ 97,741		$ 81,607		$ 65,582		$ 13,152		$ 20,489		$ 37,734
	$ 8,304		$ 32,580		$ 27,202		$ 21,861		$ 4,384		$ 6,830		$ 12,578
	$ 8,304		$ 32,580		$ 27,202		$ 21,861		$ 4,384		$ 6,830		$ 12,578
	$ 8,304		$ 32,580		$ 27,202		$ 21,861		$ 4,384		$ 6,830		$ 12,578
	$ 116,261		$ 456,124		$ 380,831		$ 306,051		$ 61,376		$ 95,613		$ 176,091
	$ 531,478		$ 2,085,140		$ 1,740,940		$ 1,399,089		$ 280,576		$ 437,089		$ 804,989
	$ 84,362		$ 129,834		$ 82,509		$ 77,727		$ 96,750		$ 79,471		$ 75,942
	$ 12,014		$ 12,014		$ 12,014		$ 12,014		$ 12,014		$ 12,014		$ 12,014
	$ 72,347		$ 117,820		$ 70,495		$ 65,713		$ 84,736		$ 67,456		$ 63,928
	$ 455,788		$ 1,892,190		$ 1,487,438		$ 1,182,831		$ 245,735		$ 371,011		$ 677,637

Segment W35		Segment W36		Segment W37		Segment W38	
Wolcott to Eagle Airport		Eagle Airport to Mid-Valley (Basalt) via Tunnel		Mid-Valley (Basalt) to Aspen Airport		Eagle Airport to Dotsero	
16.6	87,595	21.1	111,302	20.7	109,190	6.3	33,317
Quantity	Amount	Quantity	Amount	Quantity	Amount	Quantity	Amount
16.6	$ 2,141	21.1	$ 2,722	20.7	$ 2,670	6.3	$ 813
	$ -				$ -		$ -
	$2,141		$2,722		$2,670		$813
47000	$ 157,920	83302	$ 279,895	50000	$ 168,000	15000	$ 50,400
40595	$ 269,161	28000	$ 185,651	59190	$ 392,453	18317	$ 121,449
	$ -		$ -		$ -		$ -
	$ -		$ -		$ -		$ -
	$ -		$ -		$ -		$ -
	$ -	51000	$ 2,284,800		$ -		$ -
	$ 427,081		$ 2,750,346		$ 560,453		$ 171,849
16.6	$ 304,909	21.1	$ 387,565	20.7	$ 380,218	6.3	$ 115,718
16.6	$ 23,054	21.1	$ 29,304	20.7	$ 28,748	6.3	$ 8,749
	$ 327,963		$ 416,868		$ 408,966		$ 124,468
	$ -		$ -		$ -		$ -
	$ -		$ -		$ -		$ -
	$ -		$ -		$ -		$ -
	$ -		$ -		$ -		$ -
1	$ 10,000	1	$ 10,000	1	$ 10,000		$ -
	$ -		$ -		$ -		$ -
	$ 10,000		$ 10,000		$ 10,000		$ -
	$ 767,185		$ 3,179,936		$ 982,089		$ 297,130
	$ 230,156		$ 953,981		$ 294,627		$ 89,139
	$ 99,734		$ 413,392		$ 127,672		$ 38,627
	$ 19,947		$ 82,678		$ 25,534		$ 7,725
	$ 39,894		$ 165,357		$ 51,069		$ 15,451
	$ 59,840		$ 248,035		$ 76,603		$ 23,176
	$ 19,947		$ 82,678		$ 25,534		$ 7,725
	$ 19,947		$ 82,678		$ 25,534		$ 7,725
	$ 19,947		$ 82,678		$ 25,534		$ 7,725
	$ 279,255		$ 1,157,497		$ 357,481		$ 108,155
	$ 1,276,596		$ 5,291,414		$ 1,634,197		$ 494,424
	$ 76,950		$ 251,016		$ 79,023		$ 78,356
	$ 12,014		$ 12,014		$ 12,014		$ 12,014
	$ 64,935		$ 239,002		$ 67,009		$ 66,341
	$ 1,077,279		$ 5,038,152		$ 1,385,740		$ 418,613

Segment W39		Segment W40		Segment W41		Segment W42	
Dotsero to Glenwood Springs via Canyon		Glenwood Springs to Mid-Valley (Basalt)		Glenwood Springs to Grand Junction		Wolcott to Bond via RT131	
18.3	96,624	16.0	84,480	88.4	466,594	14.2	74,976
Quantity	Amount	Quantity	Amount	Quantity	Amount	Quantity	Amount
18.3	$ 2,361	16	$ 2,064		$ -	14.2	$ 1,832
	$ -		$ -		$ -		$ -
	$2,361		$2,064		$0		$1,832
	$ -	40000	$ 134,400	66,594	$ 223,756		$ -
16,624	$ 110,224	44480	$ 294,920	200,000	$ 1,326,080	30976	$ 205,383
80,000	$ 700,672		$ -	200,000	$ 1,751,680	4000	$ 35,034
	$ -		$ -		$ -	40000	$ 1,030,400
	$ -		$ -		$ -		$ -
	$ -		$ -		$ -		$ -
	$ 810,896		$ 429,320		$ 3,301,516		$ 1,270,817
18.3	$ 336,134	16	$ 293,888	88.4	$ 1,623,731	14.2	$ 260,826
18.3	$ 25,415	16	$ 22,221	88.4	$ 122,770	14.2	$ 19,721
	$ 361,549		$ 316,109		$ 1,746,501		$ 280,547
	$ -		$ -		$ -		$ -
	$ -		$ -		$ -		$ -
	$ -		$ -		$ -		$ -
	$ -		$ -		$ -		$ -
1	$ 10,000	1	$ 10,000	1	$ 10,000		$ -
	$ -		$ -		$ -		$ -
	$ 10,000		$ 10,000		$ 10,000		$ -
	$ 1,184,806		$ 757,493		$ 5,058,017		$ 1,553,195
	$ 355,442		$ 227,248		$ 1,517,405		$ 465,959
	$ 154,025		$ 98,474		$ 657,542		$ 201,915
	$ 30,805		$ 19,695		$ 131,508		$ 40,383
	$ 61,610		$ 39,390		$ 263,017		$ 80,766
	$ 92,415		$ 59,084		$ 394,525		$ 121,149
	$ 30,805		$ 19,695		$ 131,508		$ 40,383
	$ 30,805		$ 19,695		$ 131,508		$ 40,383
	$ 30,805		$ 19,695		$ 131,508		$ 40,383
	$ 431,269		$ 275,727		$ 1,841,118		$ 565,363
	$ 1,971,517		$ 1,260,468		$ 8,416,540		$ 2,584,517
	$ 107,733		$ 78,779		$ 95,242		$ 182,008
	$ 12,014		$ 12,014		$ 12,014		$ 12,014
	$ 95,719		$ 66,765		$ 83,228		$ 169,994
	$ 1,751,655		$ 1,068,239		$ 7,354,833		$ 2,413,913

Segment W43		Segment W44		Segment W45		Segment W46	
Dotsero to Bond via DRGW Existing Rail ROW		Bond to Steamboat Springs		Steamboat Springs to Hayden Airport		Hayden Airport to Craig	
38.1	200,904	62.1	327,888	24.3	128,304	16.8	88,704
Quantity	Amount	Quantity	Amount	Quantity	Amount	Quantity	Amount
38.1	$ 4,915	62.1	$ 8,011	24.3	$ 3,135	16.8	$ 2,167
	$ -		$ -		$ -		$ -
	$4,915		$8,011		$3,135		$2,167
					$ -		$ -
200,904	$ 1,332,074	327,888	$ 2,174,029	128,304	$ 850,707	88704	$ 588,143
0	$ -		$ -		$ -		$ -
	$ -		$ -		$ -		$ -
	$ -		$ -		$ -		$ -
	$ -		$ -		$ -		$ -
	$ 1,332,074		$ 2,174,029		$ 850,707		$ 588,143
38.1	$ 699,821	62.1	$ 1,140,653	24.3	$ 446,342	16.8	$ 308,582
38.1	$ 52,913	62.1	$ 86,244	24.3	$ 33,748	16.8	$ 23,332
	$ 752,734		$ 1,226,897		$ 480,090		$ 331,914
	$ -		$ -		$ -		$ -
	$ -		$ -		$ -		$ -
	$ -		$ -		$ -		$ -
	$ -		$ -		$ -		$ -
	$ -	1	$ 10,000	1	$ 10,000	1	$ 10,000
	$ -		$ -		$ -		$ -
	$ -		$ 10,000		$ 10,000		$ 10,000
	$ 2,089,723		$ 3,418,937		$ 1,343,932		$ 932,224
	$ 626,917		$ 1,025,681		$ 403,180		$ 279,667
	$ 271,664		$ 444,462		$ 174,711		$ 121,189
	$ 54,333		$ 88,892		$ 34,942		$ 24,238
	$ 108,666		$ 177,785		$ 69,884		$ 48,476
	$ 162,998		$ 266,677		$ 104,827		$ 72,714
	$ 54,333		$ 88,892		$ 34,942		$ 24,238
	$ 54,333		$ 88,892		$ 34,942		$ 24,238
	$ 54,333		$ 88,892		$ 34,942		$ 24,238
	$ 760,659		$ 1,244,493		$ 489,191		$ 339,330
	$ 3,477,299		$ 5,689,111		$ 2,236,302		$ 1,551,221
	$ 91,388		$ 91,612		$ 92,029		$ 92,335
	$ 12,014		$ 12,014		$ 12,014		$ 12,014
	$ 79,373		$ 79,598		$ 80,015		$ 80,320
	$ 3,020,153		$ 4,943,020		$ 1,944,354		$ 1,349,381

		Segment No.	Segment N1		Segment N2		Segment N3		Segment N4		Segment N5		Segment N6		Segment N7		Segment N8	
		From - To	Denver to 96 St via Brush Line		96th St to DIA greenfield		96th St to E470/US85		E470/US85 to Milliken Jct via Greeley Line		Milliken Junction to North Front Range via Milliken Line		North Front Range to Fort Collins via Milliken Line		Milliken Junction to Greeley via Greeley Line		Greeley to Fort Collins via GWRCO	
		Host Carrier	BNSF		N/A		BNSF		UP/Greenfield (GF)		UP/GF		UP		UP		GWR	
		Mileposts	MP 542.5-MP 531.3		MP 0 to MP 9		MP 531.3		MP 15.0- MP 36.5		GF 0 - MKN 18.9		Mkn 18.9 - Mkn 33		Gre 36.5-Gre 51.9		GWR 98.7-GWR 74.6	
		Miles	11.2		9.0		8.7		21.5		15.5		24.1		15.4		14.1	
		Lineal Feet	59,136		47,520		45,936		113,520		81,576		127,354		81,312		74,184	
Cost Elements	Unit	Unit Cost	Quantity	Amount	Quantity	Amount	Quantity	Amount	Quantity	Amount	Quantity	Amount	Quantity	Amount	Quantity	Amount	Quantity	Amount
Right of Way																		
Land Acquisition Rural	Mile	$ 129.0		$ -		$ -		$ -	21.5	$ 2,774	15.5	$ 2,000	20	$ 2,580	12	$ 1,548	10.1	$ 1,303
Land Acquisition Urban	Mile	$ 387.0	11.2	$ 4,334	9	$ 3,483	8.7	$ 3,367		$ -		$ -	4.1	$ 1,587	3.4	$ 1,316	4	$ 1,548
Sub Right of Way				$ 4,334		$ 3,483		$ 3,367		$ 2,774		$ 2,000		$ 4,167		$ 2,864		$ 2,851
Guideway & Track																		
At Grade Guideway	LF	$ 3.4		$ -	34520	$ 115,987		$ -		$ -		$ -		$ -		$ -		$ -
Aerial Guideway Type A	LF	$ 6.6	54,136	$ 358,943	10000	$ 66,304	45936	$ 304,574	113520	$ 752,683	81576	$ 540,882	127354	$ 844,408	81312	$ 539,131	74184	$ 491,870
Aerial Guideway Type B	LF	$ 8.8		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -
Bridge	LF	$ 25.8	5000	$ 128,800	3000	$ 77,280		$ -		$ -		$ -		$ -		$ -		$ -
Tunnel Type A	LF	$ 33.6		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -
Tunnel Type B	LF	$ 44.8		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -
Sub Guideway & Track				$ 487,743	47520	$ 259,571		$ 304,574		$ 752,683		$ 540,882		$ 844,408		$ 539,131		$ 491,870
Systems																		
Propulsion, C& C Systems	Mile	$ 18,368	11.2	$ 205,722	9	$ 165,312	8.7	$ 159,802	21.5	$ 394,912	15.5	$ 284,704	24.1	$ 442,669	15.4	$ 282,867	14.1	$ 258,989
Power Distribution	Mile	$ 1,389	11.2	$ 15,555	9	$ 12,499	8.7	$ 12,083	21.5	$ 29,859	15.5	$ 21,526	24.1	$ 33,470	15.4	$ 21,388	14.1	$ 19,582
Sub Systems				$ 221,276		$ 177,811		$ 171,884		$ 424,771		$ 306,230		$ 476,139		$ 304,255		$ 278,571
Maintenance Facilities																		
Maintenance Facilities	Sections	$ 3,080.0																
Stations & Parking																		
Full Service - New - Low Volume - 500 Surface Park		$ 5,000		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -
Full Service - Renovated - Low Volume- 500 Surface Park		$ 4,000		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -
Terminal - New - Low Volume - 500 Surface Park		$ 7,500		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -
Terminal - Renovated - Low Volume - 500 Surface Park		$ 6,000		$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -
Full Service - New- High Volume - Dual Platform - 1000 Surface Park		$ 10,000		$ -		$ -	1	$ 10,000		$ -	1	$ 10,000	1	$ 10,000	1	$ 10,000	1	$ 10,000
Terminal - New- High Volume - Dual Platform - 1000 Surface Park		$ 15,000	1	$ 15,000	1	$ 15,000		$ -		$ -		$ -		$ -		$ -		$ -
Stations & Parking				$ 15,000		$ 15,000		$ 10,000		$ -		$ 10,000		$ 10,000		$ 10,000		$ 10,000
Sub Construction Costs				$ 728,354		$ 455,865		$ 489,825		$ 1,180,228		$ 859,111		$ 1,334,714		$ 856,250		$ 783,291
Contingency	30%			$ 218,506		$ 136,760		$ 146,948		$ 354,068		$ 257,733		$ 400,414		$ 256,875		$ 234,987
Other Costs																		
Design Engineering	10%			$ 94,686		$ 59,263		$ 63,677		$ 153,430		$ 111,684		$ 173,513		$ 111,312		$ 101,828
Insurance and Bonding	2%			$ 18,937		$ 11,853		$ 12,735		$ 30,686		$ 22,337		$ 34,703		$ 22,262		$ 20,366
Program Management	4%			$ 37,874		$ 23,705		$ 25,471		$ 61,372		$ 44,674		$ 69,405		$ 44,525		$ 40,731
Const Mgt & Insp	6%			$ 56,812		$ 35,558		$ 38,206		$ 92,058		$ 67,011		$ 104,108		$ 66,787		$ 61,097
Eng During Construction	2%			$ 18,937		$ 11,853		$ 12,735		$ 30,686		$ 22,337		$ 34,703		$ 22,262		$ 20,366
Integrated Testing & Com	2%			$ 18,937		$ 11,853		$ 12,735		$ 30,686		$ 22,337		$ 34,703		$ 22,262		$ 20,366
Erosion Control & Water Mgt	2%			$ 18,937		$ 11,853		$ 12,735		$ 30,686		$ 22,337		$ 34,703		$ 22,262		$ 20,366
Sub Other Costs				$ 265,121		$ 165,935		$ 178,296		$ 429,603		$ 312,717		$ 485,836		$ 311,675		$ 285,118
Total Infrastructure Costs VHS Maglev				$ 1,211,981		$ 758,560		$ 815,069		$ 1,963,899		$ 1,429,561		$ 2,220,963		$ 1,424,799		$ 1,303,397
Cost Per Mile				$ 108,213		$ 84,284		$ 93,686		$ 91,344		$ 92,528		$ 92,080		$ 92,519		$ 92,768
Systems Cost for VHS Maglev																		
Propulsion, C& C Systems	Mile	$ 18,368																
Power Distribution	Mile	$ 1,389																
Sub Systems	Mile	$ 19,757																
System Cost for Urban Maglev	Mile	$ 7,742																
Difference in Base Cost per Mile	Mile	$ 12,014		$ 12,014		$ 12,014		$ 12,014		$ 12,014		$ 12,014		$ 12,014		$ 12,014		$ 12,014
Cost per Mile Urban Maglev				$ 96,198		$ 72,270		$ 81,672		$ 79,330		$ 80,514		$ 80,065		$ 80,505		$ 80,754
Cost per Segment Urban Maglev				$ 1,077,420		$ 650,431		$ 710,544		$ 1,705,591		$ 1,243,940		$ 1,931,177		$ 1,239,779		$ 1,134,595

Segment N9		Segment N10		Segment N11		Segment N12		Segment N13		Segment N14	
Fort Collins to North Fort Collins via BNSF		North Fort Collins to StateLine via BNSF		E470/US85 to North Front Range via I25		North Front Range to North Fort Collins via I25		North Fort Collins to StateLine via I25		StateLine to Cheyenne Union via BNSF	
BNSF		BNSF		GF		GF		GF		BNSF	
FR 74.6-FR 80.5		FR 80.5-FR 106.8		GF 18 - GF59		GF 59 - GF72		GF 72 - GF98		FR106.8- UD	
5.9		27.1		41.0		13.0		26.0		12.6	
31,099		143,088		216,480		68,640		137,016		66,528	
Quantity	Amount	Quantity	Amount	Quantity	Amount	Quantity	Amount	Quantity	Amount	Quantity	Amount
	$ -	27.1	$ 3,496		$ -		$ -		$ -	12.6	$ 1,625
5.9	$ 2,283		$ -		$ -		$ -		$ -		$ -
	$ 2,283		$ 3,496		$ -		$ -		$ -		$ 1,625
	$ -		$ -	80000	$ 268,800	26640	$ 89,510	47016	$ 157,974	24000	$ 80,640
31099	$ 206,199	143088	$ 948,731	96480	$ 639,701	30000	$ 198,912	60000	$ 397,824	30528	$ 202,413
	$ -		$ -	20000	$ 175,168	6000	$ 52,550	15000	$ 131,376	6000	$ 52,550
	$ -		$ -	20000	$ 515,200	6000	$ 154,560	15000	$ 386,400	6000	$ 154,560
	$ -		$ -		$ -		$ -		$ -		$ -
	$ -		$ -		$ -		$ -		$ -		$ -
	$ 206,199		$ 948,731		$ 1,598,869		$ 495,533		$ 1,073,574		$ 490,163
5.9	$ 108,371	27.1	$ 497,773	41	$ 753,088	13	$ 238,784	26	$ 477,568	12.6	$ 231,437
5.9	$ 8,194	27.1	$ 37,636	41	$ 56,941	13	$ 18,054	26	$ 36,109	12.6	$ 17,499
	$ 116,565		$ 535,409		$ 810,029		$ 256,838		$ 513,677		$ 248,936
	$ -		$ -		$ -		$ -		$ -		$ -
	$ -		$ -		$ -		$ -		$ -		$ -
	$ -		$ -		$ -		$ -		$ -		$ -
	$ -		$ -		$ -		$ -		$ -		$ -
	$ -		$ -	1	$ 10,000	1	$ 10,000		$ -	1	$ 10,000
	$ -		$ -		$ -		$ -		$ -		$ -
	$ -		$ -		$ 10,000		$ 10,000		$ -		$ 10,000
	$ 325,047		$ 1,487,636		$ 2,418,898		$ 762,371		$ 1,587,251		$ 750,724
	$ 97,514		$ 446,291		$ 725,669		$ 228,711		$ 476,175		$ 225,217
	$ 42,256		$ 193,393		$ 314,457		$ 99,108		$ 206,343		$ 97,594
	$ 8,451		$ 38,679		$ 62,891		$ 19,822		$ 41,269		$ 19,519
	$ 16,902		$ 77,357		$ 125,783		$ 39,643		$ 82,537		$ 39,038
	$ 25,354		$ 116,036		$ 188,674		$ 59,465		$ 123,806		$ 58,556
	$ 8,451		$ 38,679		$ 62,891		$ 19,822		$ 41,269		$ 19,519
	$ 8,451		$ 38,679		$ 62,891		$ 19,822		$ 41,269		$ 19,519
	$ 8,451		$ 38,679		$ 62,891		$ 19,822		$ 41,269		$ 19,519
	$ 118,317		$ 541,499		$ 880,479		$ 277,503		$ 577,759		$ 273,264
	$ 540,879		$ 2,475,426		$ 4,025,046		$ 1,268,586		$ 2,641,185		$ 1,249,205
	$ 91,830		$ 91,344		$ 98,172		$ 97,584		$ 101,780		$ 99,143
	$ 12,014		$ 12,014		$ 12,014		$ 12,014		$ 12,014		$ 12,014
	$ 79,816		$ 79,330		$ 86,158		$ 85,569		$ 89,765		$ 87,129
	$ 470,114		$ 2,149,837		$ 3,532,458		$ 1,112,399		$ 2,329,413		$ 1,097,825

		Segment No.	Segment S1		Segment S2		Segment S3		Segment S4		Segment S5		Segment S6	
		From - To	Denver to Suburban South via Joint Line		Suburban South to Castle Rock via Joint Line		Suburban South to Castle Rock via Greenfield		Castle Rock to Palmer Lake via Joint Line		Palmer Lake to Colorado Springs via restored ATSF and I25 segment		Palmer Lake to Colorado Springs via double track DRGW	
		Host Carrier	BNSF/UP		BNSF/UP		GF		BNSF/UP		BNSF/UP		BNSF/UP	
		Mileposts	JL 14-JL 0		JL 32.8-JL 14		GF 190.2-GF212		JL 51.2-JL 32.8		JL 73-ATSF 686.3		JL 72.8 - JL52	
		Miles		14.0		18.8		21.8		18.4		21.6		20.8
		Lineal Feet		73,920		99,106		114,946		96,941		114,206		109,771
Cost Elements	Unit	**Unit Cost**	Quantity	Amount	Quantity	Amount	Quantity	Amount	Quantity	Amount	Quantity	Amount	Quantity	Amount
Right of Way														
Land Acquisition Rural	Mile	$ 129.0		$ -	14	$ 1,806	15	$ 1,935	14.4	$ 1,858	16.6	$ 2,141	15	$ 1,935
Land Acquisition Urban	Mile	$ 387.0	14	$ 5,418	4.8	$ 1,858	6.8	$ 2,632	4	$ 1,548	5	$ 1,935	5.8	$ 2,245
Sub Right of Way				$ 5,418		$ 3,664		$ 4,567		$ 3,406		$ 4,076		$ 4,180
Guideway & Track														
At Grade Guideway	LF	$ 3.4		$ -		$ -	40000	$ 134,400		$ -	20000	$ 67,200		$ -
Aerial Guideway Type A	LF	$ 6.6	69920	$ 463,598	94106	$ 623,960	63000	$ 417,715	91941	$ 609,606	85206	$ 564,950	104771	$ 694,674
Aerial Guideway Type B	LF	$ 8.8		$ -		$ -	5000	$ 43,792	0	$ -	3000	$ 26,275		$ -
Bridge	LF	$ 25.8	4000	$ 103,040	5000	$ 128,800	6946	$ 178,929	5000	$ 128,800	6000	$ 154,560	5000	$ 128,800
Tunnel Type A	LF	$ 33.6		$ -		$ -		$ -		$ -		$ -		$ -
Tunnel Type B	LF	$ 44.8		$ -		$ -		$ -		$ -		$ -		$ -
Sub Guideway & Track				$ 566,638		$ 752,760	114946	$ 774,836		$ 738,406		$ 812,985		$ 823,474
Systems														
Propulsion, C& C Systems	Mile	$ 18,368	14	$ 257,152	18.8	$ 345,318	21.8	$ 400,422	18.4	$ 337,971	21.6	$ 396,749	20.8	$ 382,054
Power Distribution	Mile	$ 1,389	14	$ 19,443	18.8	$ 26,109	21.8	$ 30,276	18.4	$ 25,554	21.6	$ 29,998	20.8	$ 28,887
Sub Systems				$ 276,595		$ 371,428		$ 430,698		$ 363,525		$ 426,747		$ 410,941
Maintenance Facilities														
Maintenance Facilities	Sections	$ 3,080.0												
Stations & Parking														
Full Service - New - Low Volume - 500 Surface Park		$ 5,000		$ -		$ -		$ -		$ -		$ -		$ -
Full Service - Renovated - Low Volume- 500 Surface Park		$ 4,000		$ -		$ -		$ -		$ -		$ -		$ -
Terminal - New - Low Volume - 500 Surface Park		$ 7,500		$ -		$ -		$ -		$ -		$ -		$ -
Terminal - Renovated - Low Volume - 500 Surface Park		$ 6,000		$ -		$ -		$ -		$ -		$ -		$ -
Full Service - New- High Volume - Dual Platform - 1000 Surface Park		$ 10,000	1	$ 10,000	1	$ 10,000	1	$ 10,000	1	$ 10,000	1	$ 10,000	1	$ 10,000
Terminal - New- High Volume - Dual Platform - 1000 Surface Park		$ 15,000	1	$ 15,000		$ -		$ -		$ -		$ -		$ -
Stations & Parking				$ 25,000		$ 10,000		$ 10,000		$ 10,000		$ 10,000		$ 10,000
Sub Construction Costs				$ 873,651		$ 1,137,852		$ 1,220,101		$ 1,115,336		$ 1,253,808		$ 1,248,595
Contingency	30%			$ 262,095		$ 341,356		$ 366,030		$ 334,601		$ 376,143		$ 374,578
Other Costs														
Design Engineering	10%			$ 113,575		$ 147,921		$ 158,613		$ 144,994		$ 162,995		$ 162,317
Insurance and Bonding	2%			$ 22,715		$ 29,584		$ 31,723		$ 28,999		$ 32,599		$ 32,463
Program Management	4%			$ 45,430		$ 59,168		$ 63,445		$ 57,997		$ 65,198		$ 64,927
Const Mgt & Insp	6%			$ 68,145		$ 88,752		$ 95,168		$ 86,996		$ 97,797		$ 97,390
Eng During Construction	2%			$ 22,715		$ 29,584		$ 31,723		$ 28,999		$ 32,599		$ 32,463
Integrated Testing & Com	2%			$ 22,715		$ 29,584		$ 31,723		$ 28,999		$ 32,599		$ 32,463
Erosion Control & Water Mgt	2%			$ 22,715		$ 29,584		$ 31,723		$ 28,999		$ 32,599		$ 32,463
Sub Other Costs				$ 318,009		$ 414,178		$ 444,117		$ 405,982		$ 456,386		$ 454,488
Total Infrastructure Costs VHS Maglev				$ 1,453,755		$ 1,893,385		$ 2,030,248		$ 1,855,920		$ 2,086,337		$ 2,077,662
Cost Per Mile				$ 103,840		$ 100,873		$ 93,259		$ 101,085		$ 96,456		$ 99,936
Systems Cost for VHS Maglev														
Propulsion, C& C Systems	Mile	$ 18,368												
Power Distribution	Mile	$ 1,389												
Sub Systems	Mile	$ 19,757												
System Cost for Urban Maglev	Mile	$ 7,742		$ 12,014		$ 12,014		$ 12,014		$ 12,014		$ 12,014		$ 12,014
Difference in Base Cost per Mile	Mile	$ 12,014		$ 91,825		$ 88,859		$ 81,245		$ 89,071		$ 84,441		$ 87,921
Cost per Mile Urban Maglev				$ 1,285,554		$ 1,667,876		$ 1,768,696		$ 1,635,336		$ 1,826,467		$ 1,827,883
Cost per Segment Urban Maglev														

Segment S7		Segment S8		Segment S9		Segment S10		Segment S11		Segment S12		Segment S13		Segment S14	
Castle Rock to Colorado Springs via Greenfield (no Diversion)		Greenfield Monument Diversion - Placeholder, net of 15.03 Straight Line miles		Colorado Springs to Fountain		Fountain to Pueblo via Joint Line		Fountain to Pueblo via Greenfield		Pueblo to North Trinidad via Spanish Peaks Sub		Pueblo to North Trinidad via Greenfield		North Trinidad to downtown Trinidad	
BNSF/UP/GF		GF		BNSF/UP		BNSF/UP		BNSF/UP/GF		BNSF		GF		BNSF	
JL 72.8-GF 190.2		GF 144.4-GF 171.7		JL 84.5-JL 73		ATSF618.4-JL 84.5		GF 80- JL 84.4		ATSF 618.4-SP204		GF 0-GF 80		Transcon- SP 204	
	27.8		27.8		11.5		36.4		48.1		84.0		80.0		8.2
	146,626		146,626		60,720		191,981		253,757		443,520		422,400		43,085
Quantity	Amount	Quantity	Amount	Quantity	Amount	Quantity	Amount	Quantity	Amount	Quantity	Amount	Quantity	Amount	Quantity	Amount
21	$ 2,709	21	$ 2,709	8	$ 1,032	30	$ 3,870	40	$ 5,160	80	$ 10,320	72	$ 9,288	6.2	$ 800
6.8	$ 2,632	6.8	$ 2,632	3.5	$ 1,355	6.4	$ 2,477	8.1	$ 3,135	4	$ 1,548	8	$ 3,096	2	$ 774
	$ 5,341		$ 5,341		$ 2,387		$ 6,347		$ 8,295		$ 11,868		$ 12,384		$ 1,574
30000	$ 100,800	30000	$ 100,800		$ -		$ -	108757	$ 365,424		$ -	180000	$ 604,800		$ -
100000	$ 663,040	100000	$ 663,040	56000	$ 371,302	181981	$ 1,206,607	125000	$ 828,800	400000	$ 2,652,160	200000	$ 1,326,080	40085	$ 265,780
6626	$ 58,033	6626	$ 58,033		$ -		$ -	5000	$ 43,792		$ -		$ -	1000	$ 8,758
10000	$ 257,600	10000	$ 257,600	4720	$ 121,587	10000	$ 257,600	15000	$ 386,400	43520	$ 1,121,075	42240	$ 1,088,102	2000	$ 51,520
	$ -		$ -		$ -		$ -	0	$ -		$ -		$ -		$ -
	$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -
	$ 1,079,473		$ 1,079,473		$ 492,890		$ 1,464,207	253757	$ 1,624,416		$ 3,773,235		$ 3,018,982		$ 326,058
27.8	$ 510,630	27.8	$ 510,630	11.5	$ 211,232	36.4	$ 668,595	48.1	$ 883,501	84	$ 1,542,912	80	$ 1,469,440	8.2	$ 150,618
27.8	$ 38,609	27.8	$ 38,609	11.5	$ 15,971	36.4	$ 50,552	48.1	$ 66,801	84	$ 116,659	80	$ 111,104	8.2	$ 11,388
	$ 549,239		$ 549,239		$ 227,203		$ 719,148		$ 950,302		$ 1,659,571		$ 1,580,544		$ 162,006
	$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -
	$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -
	$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -
	$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -
1	$ 10,000		$ -		$ -	1	$ 10,000	1	$ 10,000		$ -		$ -	1	$ 10,000
	$ -		$ -		$ -		$ -		$ -		$ -		$ -		$ -
	$ 10,000		$ -		$ -		$ 10,000		$ 10,000		$ -		$ -		$ 10,000
	$ 1,644,053		$ 1,634,053		$ 722,479		$ 2,199,701		$ 2,593,012		$ 5,444,674		$ 4,611,910		$ 499,638
	$ 493,216		$ 490,216		$ 216,744		$ 659,910		$ 777,904		$ 1,633,402		$ 1,383,573		$ 149,891
	$ 213,727		$ 212,427		$ 93,922		$ 285,961		$ 337,092		$ 707,808		$ 599,548		$ 64,953
	$ 42,745		$ 42,485		$ 18,784		$ 57,192		$ 67,418		$ 141,562		$ 119,910		$ 12,991
	$ 85,491		$ 84,971		$ 37,569		$ 114,384		$ 134,837		$ 283,123		$ 239,819		$ 25,981
	$ 128,236		$ 127,456		$ 56,353		$ 171,577		$ 202,255		$ 424,685		$ 359,729		$ 38,972
	$ 42,745		$ 42,485		$ 18,784		$ 57,192		$ 67,418		$ 141,562		$ 119,910		$ 12,991
	$ 42,745		$ 42,485		$ 18,784		$ 57,192		$ 67,418		$ 141,562		$ 119,910		$ 12,991
	$ 42,745		$ 42,485		$ 18,784		$ 57,192		$ 67,418		$ 141,562		$ 119,910		$ 12,991
	$ 598,435		$ 594,795		$ 262,982		$ 800,691		$ 943,856		$ 1,981,861		$ 1,678,735		$ 181,868
	$ 2,735,704		$ 2,719,064		$ 1,202,206		$ 3,660,303		$ 4,314,772		$ 9,059,938		$ 7,674,219		$ 831,397
	$ 98,513		$ 97,914		$ 104,540		$ 100,668		$ 89,779		$ 107,856		$ 95,928		$ 101,887
	$ 12,014		$ 12,014		$ 12,014		$ 12,014		$ 12,014		$ 12,014		$ 12,014		$ 12,014
	$ 86,499		$ 85,899		$ 92,525		$ 88,654		$ 77,765		$ 95,842		$ 83,913		$ 89,873
	$ 2,402,066		$ 2,385,426		$ 1,064,041		$ 3,223,461		$ 3,737,363		$ 8,050,734		$ 6,713,072		$ 733,360

E.5 Capital Cost Development for RMRA Feasible Options

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INFRASTRUCTURE CAPITAL COSTS DETAIL FOR THE FEASIBLE OPTIONS

Section 1: Segment Costs included in Representative Routes

Maintenance Bases

	110-mph wo/ Electrification	Electric Rail + Maglev
System Maintenance Base	$80,000	$100,000
Turnaround Facilities	$30,000	$70,000

110-mph and 150-mph Networks in I-25:

ID	Segment	Miles	110-mph wo/ Electrification	150-mph w/ Electrification
Segment N1	Denver to 96 St via Brush Line	11.2	$337,239	$357,399
Segment N3	96th St to E470/US85	8.7	$164,969	$180,629
Segment N4	E470/US85 to Milliken Jct via Greeley Line	21.5	$165,749	$204,449
Segment N5	Milliken Junction to North Front Range via Milliken Line	15.45	$242,265	$270,075
Segment N6	North Front Range to Fort Collins via Milliken Line	24.12	$91,502	$134,918
Segment S1	Denver to Suburban South via Joint Line	14	$73,347	$98,547
Segment S2	Suburban South to Castle Rock via Joint Line	18.77	$350,554	$384,340
Segment S4	Castle Rock to Palmer Lake via Joint Line	18.36	$103,238	$136,286
Segment S6	Palmer Lake to Colorado Springs via double track DRGW	20.79	$550,404	$587,826
Segment S9	Colorado Springs to Fountain	11.5	$90,856	$111,556
Segment S10	Fountain to Pueblo via Joint Line	36.36	$213,025	$278,473
			$2,383,148	**$2,744,498**

220-mph Network in I-25:

			220-mph w/ Electrification	300-mph Maglev
Segment N1	Denver to 96 St via Brush Line	11.2	$357,399	$1,211,981
Segment N3	96th St to E470/US85	8.7	$180,629	
Segment N11	E470/US85 to North Front Range via I25	41	$1,123,966	
Segment N12	North Front Range to North Fort Collins via I25	13	$369,962	
Segment S1	Denver to Suburban South via Joint Line	14	$98,547	
Segment S3	Suburban South to Castle Rock via Greenfield	21.77	$1,186,088	
Segment S7	Castle Rock to Colorado Springs via Greenfield (no Diversion)	27.77	$913,392	
Segment S9	Colorado Springs to Fountain	11.5	$111,556	
Segment S11	Fountain to Pueblo via Greenfield	48.06	$1,518,768	
			$5,860,307	

DIA Branch

ID	Segment	Miles	110-mph wo/ Electrification	150-mph and 220-mph w/ Electrification	300-mph Maglev
Segment N2	96th St to DIA greenfield	9	**$173,183**	**$189,383**	**$758,560**

220-mph Network in I-70 (Constrained or HWY Footprint):

			220-mph w/ Electrification	300-mph Maglev
Segment W1	Denver to US6/I70 Junction via US6	11.55	$921,307	$1,090,509
Segment W9	US6/I70 Junction to Floyds Hill via El Rancho on I70	17.25	$1,482,537	$1,543,234
Segment W8	Black Hawk Tunnel N Portal to Central City/Black Hawk	4	$411,716	$381,158
Segment W10	Floyds Hill to Blackhawk Tunnel N Portal	1	$402,564	$453,694
Segment W11	Floyds Hill to Idaho Springs via I70	4.35	$428,461	$416,731
Segment W13	Idaho Springs to Georgetown via I70	10.5	$909,739	$872,450
Segment W15	Georgetown to Silver Plume via I70	4.9	$419,241	$465,131
Segment W17	Silver Plume to Loveland Pass via I70	8.6	$754,951	$717,589
Segment W20	Loveland Pass to Silverthorne via EJMT	9.9	$1,461,341	$1,569,019
Segment W21	Keystone to West Keystone via US6	2.85	$136,400	$279,484
Segment W22	West Keystone to Silverthorne via US6	4.2	$294,754	$319,287

Segment W23	West Keystone to Breckenridge Junction	4.3	$983,491	$1,200,275
Segment W24	Breckenridge Junction to Breckenridge	1.21	$47,216	$111,027
Segment W27	Silverthorne to Frisco via I70	4.6	$393,573	$392,554
Segment W28	Frisco to Copper Mtn via I70	6.3	$559,279	$531,478
Segment W30	Copper Mtn to Vail via I70	21.1	$1,808,918	$1,740,940
Segment W32	Vail to Minturn via I70	2.9	$274,988	$280,576
Segment W33	Minturn to Avon	5.5	$238,033	$437,089
Segment W34	Avon to Wolcott	10.6	$497,154	$804,989
Segment W35	Wolcott to Eagle Airport	16.59	$668,293	$1,276,596
			$13,093,956	**$14,883,810**

150-mph Network in I-70 (Unconstrained):

			150-mph w/ Electrification
Segment W3	Denver to Downtown Golden via Arvada	16	$1,015,636
Segment W4	Downtown Golden to entrance to Clear Creek Canyon	0.9	$55,731
Segment W5	Clear Creek Canyon entrance to Forks Creek via US6	9.6	$2,091,456
Segment W6	Forks Creek to Floyds Hill via US6	3.38	$530,778
Segment W7	Forks Creek to Black Hawk Tunnel N Portal	2.9	$202,754
Segment W8	Black Hawk Tunnel N Portal to Central City/Black Hawk	4	$411,716
Segment W12	Floyds Hill to Idaho Springs via Unconstrained	4.35	$367,312
Segment W14	Idaho Springs to Georgetown via Unconstrained	10.5	$591,978
Segment W16	Georgetown to Silver Plume via Unconstrained	4.85	$1,108,135
Segment W18	Silver Plume to Loveland Pass via Unconstrained	9.17	$377,810
Segment W19	Loveland Pass to Keystone via North Fork Tunnel	8.63	$2,399,883
Segment W21	Keystone to West Keystone via US6	2.85	$136,400
Segment W23	West Keystone to Breckenridge Junction	4.3	$983,491
Segment W24	Breckenridge Junction to Breckenridge	1.21	$47,216
Segment W25	Breckenridge to Copper Mtn via Tunnel	4.84	$1,700,903
Segment W29	Copper Mtn to Pando via Greenfield	16.06	$818,829
Segment W31	Pando to Minturn via existing Rail ROW	18	$911,365
Segment W32	Vail to Minturn via I70	2.9	$274,988
Segment W33	Minturn to Avon	5.5	$238,033
Segment W34	Avon to Wolcott	10.6	$497,154
Segment W35	Wolcott to Eagle Airport	16.59	$668,293
			$15,429,861

Section 2: Infrastructure Cost Summaries*

Option 2- 110 mph in I-25 (Truncated)

I-25 Existing Rail mainline	$2,383,148
DIA Branch	$173,183
System Maintenance Base	$80,000
Turnaround Facilities	$30,000
I-25 Subtotal	**$2,666,331**---> Rounds to $2.7 Billion

Option 4- 150 mph in I-25 and I-70 (Truncated)

I-25 Existing Rail mainline (Electrified)	$2,744,498
DIA Branch	$189,383
I-25 Subtotal	**$2,933,881**---> Rounds to $2.9 Billion
I-70 Unconstrained Alignment	$15,429,861
System Maintenance Base	$100,000
Turnaround Facilities	$70,000
I-70 Subtotal	**$15,599,861**---> Rounds to $15.6 Billion

Option 5- 220 mph in I-25 and I-70 (Truncated)

I-25 Greenfield	$5,860,307
DIA Branch	$189,383
I-25 Subtotal	**$6,049,690**---> Rounds to $6.0 Billion
I-70 Constrained Alignment	$13,093,956
System Maintenance Base	$100,000
Turnaround Facilities	$70,000
I-70 Subtotal	**$13,263,956**---> Rounds to $13.3 Billion

Option 7- 110 mph in I-25 and 220-mph on I-70 (Truncated)

I-25 Existing Rail mainline	$2,383,148	
DIA Branch	$189,383	
I-25 Subtotal	**$2,572,531**	---> Rounds to $2.5 Billion
I-70 Constrained Alignment	$13,093,956	
System Maintenance Base	$100,000	
Turnaround Facilities	$70,000	
I-70 Subtotal	**$13,263,956**	---> Rounds to $13.3 Billion

Option 8- 150 mph in I-25 and 220-mph on I-70 (Truncated)

I-25 Existing Rail mainline (Electrified)	$2,744,498	
DIA Branch	$189,383	
I-25 Subtotal	**$2,933,881**	---> Rounds to $2.9 Billion
I-70 Constrained Alignment	$13,093,956	
System Maintenance Base	$100,000	
Turnaround Facilities	$70,000	
I-70 Subtotal	**$13,263,956**	---> Rounds to $13.3 Billion

Option 9- 110 mph in I-25 and 300-mph on I-70 (Truncated)

I-25 Existing Rail mainline	$2,383,148	
DIA Branch Rail	$189,383	
Turnaround Facilities	$70,000	
I-25 Subtotal	**$2,642,531**	---> Rounds to $2.6 Billion
I-70 Constrained Alignment Maglev	$14,883,810	
System Maintenance Base	$100,000	

US6/US25 to Downtown Denver subsegment (est)	$600,000
I-70 Subtotal	**$15,583,810**---> Rounds to $15.6 Billion

Options 5W and 9W

These are the same as options 5 and 9, respectively; with $1 Billion in infrastructure cost added for 110-mph option and $200 million added for Vehicles

* *All costs in thousands of $2008. Some costs were rounded up or down, so the overall total would come closer*

F Unit Price Regional & Escalation Analysis

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Rocky Mountain Rail Authority
High Speed Rail Feasibility Study
Capital Cost Estimate
Unit Price Development
March 13, 2008

The principals of Quandel Consultants, LLC developed unit costs for the design and construction of high speed passenger rail infrastructure on a series of previous planning projects. Initially the unit costs were applied to planned construction of the Midwest Regional Rail Initiative. Later the costs were applied to capital cost estimates for high speed rail in Florida, Ohio, Minnesota and California.

The base set of unit costs addresses typical passenger rail infrastructure construction elements including: roadbed and trackwork, systems, facilities, structures, and grade crossings.

The unit costs have been evaluated by peer panels, freight railroads and contractors. The values have been found to be reasonable for developing the capital costs under normal contractor bidding procedures and under railroad force account agreements for construction. It should be noted that in two cases the costs have not been sufficient, specifically:

- DBOM procurement, where the contractor takes on large future operating risks and seeks to front load the risk in the initial construction
- Rail alignments constructed in narrow highway medians under congested urban traffic

The unit costs were developed and evaluated in the period between January 2000 and June 2002. Two questions must be considered in applying these costs to high speed rail planning in Colorado:

1. Relative Costs: Are the costs reasonable for rail construction in Colorado considering local costs of materials and labor?
2. Cost Escalation: How should the costs be escalated from the nominal June 2002 values to current values considering the historical changes in construction costs?

A variety of indices are employed to monitor construction costs throughout the United States. However, no publicly available index exists for rail construction. In addition, relatively few recent examples of completed intercity passenger rail construction are found. This is especially true for high speed applications.

Relative Costs:

Engineering News Record tracks a Building Cost index and a more general Construction Cost Index in major cities and averages the values to produce national indices. It is reasonable to assume that the Construction Cost Index is a better indicator of regional cost differences for a transportation project than the Building Cost Index. The Construction Cost Index (CCI) is calculated as the sum of 200 hours of local (union) common labor including fringes plus the local cost of 1.128 tons of Portland cement plus the national average price of 25cwt of fabricated structural steel. The Construction Cost indices from 1990 to 2008 indicate that construction costs in Denver have been typically 20-30% lower than national construction costs and 25-40% lower than an arbitrary average of costs in the Midwest. However, Kansas City has had a consistently lower CCI than Denver over the period.

To some extent, the construction cost of relatively specialized products and systems is independent of local regional costs. In the case of railroad construction, the costs of key materials such as rail, concrete ties and signal equipment are relatively uniform throughout the country. Similarly, the cost of skilled labor and mechanized track laying systems will be similar in all locations. These factors tend to diminish the regional construction cost differences.

Cost Escalation:

Multiple State DOTs prepare periodic highway construction cost indices based on the tabulated bid prices of earthwork, asphalt pavement, concrete pavement, structural concrete, reinforcing steel and structural steel to assemble a composite index tied to base year costs in 1987. The State of Washington publishes the indices for the states of Washington, California, Colorado, Oregon, South Dakota, Utah and an FHWA composite. (The FHWA discontinued preparing the composite index in 2006). This data cannot be used to compare the absolute costs of highway construction among states, but may be used to compare the price trends. Comparing the indices over the 6 year period from 2002 to 2008, the Colorado index has outpaced the others, increasing by a factor of 2.21 compared to an average of 1.91 for the six states.

The Bureau of Labor Statistics prepares a variety of monthly, national Producer Price Indices, which are often used for escalation cost adjustments in construction projects. Two such indices may be suitable for our application, the Highway and Street Construction Index (PCUBHWY) and the Other Heavy Construction Index (PCUBHVY). A computation of escalation from June 2002 to January 2009 using either index yields similar results (HWY=51%, HVY=44%), but as the highway index is heavily influenced by the costs of petroleum products such as asphalt, it is reasonable to assume that the Other Heavy Construction Index is more suitable for our purpose.

Unit Price Adjustment:

Based on the available data, it is reasonable to believe that the June 2002 unit costs developed for the Midwest can be adjusted downward for use in Colorado during the same time period. Considering the regional CCI difference and the relative uniformity of railroad material prices, an adjustment factor of 0.85 is reasonable.

While the BLS PPI suggests a national escalation factor of 1.44 for the period, the coincident Colorado DOT highway cost escalation factor of 2.21 is significant and suggests that construction cost escalation in Colorado exceeds that represented in the BLS value. The State of Colorado DOT has attributed much of the highway cost escalation to a regional shortage of Portland cement and high worldwide demand for asphalt, petroleum products and steel.

While the cost of rail construction is energy intensive due to the requirement for extensive grading to achieve desirable grades and curves, it is less so than highway construction which uses petroleum products such as asphalt as a construction material. While a precise methodology for discounting the observed Colorado highway cost inflation does not exist, it is reasonable to believe that the regional escalation factor for rail construction over the period lies somewhere between the BLS PPI value of 1.44 and the CDOT value of 2.21. An average of the two values yields 1.825.

Therefore the unit cost adjustment value considering regional cost differences and inflation from June 2002 to January 2009 is computed as follows:

New Unit Cost = Original Unit Cost x 0.85 x 1.825 or Original Unit Cost x 1.55

ENR Construction Cost Index

The construction cost index for ENR's individual cities use the same components and weighting as those for the 20-city national indexes. The city indexes use local prices for portland cement and 2 X 4 lumber and the national average price for structural steel. The city's CCI uses local union wages, plus fringes, for laborers. Year 1913=100.

		Denver		National		Chicago	Kansas City	Cincinnati	St Louis	Midwest	Ratio	Ratio
										Coarse	Denver	Denver
										Avg	National	Midwest
1990	**Dec.**	3668		4777		4999	4764	4934	5091	4947	77%	74%
1991	**Dec.**	3715		4889		5384	4762	5011	5172	5082	76%	73%
1992	**Dec.**	3834		5059		5644	4956	5209	5316	5281	76%	73%
1993	**Dec.**	4012		5310		5963	5224	5345	5765	5574	76%	72%
1994	**Dec.**	4009		5439		6178	5305	5504	5947	5733	74%	70%
1995	**Dec.**	4088		5524		6334	5370	5451	6054	5802	74%	70%
1996	**Dec.**	4334		5744		6743	5653	5489	6302	6047	75%	72%
1997	**Dec.**	4329		5858		6626	5909	5585	6475	6149	74%	70%
1998	**Dec.**	4470		5991		7087	5981	5641	6599	6327	75%	71%
1999	**Dec.**	4498		6127		7465	6000	5889	6806	6540	73%	69%
2000	**Dec.**	4767		6283		7748	6221	6045	6851	6716	76%	71%
2001	**Dec.**	4663		6390		7680	6477	5858	7048	6766	73%	69%
2002	**Dec.**	4744		6563		7965	6782	6156	7197	7025	72%	68%
2003	**Dec.**	5015		6782		8348	6972	6287	7414	7255	74%	69%
2004	**Dec.**	5450		7308		9351	8020	6997	7882	8063	75%	68%
2005	**Dec.**	5552		7647		10126	8125	7108	8449	8452	73%	66%
2006	**Dec.**	5714		7888		10523	8705	7416	8537	8795	72%	65%
2007	**Dec.**	5747		8089		11138	8975	7588	8749	9112	71%	63%
2008	**Dec.**	5936		8551		11858	9392	7924	9044	9554	69%	62%

CONSTRUCTION COST INDICES

YEAR	WASHINGTON 1990 = 110	FHWA 1987 = 100	CALIFORNIA 1987 = 100	COLORADO 1987 = 100	OREGON 1987 = 100	SOUTH DAKOTA 1987 = 100	UTAH 1987 = 100
1990	110	109	114	103	107	112	128
1991	121	108	108	111	119	114	126
1992	108	105	107	111	109	112	126
1993	106	108	113	115	115	117	151
1994	105	115	119	119	112	120	135
1995	124	122	115	122	138	133	166
1996	124	120	119	142	135	133	176
1997	139	131	125	140	150	147	163
1998	116	127	129	158	142	149	146
1999	120	137	139	159	155	169	143
2000	128	146	146	171	148	180	132
2001	129	145	154	157	130	153	153
2002	139	148	142	150	164	154	153
2003	145	150	149	154	172	161	127
2004	170	154	216	168	162	202	153
2005	176	184	268	255	206	196	260
2006	228	221	281	256	248	246	294
2007	230	—	261	271	241	268	253
2008	241	—	287	331	283	256	323

WSDOT 2008 Index is for the 2008 calendar year

California, Colorado, Oregon, and Utah 2008 CCI is for quarters 1, 2, & 3. South Dakota CCI is for quarters 1 & 2.

WSDOT 2003 and 2004 CCI data points adjusted to correct for spiking bid prices on structural steel

Note: FHWA CCI discontinued in 2007

Washington State Department of Transportation

For more information, please call the WSDOT Construction Office at (360) 705-7822
or visit http://www.wsdot.wa.gov/biz/construction

1/5/2009

Escalation Factor Calculation 2002-2008

	2008	2002	Ratio
Washington	241	139	1.73
California	287	142	2.02
Colorado	331	150	2.21
Oregon	283	164	1.73
South Dakota	256	154	1.66
Utah	323	153	2.11
Average Ratio	1721	902	1.91

ENR Construction Cost Index

The construction cost index for ENR’s individual cities use the same components and weighting as those for the 20-city national indexes. The city indexes use local prices for portland cement and 2 X 4 lumber and the national average price for structural steel. The city’s CCI uses local union wages, plus fringes, for laborers. Year 1913=100.

		Denver	National	Chicago	Kansas City	Cincinatti	St Louis	Midwest
1978	Dec.	2564.8						Coarse
1979	Dec.	2739.1						Avg
1980	Dec.	2947.1						
1981	Dec.	3200.6						
1982	Dec.	3445.7						
1983	Dec.	3690.2						
1984	Dec.	3106.4						
1985	Dec.	3316.2						
1986	Dec.	3503.4						
1987	Dec.	3507.0						
1988	Dec.	3538.3						
1989	Dec.	3641.8						
1990	Dec.	3668.2	4777	4999	4764	4934	5091	4947
1991	Dec.	3715.3	4889	5384	4762	5011	5172	5082
1992	Dec.	3833.6	5059	5644	4956	5209	5316	5281
1993	Dec.	4012.0	5310	5963	5224	5345	5765	5574
1994	Dec.	4008.7	5439	6178	5305	5504	5947	5733
1995	Dec.	4087.8	5524	6334	5370	5451	6054	5802
1996	Dec.	4334.1	5744	6743	5653	5489	6302	6047
1997	Dec.	4329.2	5858	6626	5909	5585	6475	6149
1998	Dec.	4470.4	5991	7087	5981	5641	6599	6327
1999	Dec.	4498.5	6127	7465	6000	5889	6806	6540
2000	Dec.	4766.7	6283	7748	6221	6045	6851	6716
2001	Dec.	4663.1	6390	7680	6477	5858	7048	6766
2002	Dec.	4744.3	6563	7965	6782	6156	7197	7025
2003	Dec.	5015.4	6782	8348	6972	6287	7414	7255
2004	Dec.	5450.3	7308	9351	8020	6997	7882	8063
2005	Dec.	5551.6	7647	10126	8125	7108	8449	8452
2006	Dec.	5714.3	7888	10523	8705	7416	8537	8795
2007	Dec.	5747.0	8089	11138	8975	7588	8749	9112
2008	Dec.	5935.7	8551	11858	9392	7924	9044	9554
2009	Jan.	5921.7						
	Feb.	5907.5						
	Mar.	5910.0						

Bureau of Labor Statistics: Producer Price Indices

Series Id: PCUBHVY--BHVY--
Industry: Other heavy construction
Product: Other heavy construction
Base Date: 198606

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1999	132.4	132.2	132.6	133.7	134.2	134.5	135.7	136.2	136.4	136.1	136.3	136.9	134.8
2000	137.8	139	140	139.5	139.3	140.5	140.3	139.8	140.8	140.6	140.4	139.7	139.8
2001	140.1	140.3	139.9	140.5	141.9	141.7	139.7	139.7	140.4	137.9	137.1	136.1	139.6
2002	136.3	136.2	136.7	137.4	137.3	137.5	137.6	137.8	138.1	138.1	137.6	137.4	137.3
2003	138	138.8	139.2	138.8	138.6	138.9	139.2	139.5	140.3	140.3	140.6	141	139.4
2004	143.3	145.3	148.4	151.3	153.8	153.9	155.5	157.9	159	161.5	161.2	159.9	154.2
2005	162.3	163.9	166.4	167.4	166.8	167.8	169.8	171.2	174.1	177.1	173.2	174	169.5
2006	176.3	175.8	177.8	181.5	184	186.4	187.7	188.6	184.4	182.9	182.7	183.5	182.6
2007	182.6	183.9	187.1	190.3	192.6	192.6	194.6	192.3	193.1	193.3	197.4	196.1	191.3
2008	197.9	199.7	205.3	210.1	216.9	222.5	227.3	224.7	225.3	216.5(p)	206.0(p)	198.8(p)	212.6(p)
2009	198.0(p)												

p : Preliminary. All indexes are subject to revision four months after original publication.

PCUBHVY Computation	Jan 09	198	Ratio	1.44
	Jun 02	137.5		

Series Id: PCUBHWY--BHWY--
Industry: Highway and street construction
Product: Highway and street construction
Base Date: 198606

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1999	122.8	122.6	123.3	125.4	125.9	126	126.9	128.1	129	128.8	129.6	130.7	126.6
2000	132	134	136	135.6	135.8	137.6	137.1	136.6	138.9	138.5	138.4	137.3	136.5
2001	137.8	138.2	137.4	138.5	139.9	138.8	136.6	137	138.4	135.4	134.1	132.4	137
2002	132.9	132.4	132.7	133.3	133.8	133.9	134.1	134.2	134.4	134.4	133.9	133.7	133.7
2003	134.7	135.7	136.8	137.1	137	136.9	136.7	136.9	136.8	136.7	137.1	137.2	136.6
2004	140.5	141.2	142.5	145.2	147.9	147	149.2	150.5	151.8	155.5	155.4	152	148.2
2005	154.3	156.5	160.4	162.9	162.4	163.7	167.6	170	176.1	180.8	173.1	173.4	166.8
2006	177.5	175.9	179.4	185.4	187.9	190.4	191.8	192.9	185.9	183.2	182.9	184.1	184.8
2007	183.1	185.2	190	194.6	197.6	196.8	200	195.9	197.5	197.5	204.9	202.7	195.5
2008	204.7	205.9	213.8	218.5	227.3	234.4	243.5	239.3	241.1	227.4(p)	212.4(p)	201.0(p)	222.5(p)
2009	201.8(p)												

ENR Cost Indices		BCI		CCI	
City Cost Index - Chicago					
1990	**Dec.**	2893.6	1.3	4999	0.8
1991	**Dec.**	3034.72	4.9	5384	7.7
1992	**Dec.**	3162.99	4.2	5644	4.8
1993	**Dec.**	3347.46	5.8	5963	5.7
1994	**Dec.**	3415.62	2	6178	3.6
1995	**Dec.**	3446.51	0.9	6334	2.5
1996	**Dec.**	3738.78	8.5	6743	6.5
1997	**Dec.**	3621.15	-3.2	6626	-1.7
1998	**Dec.**	3809.94	5.2	7087	7
1999	**Dec.**	4029.25	5.8	7465	5.3
2000	**Dec.**	4167.18	3.4	7748	3.8
2001	**Dec.**	4135.3	-0.8	7680	-0.9
2002	**Dec.**	4221.9	2.1	7965	3.7
2003	**Dec.**	4421.79	4.7	8348	4.8
2004	**Dec.**	4821.71	9	9351	12
2005	**Dec.**	5113.15	6	10126	8.3
2006	**Dec.**	5367.5	5	10523	3.9
2007	**Dec.**	5582.09	4	11138	5.9
2008	**Dec.**	5905.54	5.8	11858	6.5
City Cost Index - Cincinnati					
1990	**Dec.**	2638.73	1.9	4934	1.2
1991	**Dec.**	2674.15	1.3	5011	1.6
1992	**Dec.**	2817.16	5.4	5209	4
1993	**Dec.**	2892.78	2.7	5345	2.6
1994	**Dec.**	3001.15	3.8	5504	3
1995	**Dec.**	2942.02	—2.0	5451	—1.0
1996	**Dec.**	2977.85	1.2	5489	0.7
1997	**Dec.**	3103.51	4.2	5585	1.8
1998	**Dec.**	3130.94	0.9	5641	1
1999	**Dec.**	3245.02	3.6	5889	4.4
2000	**Dec.**	3377.42	4.1	6045	2.7
2001	**Dec.**	3190.66	-5.5	5858	-3.1
2002	**Dec.**	3333.19	4.5	6156	5.1
2003	**Dec.**	3429.28	2.9	6287	2.1
2004	**Dec.**	3845.89	12.2	6997	11.3
2005	**Dec.**	4003.69	4.1	7108	1.6
2006	**Dec.**	3898.44	–2.6	7416	4.3
2007	**Dec.**	3988.78	2.3	7588	2.3
2008	**Dec.**	4201.04	5.3	7924	4.4
2009	**Jan.**	4188.79	5	7911	4.2
	Feb.	4174.54	4.6	7897	4.1
	Mar.	4177.04	4.3	7900	3.9

City Cost Index Kansas City					
1990	Dec.	2645.28	1.6	4764	0.9
1991	Dec.	2637.2	-0.3	4762	0
1992	Dec.	2677.21	1.5	4956	4.1
1993	Dec.	2874.34	7.4	5224	5.4
1994	Dec.	2916.25	1.5	5305	1.5
1995	Dec.	2889.17	-0.9	5370	1.2
1996	Dec.	3202.29	10.8	5653	5.3
1997	Dec.	3343.32	4.4	5909	4.5
1998	Dec.	3304.51	-1.2	5981	1.2
1999	Dec.	3415.89	3.4	6000	0.3
2000	Dec.	3436.62	0.6	6221	3.7
2001	Dec.	3516.74	2.3	6477	4.1
2002	Dec.	3607.87	2.6	6782	4.7
2003	Dec.	3711.13	2.9	6972	2.8
2004	Dec.	4300.41	15.9	8020	15
2005	Dec.	4428.85	3	8125	1.3
2006	Dec.	4715.49	6.5	8705	7.1
2007	Dec.	4780.99	1.4	8975	3.1
2008	Dec.	5135.71	7.4	9392	4.7
2009	Jan.	5164.03	8	9680	7.8
	Feb.	5149.78	7.7	9665	7.7
	Mar.	5152.28	7.4	9668	7.5
City Cost Index St Louis					
1990	Dec.	2602.16	-0.9	5091	-0.8
1991	Dec.	2686.93	3.3	5172	1.6
1992	Dec.	2743.01	2.1	5316	2.8
1993	Dec.	3034.48	10.6	5765	8.5
1994	Dec.	3091.81	1.9	5947	3.2
1995	Dec.	3089.59	-0.1	6054	1.8
1996	Dec.	3253.4	5.3	6302	4.1
1997	Dec.	3325.68	2.2	6475	2.7
1998	Dec.	3394.54	2.1	6599	1.9
1999	Dec.	3505.65	3.3	6806	3.1
2000	Dec.	3463.92	-1.2	6851	0.7
2001	Dec.	3540.7	2.2	7048	2.9
2002	Dec.	3556.96	0.5	7197	2.1
2003	Dec.	3772.85	6.1	7414	3
2004	Dec.	4071.93	7.9	7882	6.3
2005	Dec.	4306.73	5.8	8449	7.2
2006	Dec.	4437.08	3	8537	1
2007	Dec.	4509.06	1.6	8749	2.5
2008	Dec.	4705.5	4.4	9044	3.4
2009	Jan.	4687.81	3.9	9027	3.2
	Feb.	4673.56	4.1	9012	3.3
	Mar.	4676.06	3.8	9015	3.1

Bureau of Labor Statistics: Producer Price Indices

Series Id: PCUBHVY--BHVY--
Industry: Other heavy construction
Product: Other heavy construction
Base Date: 198606

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1999	132.4	132.2	132.6	133.7	134.2	134.5	135.7	136.2	136.4	136.1	136.3	136.9	134.8
2000	137.8	139	140	139.5	139.3	140.5	140.3	139.8	140.8	140.6	140.4	139.7	139.8
2001	140.1	140.3	139.9	140.5	141.9	141.7	139.7	139.7	140.4	137.9	137.1	136.1	139.6
2002	136.3	136.2	136.7	137.4	137.3	137.5	137.6	137.8	138.1	138.1	137.6	137.4	137.3
2003	138	138.8	139.2	138.8	138.6	138.9	139.2	139.5	140.3	140.3	140.6	141	139.4
2004	143.3	145.3	148.4	151.3	153.8	153.9	155.5	157.9	159	161.5	161.2	159.9	154.2
2005	162.3	163.9	166.4	167.4	166.8	167.8	169.8	171.2	174.1	177.1	173.2	174	169.5
2006	176.3	175.8	177.8	181.5	184	186.4	187.7	188.6	184.4	182.9	182.7	183.5	182.6
2007	182.6	183.9	187.1	190.3	192.6	192.6	194.6	192.3	193.1	193.3	197.4	196.1	191.3
2008	197.9	199.7	205.3	210.1	216.9	222.5	227.3	224.7	225.3	216.5(p)	206.0(p)	198.8(p)	212.6(p)
2009	198.0(p)												

p : Preliminary. All indexes are subject to revision four months after original publication.

Series Id: PCUBHWY--BHWY--
Industry: Highway and street construction
Product: Highway and street construction
Base Date: 198606

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1999	122.8	122.6	123.3	125.4	125.9	126	126.9	128.1	129	128.8	129.6	130.7	126.6
2000	132	134	136	135.6	135.8	137.6	137.1	136.6	138.9	138.5	138.4	137.3	136.5
2001	137.8	138.2	137.4	138.5	139.9	138.8	136.6	137	138.4	135.4	134.1	132.4	137
2002	132.9	132.4	132.7	133.3	133.8	133.9	134.1	134.2	134.4	134.4	133.9	133.7	133.7
2003	134.7	135.7	136.8	137.1	137	136.9	136.7	136.9	136.8	136.7	137.1	137.2	136.6
2004	140.5	141.2	142.5	145.2	147.9	147	149.2	150.5	151.8	155.5	155.4	152	148.2
2005	154.3	156.5	160.4	162.9	162.4	163.7	167.6	170	176.1	180.8	173.1	173.4	166.8
2006	177.5	175.9	179.4	185.4	187.9	190.4	191.8	192.9	185.9	183.2	182.9	184.1	184.8
2007	183.1	185.2	190	194.6	197.6	196.8	200	195.9	197.5	197.5	204.9	202.7	195.5
2008	204.7	205.9	213.8	218.5	227.3	234.4	243.5	239.3	241.1	227.4(p)	212.4(p)	201.0(p)	222.5(p)
2009	201.8(p)												

Construction Cost Index History

HOW ENR BUILDS THE INDEX: 200 hours of common labor at the 20-city average of common labor rates, plus 25 cwt of standard structural steel shapes at the mill price prior to 1996 and the fabricated 20-city price from 1996, plus 1.128 tons of portland cement at the 20-city price, plus 1,088 board ft of 2 x 4 lumber at the 20-city price.

ENR's Construction Cost Index History (1908-2009)

1913=100 * Revised	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL AVERAGE
1990	4680	4685	4691	4693	4707	4732	4734	4752	4774	4771	4787	4777	4732
1991	4777	4773	4772	4766	4801	4818	4854	4892	4891	4892	4896	4889	4835
1992	4888	4884	4927	4946	4965	4973	4992	5032	5042	5052	5058	5059	4985
1993	5071	5070	5106	5167	5262	5260	5252	5230	5255	5264	5278	5310	5210
1994	5336	5371	5381	5405	5405	5408	5409	5424	5437	5437	5439	5439	5408
1995	5443	5444	5435	5432	5433	5432	5484	5506	5491	5511	5519	5524	5471
1996	5523	5532	5537	5550	5572	5597	5617	5652	5683	5719	5740	5744	5620
1997	5765	5769	5759	5799	5837	5860	5863	5854	5851	5848	5838	5858	5826
1998	5852	5874	5875	5883	5881	5895	5921	5929	5963	5986	5995	5991	5920
1999	6000	5992	5986	6008	6006	6039	6076	6091	6128	6134	6127	6127	6059
2000	6130	6160	6202	6201	6233	6238	6225	6233	6224	6259	6266	6283	6221
2001	6281	6272	6279	6286	6288	6318	6404	6389	6391	6397	6410	6390	6343
2002	6462	6462	6502	6480	6512	6532	6605	6592	6589	6579	6578	6563	6538
2003	6581	6640	6627	6635	6642	6694	6695	6733	6741	6771	6794	6782	6694
2004	6825	6862	6957	7017	7065	7109	7126	7188	7298	7314	7312	7308	7115
2005	7297	7298	7309	7355	7398	7415	7422	7479	7540r	7563	7630	7647	7446
2006	7660	7689	7692	7695	7691	7700	7721	7722	7763	7883	7911	7888	7751
2007	7880	7880	7856	7865	7942	7939	7959	8007	8050	8045	8092	8089	7966
2008	8090	8094	8109	8112*	8141	8185	8293	8362	8557	8623	8602	8551	8310
2009	8549	8533	8534										

Annual Average

1908	97	1931	181	1954	628	1977	2576
1909	91	1932	157	1955	660	1978	2776
1910	96	1933	170	1956	692	1979	3003
1911	93	1934	198	1957	724	1980	3237
1912	91	1935	196	1958	759	1981	3535
1913	100	1936	206	1959	797	1982	3825
1914	89	1937	235	1960	824	1983	4066
1915	93	1938	236	1961	847	1984	4146
1916	130	1939	236	1962	872	1985	4195
1917	181	1940	242	1963	901	1986	4295
1918	189	1941	258	1964	936	1987	4406
1919	198	1942	276	1965	971	1988	4519
1920	251	1943	290	1966	1019	1989	4615
1921	202	1944	299	1967	1074		
1922	174	1945	308	1968	1155		
1923	214	1946	346	1969	1269		
1924	215	1947	413	1970	1381		
1925	207	1948	461	1971	1581		
1926	208	1949	477	1972	1753		
1927	206	1950	510	1973	1895		
1928	207	1951	543	1974	2020		
1929	207	1952	569	1975	2212		
1930	203	1953	600	1976	2401		

		Sandag				
		2005	2008	National ENR Index		Denver
				2005	7647	
Cost Elements	**Unit**	**Unit Cost**		2008	8551	
Right of Way				Esc	1.118216	
Land Acquisition Rural	Mile		$129.0			
Land Acquisition Urban	Mile		$387.0			
Sub Right of Way						
Guideway & Track						
At Grade Guideway	LF	$3.0	$3.4			
Aerial Guideway Type A	LF	$5.9	$6.6			
Aerial Guideway Type B	LF	$7.8	$8.8			
Bridge	LF	$23.0	$25.8			
Tunnel Type A	LF	$30.0	$33.6			
Tunnel Type B	LF	$40.0	$44.8			
Sub Guideway & Track						
Systems						
Propulsion, C& C Systems	Mile	$16,400	$18,368			
Power Distribution	Mile	$1,240	$1,389			
Sub Systems						
Maintenance Facilities						
Maintenance Facilities	Sections	$2,750	$3,080			
Stations & Parking						
Full Service - New - Low Volume - 500 Surface Park			$ 5,000			
Full Service - Renovated - Low Volume- 500 Surface Park			$ 4,000			
Terminal - New - Low Volume - 500 Surface Park			$ 7,500			
Terminal - Renovated - Low Volume - 500 Surface Park			$ 6,000			
Full Service - New- High Volume - Dual Platform - 1000 Surface Park			$ 10,000			
Terminal - New- High Volume - Dual Platform - 1000 Surface Park			$ 15,000			
Stations & Parking						
Sub Construction Costs						
Contingency	30%					
Other Costs						
Design Engineering	10%					
Insurance and Bonding	2%					
Program Management	4%					
Construction Management & Inspection	6%					
Engineering Services During Construction	2%					
Integrated Testing and Commissioning	2%					
Erosion Control and Water Quality Management	2%					
Sub Other Costs						
Total Infrastructure Costs						
URBAN MAGLEV						
Construction Cost						
Maintenance Facilities						
Station & Parking						
Contingency						
Other Costs						

COST PER MILE ANALYSIS, AGS COSTS FROM JF SATO				Stations/MF	TOTAL	
Pure		28,994,242	28,994,242	1,391,102	30,385,344	
escalation factor		1.55	2.21		1.66	national inflation
		44,941,075	64,077,275		50,439,671	
	30%	13,482,323	19,223,182		15,131,901	
sub		58,423,398	83,300,457		65,571,572	
	28%	16,358,551	23,324,128		18,360,040	
		74,781,949	106,624,585		83,931,612	

	RMRA: High Speed Rail Unit Costs					
			Midwest Unit Cost including contingency & soft	Eliminate 31% on Unit Cost for contingency & soft costs	Escalation Factor	Comments
				"Pure" construction cost	1.55	
			2002	2002	2009	
		Unit	Unit Cost		Unit Cost	
Trackwork						
1.1	HSR on Existing Roadbed	per mile	$ 993	$ 758	$ 1,175	
1.2	HSR on Existing Roadbed	per mile	$ 1,059	$ 808	$ 1,253	
1.3	HSR on New Roadbed & New Embankment	per mile	$ 1,492	$ 1,139	$ 1,765	
1.4	HSR on New Roadbed & New Embankment (Double Track)	per mile	$ 2,674	$ 2,041	$ 3,164	
1.5	HSR Double Track on 15' Retained Earth Fill	per mile	$ 16,280	$ 10,781	$ 16,711	51% on unit cost
1.6	Timber & Surface w/ 33% Tie replacement	per mile	$ 222	$ 169	$ 263	
1.7	Timber & Surface w/ 66% Tie Replacement	per mile	$ 331	$ 253	$ 392	
1.8	Relay Track w/ 136# CWR	per mile	$ 354	$ 270	$ 419	
1.9	Freight Siding	per mile	$ 912	$ 696	$ 1,079	
2.0	Passenger Siding	per mile	$ 1,376	$ 1,050	$ 1,628	
2.10	NCHRP Class 6 Barrier (on tangent)	lineal ft	$ 1.3	$ 0.86	$ 1.33	51% on unit cost
2.11	NCHRP Class 5 Barrier (on curves)	lineal ft	$ 0.2	$ 0.13	$ 0.21	51% on unit cost
2.12	Fencing, 4 ft Woven Wire (both sides)	per mile	$ 51	$ 39	$ 60	
2.13	Fencing, 6 ft Chain Link (both sides)	per mile	$ 153	$ 117	$ 181	
2.14	Fencing, 10 ft Chain Link (both sides)	per mile	$ 175	$ 134	$ 207	
2.15	Decorative Fencing (both sides)	per mile	$ 394	$ 301	$ 466	
2.16	Drainage Improvements (cross country)	per mile	$ 66	$ 50	$ 78	need to combine with 1.36 and 1.40 below -
2.17	Drainage Improvements in Median or along highway	per mile	$ 528	$ 403	$ 625	
2.18	Land Acquisition Urban	per mile	$ 327	$ 250	$ 387	have a call into Jim Rogers at CDOT - have R2C2 for rural
2.19	Land Acquisition Rural	per mile	$ 129	$ 98	$ 153	have a call into Jim Rogers at CDOT
2.20	#33 High Speed Turnout	each			$ 672	made half of crossover
2.21	#24 High Speed Turnout	each	$ 450	$ 344	$ 532	
2.22	#20 Turnout Timber	each	$ 124	$ 95	$ 147	
2.23	#10 Turnout Timber	each	$ 69	$ 53	$ 82	
2.24	#20 Turnout Concrete	each	$ 249	$ 190	$ 295	
2.25	#10 Turnout Concrete	each	$ 118	$ 90	$ 140	
2.26	#33 Crossover	each	$ 1,136	$ 867	$ 1,344	
2.27	#20 Crossover	each	$ 710	$ 542	$ 590	revised to double concrete turnout
2.28	Elevate & Surface Curves	per mile	$ 58	$ 44	$ 69	
2.29	Curvature Reduction	per mile	$ 393	$ 300	$ 465	
2.30	Elastic Fasteners	per mile	$ 82	$ 63	$ 97	
2.31	Realign Track for Curves (See Table G6 for Costs)	lump sum			$ -	we may need for chip's work
	Sub-total Trackwork					
Structures						
	Bridges-under					
2.1	Four Lane Urban Expressway	each	$ 4,835	$ 3,691	$ 5,721	
2.2	Four Lane Rural Expressway	each	$ 4,025	$ 3,073	$ 4,762	
2.3	Two Lane Highway	each	$ 3,054	$ 2,331	$ 3,614	
2.4	Rail	each	$ 3,054	$ 2,331	$ 3,614	
2.5	Minor river	each	$ 810	$ 618	$ 958	
2.6	Major River	each	$ 8,098	$ 6,182	$ 9,582	
2.7	Double Track High (50') Level Bridge	per LF	$ 14	$ 9	$ 14	From Tampa 51%
2.8	Rehab for 110	per LF	$ 14	$ 10.7	$ 16.6	This looks too high. We need to check
2.9	Convert open deck bridge to ballast deck (single track)	per LF	$ 4.7	$ 3.6	$ 5.5	This looks too high. We need to check
2.10	Convert open deck bridge to ballast deck (double track)	per LF	$ 9.4	$ 7.1	$ 11.1	This looks too high. We need to check
2.11	Single Track on Flyover/Elevated Structure	per LF	$ 4.0	$ 3.1	$ 4.7	
2.12	Single Track on Approach Embankment w/ Retaining Wall	per LF	$ 3.0	$ 2.3	$ 3.5	
2.13	Double Track on Flyover/Elevated Structure	per LF	$ 7.0	$ 5.3	$ 8.3	
2.14	Double Track on Approach Embankment w/ Retaining Wall	per LF	$ 5.5	$ 4.2	$ 6.5	
2.15	Ballasted Concrete Deck Replacement Bridge	per LF	$ 2.1	$ 1.6	$ 2.5	
2.16	Land Bridges	per LF	$ 2.6	$ 2.0	$ 3.1	construction cost at $2000 per lf as per Dane County
	Bridges-over					
2.17	Four Lane Urban Expressway	each	$ 2,087	$ 1,593	$ 2,469	
2.18	Four Lane Rural Expressway	each	$ 2,929	$ 2,236	$ 3,466	
2.19	Two Lane Highway	each	$ 1,903	$ 1,453	$ 2,252	
2.20	Rail	each	$ 6,110	$ 4,664	$ 7,229	
	Tunnels					
	Two Bore Long Tunnel	route ft			$ 44,000	
	Single Bore Short Tunnel	lineal ft			$ 25,000	
	Sub-total Structures					
Systems						
3.1	Signals for Siding w/ High Speed Turnout	each	$ 1,268	$ 968	$ 1,500	
3.2	Install CTC System (Single Track)	per mile	$ 183	$ 140	$ 217	
3.3	Install CTC System (Double Track)	per mile	$ 300	$ 229	$ 355	
3.4	Install PTC System	per mile	$ 197	$ 150	$ 171	Revised based on Milw-Water PTC Report
3.5	Electric Lock for Industry Turnout	each	$ 103	$ 79	$ 122	
3.6	Signals for Crossover	each	$ 700	$ 534	$ 828	
3.7	Signals for Turnout	each	$ 400	$ 305	$ 473	
3.8	Signals, Communications & Dispatch	per mile	$ 1,500	$ 993	$ 1,540	51% on Unit cost
3.9	Electrification (Double Track)	per mile	$ 3,000	$ 1,987	$ 3,079	51% on Unit cost
3.10	Electrification (Single Track)	per mile	$ 1,500	$ 993	$ 1,540	51% on Unit cost
	Sub-total Systems					
Crossings						
4.1	Private Closure	each	$ 83	$ 63.4	$ 98.2	31%
4.2	Four Quadrant Gates w/ Trapped Vehicle Detector	each	$ 492	$ 376	$ 582	31%
4.3	Four Quadrant Gates	each	$ 288	$ 220	$ 341	31%
4.4	Convert Dual Gates to Quad Gates	each	$ 150	$ 115	$ 177	31%
4.5	Conventional Gates single mainline track	each	$ 166	$ 127	$ 196	31%
4.6	Conventional Gates double mainline track	each	$ 205	$ 156	$ 243	31%

4.7	Convert Flashers Only to Dual Gate	each	$ 50	$ 38.2	$ 59.2	31%
4.8	Single Gate with Median Barrier	each	$ 180	$ 137	$ 213	31%
4.9	Convert Single Gate to Extended Arm	each	$ 15	$ 11.5	$ 17.7	31%
4.10	Precast Panels without Rdway Improvements	each	$ 80	$ 61.1	$ 94.7	31%
4.11	Precast Panels with Rdway Improvements	each	$ 150	$ 115	$ 177	31%
	Sub-total Crossings					
Station/Maintenance Facilities						
5.1	Full Service - New - Low Volume - 500 Surface Park	each	$ 1,000		$ 5,000	Revised to reflect reasonable value
5.2	Full Service - Renovated - Low Volume- 500 Surface Park	each	$ 500		$ 4,000	Revised to reflect reasonable value
5.3	Terminal - New - Low Volume - 500 Surface Park	each	$ 2,000		$ 7,500	Revised to reflect reasonable value
5.4	Terminal - Renovated - Low Volume - 500 Surface Park	each	$ 1,000		$ 6,000	Revised to reflect reasonable value
5.5	Full Service - New- High Volume - Dual Platform - 1000 Surface Park	each			$ 10,000	Revised to reflect reasonable value
5.6	Terminal - New- High Volume - Dual Platform - 1000 Surface Park	each			$ 15,000	Revised to reflect reasonable value
5.5	Maintenance Facility (non-electrified track)	each	$ 10,000		$ 80,000	Revised to reflect reasonable value
5.6	Maintenance Facility (electrified track)	each	$ 86,000		$ 100,000	Revised to reflect reasonable value
5.7	Layover Facility	lump sum	$ 6,536		$ 10,000	Revised to reflect reasonable value
	Sub-total Station/Maintenance Facilities					
	This sp					

G Rail Tunnel Evaluation

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ROCKY MOUNTAIN HIGH SPEED RAIL FEASIBILITY STUDY

TECHNICAL MEMORANDUM:

RAIL TUNNEL EVALUATION

Prepared by:

Myers Bohlke Enterprise, LLC

Great Falls, VA 22066

Prepared for:

Quandel Consultants, LLC

Figure 1 . Eurostar high speed trainset in Eurotunnel mock up

Introduction:

Railroads have been building tunnels for over a hundred in an effort to cross barriers imposed by mountains, rivers, seas, or other existing infrastructure. The tunnels often serve to ease the operations by providing short cuts, and easing of the grades, and avoiding persistent alignment problems. As the high speed rail networks are built out worldwide, tunnels provide opportunities to eliminate curves, and keeping grades as flat as possible to maintain service levels that attract riders.

France, England, Germany, Italy and Spain advanced their high speed rail industry complex at the same time and began their build out within in their borders with their own rolling stock, power supply and track configurations prior to the establishment of the European Union. Since the EU intercity high speed rail has expanded from intra-country schemes into cross-border, trans-Europe networks that allow the use of French, German, Italian or other rolling stock to provide international city connections. Tunnels have been used to shorten the routes and cross intervening seas or mountain ranges. The most famous tunnel is the English Channel Tunnel, or Chunnel, that connects England with France, and carries high speed rail between London and Paris and beyond with the continuing build out of the rail network. German and Italian intercity rail networks contain numerous tunnels and viaducts. With the exception of the English Channel Tunnel, all of these tunnels are designed as twin parallel tunnels carrying a single track and measuring approximately 24-33 (7.4-10 m) in diameter. The parallel tunnels are connected by cross passages at regular intervals to provide movement of air with the passage of the train into and through the tunnel, and to allow for safe evacuation of passengers into parallel tunnel in the case of fire. The cross passages are typically 11 ft (3.5m) in diameter are typically at least one tunnel diameter or more.

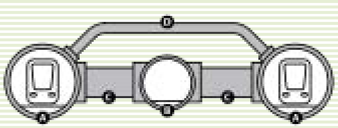

Figure 2 Three parallel tunnel configuration of the English Channel Tunnel, showing two running tunnels, center service tunnel, and pressure relief ducts.

The English Channel Tunnel consists of three parallel tunnels, two that carry opposing rail traffic, and a smaller center “service” tunnel. The service tunnel functions are a carriage way for service vehicles for operations and maintenance, emergency egress, and air pressure relief. The service tunnel also served as the “exploratory pilot tunnel”, permitting an assessment of the geologic and hydrologic conditions along the entire route prior to the construction of the two larger tunnels to either side.   Despite, the additional cost and longer period of construction, this three tunnel configurations provides many useful functions before and during operations. Based on evidence from the Channel Tunnel an analysis of air pressures, pressure relief ducts and the lateral forces imposed on the train is required during the next level of design.

Figure 3._ ICE 3 train exiting the Oberhaider-Wald tunnel in Germany

The higher speeds of the modern passenger trains passing into and through tunnels require slightly larger tunnels to provide space for catenary, safety walkways, ventilation equipments and structures, and to provide a larger clearance envelope. Portals also are taking on more flared designs to reduce some of the air pressure impacts at the portal interface and reduced cross section within the tunnel. Passenger cars often are pressurized to eliminate passenger discomfort as trains pass in and out of tunnels.

Worldwide high speed rail networks include large percentages of tunnels and viaducts such as in Germany, where as much as 34% of the ICE line between Frankfurt to Cologne route is built in tunnel. Similarly, tunnels are common on the Eurostar high speed rail lines between England and France, on TGV routes in France and into Spain, Taiwan, Korea, Japan, Italy, France and Spain and Sweden, Norway. Throughout Europe, former national railway operations are upgrading power supplies, systems, and track gauge to allow for cross border operations of their equipment which until recently had been precluded by national network configurations.

In the US, proposed high speed rail corridors in most of the major physiographic and economically defined regions---including Northeast, Southeast, Midwest, Northwest, California, as well as other local service areas as the Rocky Mountain High Speed Rail Network.   As elsewhere, mountains, rivers, and cities impose the need for tunnels along their routes.

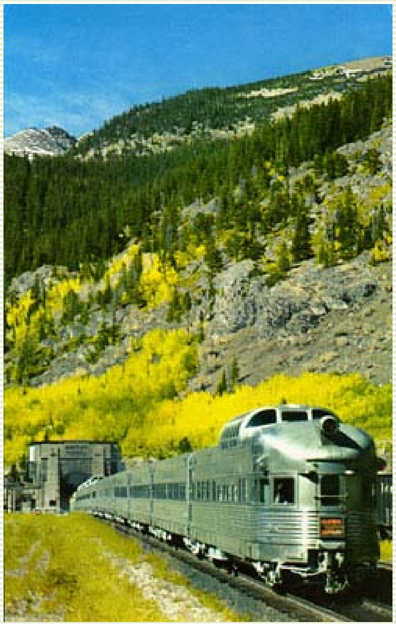

Figure 4. East Portal of the Moffat Tunnel passing under James Peak in the Rocky Mountains (West of Denver, pass at about elevation 9000 ft.)

Completed in 1927

Measures 16 ft w x 24 ft hight

Constructed using Drill and Blast

Concrete lined tunnel horseshoe

Figure 5. West Portal of the Roger's Pass Mt. MacDonald Rail Tunnel, longest tunnel in North America

Rail alignment alternatives through the Rocky Mountains will require a significant amount of tunneling to maintain operable and safe grades, avoid areas prone to rock falls and avalanches, and to provide the shortest routes There are a number of historic tunnels through the Rocky Mountains and a few of these are dedicated to freight and passenger rail services. The Moffat Tunnel, completed in 1927, is a single track tunnel that was built to cut off 27 miles to reduce the elevation of the older tunnel. The Moffat Tunnel passes under James Peak, has a cross section of 16 ft wide by 24 ft high. The longest tunnel (14.7 km) in North America is the Mount MacDonald Rail Tunnel at Roger's Pass through the Rocky Mountains in British Columbia, Canada. The Mt. MacDonald Tunnel provided additional capacity and safer, separate, bi-direction traffic. The most recent US tunnels have been built for highway services including the older Eisenhower tunnel, and the environmentally sensitive and aesthetic Glenwood Canyon Tunnels along Route 70. These tunnels are not long when compared to recent rail and highway tunnel in Europe and compared to those planned as part of this feasibility study.

RMRA HSR Tunnel Configurations:

There are a couple of tunnel configurations to consider, depending on a number of parameters and conditions, including tunnel length, geology, groundwater conditions, as well as fire-life safety and ventilation requirements.

The three basic configurations included in this feasibility evaluation include:

- Two tunnels, connected with cross passages
- Three tunnels (incl. Service tunnel and cross passages (e.g., English Channel Tunnel)
- Single large "bore" tunnels carrying two rail tracks in a single tunnel

The Cross passages function as access and egress to and from running tunnels for operations and maintenances services as well as emergency evacuation, ventilation. Cross passages are 11 ft diameter and are spaced every 1230 (375m). Piston relief ducts measured 7 ft (2 m) and were located every 820 ft or (250 m), relieved the air pressure build up ahead of the train.

Modern Tunnel Construction

Figure 6. Double Shielded Robbins TBMs measuring 30 ft diameter ready for the Spanish high speed rail tunnels.

Tunnel size and designs of rail tunnel are constrained by the clearance envelopes of the train, and catenary, allowable grades, the speeds through the tunnel, ventilation, and more recently, the criteria for safe egress of passengers in the event of a fire within the tunnel. With regard to size, smaller tunnels were always considered to be the most stable and safest to construct. As a consequence, historically, most tunnels, unless unusually short and in sound rock, were built as two parallel tunnels. Until the mid-1980's most rail tunnels were constructed using drill and blast methods through rock, as expected in the Rocky Mountain HSR Tunnels. Moffat Tunnel, Eisenhower Tunnel, the Glenwood Canyon Tunnels, and most of Mt. MacDonald tunnel were built this way. In the 1980's Robbins Company developed the first tunnel boring machine, and the tunneling business continues to evolve with tunnel boring machines taking on the arduous task of tunneling through all types of rock, soil, faults zone and under high water pressures, not possible until recently.

Tunnel with a diameter of 25-30 feet are now common, with demand for tunnels with diameters over 30 ft growing with recent demonstrated success in Europe and throughout Asia. At the present time, tunnel boring machine with higher thrust capacity and torque can bore tunnels over 50 ft (15.4 m) in diameter, which are capable of carrying multiple rail tracks or lanes of highway. As the geologic conditions deteriorate, the machine designs become more sophisticated with single and double shields to support the ground at the face and allow for immediate installation of the permanent ground support.

Robbins rock TBMS have been used on many of the high speed rail tunnels, including five machine used on the English Channel tunnel or Eurotunnel, and double shield rock TBMs, shown in Figure 7, recently commissioned for the tunnels for the TGV trains to connect into Spain.

Table 1. Typical Rail Tunnel Configuration

Configuration	No. Tunnels/tracks	Cross Passages	Example - Rail
Twin parallel	2 tunnels; single track; std gauge;	Spacing about 1200 ft; similar to metro tunnels	ICE-Simplon Tunnels; TGV tunnels in Spain
Three parallel	Smaller third tunnel provides service, egress, & ventilation and opportunity to be pilot exploratory tunnels	Cross Passages About 11 ft diam.	Chunnel; 25 ft diameter; 16 ft service tunnel; 11 ft cross passages
Single large bore	1 tunnel/ double track	Possible refuge chambers or shaft egress	Trans Hudson Express (out for bid); typ 40-55 ft diameter (14-15 m) China Rail Tunnel

A number of tunnels measuring 46-51ft (14-15.4 m) have been successfully completed and open to operations including the 4th Elbe Tunnel in Germany, the SMART dual use tunnel in Malaysia, Madrid and Barcelona, and Sir Adam Beck –Niagara Tunnel –most of the large bores are highway tunnels, but there is nothing to preclude a single large bore tunnel for rail operations, unless local operational and safety concerns would dictate other design considerations. A large double stack single bore is envisioned for the new rail tunnel that will connect New Jersey and New York under the Hudson River. (the ARC tunnel or Access to the Region's Core). The ARC tunnel will carry two Rail tracks on two levels.

Rocky Mountain HSR Tunnels:
Five principal tunnels, listed below, are proposed in the alignment study. These are proposed as 25 ft diameter. Twin bore, tri-bore and single bore configurations are considered.

Table 2. Principal Rocky Mountain High Speed Rail Tunnels

RMR Tunnel	Length of Tunnel
Aspen	51,000 ft
Georgetown	14,000 ft
North Fork	30,000 ft
Breckenridge	22000 ft
Black Hawk	6,000 ft

At the feasibility and concept level design, the recommended configuration for long term operations of high speed system would dictate twin parallel tunnels, connected with cross passages and large enough to provide safe egress and supply proper ventilation and ventilation controls in the event of a fire or mishap in the tunnels.

In the last 20 years, the demand for more and higher speed intercity passenger rail in various regions of the US and a couple of rail fires has raised the issue of passenger safety. Recent tunnel fires in the Baltimore Rail tunnel, the Mont Blanc highway tunnel, and English Channel Tunnel have reinforced the concern about passenger evacuation and egress in tunnels. In the case of the two fires in the Chunnel, the safe evacuation and transport of the passengers to and from the parallel tunnel has been proven safe and effective. Repairs have been made to the tunnel lining and the tunnels returned to service. The Mont Blanc Tunnel highway tunnel with large quantities of combustible fuels, resulted in loss of life. The lessons learned from this tunnel fire, many having to do with human behavior and response, are still being evaluated. Unlike urban metro systems, there are no guidelines at the present time for the safe egress and safe operations of rail tunnels and bridges. Proliferation of high speed rail systems and the increase of passenger rails systems, in general, will put pressure on the state departments of transportation to consider similar guidelines.

Currently, in the United States, the design of railroad tunnels does not specifically require nor specify fire life safety and ventilation requirements in rail tunnels. However, recent fires in the English Channel tunnel and safe evacuation and rescue of the passengers, has demonstrated the merits of regularly spaced cross passages between parallel tunnels. In the design phase, we recommend a sensitivity analysis be conducted to evaluate the trade-offs among the diameter of the tunnels and number, size and spacing of pressure relief ducts or shafts, as well as operating speeds within the tunnels.

Based on the conceptual level of information about the tunnel alignments and lengths, we feel these tunnels are constructible with modern tunneling methods, but will require careful preliminary site investigation and mapping to identify and locate major fault zones, rock types and ground conditions along each tunnel alignment. A potential cost savings could be realized with advanced mapping to determine if a liner is necessary for the entire length of tunnel, and if so what type of lining would suffice.

Tunnel Costs:

There are many factors that go into the costs of tunnels, the most important of which is the location, geography, and hydro-geological conditions encountered. At this level of study a range of costs per linear ft or mile of tunnel is best. Review of a number of rail projects constructed in the past ten years, in the US and Europe provided the ranges of costs. These costs are based on published projects costs and included only those tunnel projects that have been constructed. It is assumed that each of these projects include some portions of cut and cover or open cut portal transition to the tunnel.

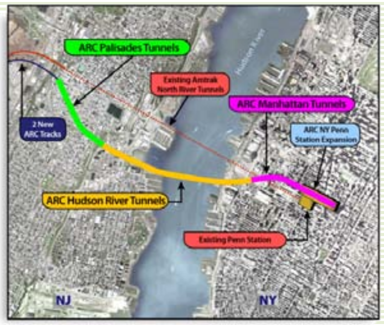

Figure 7. New large bore tunnel for rail into NYC:

Access to the Region's Core-Trans-Hudson Tunnel that will carry intercity rail between New Jersey and Manhattan will measure approximately 50 ft diameter.

Figure 8. Robbins Tunnel Boring Machine single shield used in unstable ground

Based on a review of the English Channel Tunnel, ICE tunnels, and recent TGV tunnels, we recommend a range of tunnel costs for this conceptual level evaluation between $20,000 and $73,000 per linear foot, reflecting a twin 25 ft diameter tunnel at the low end and the complex, long, three tunnel and cross passages of the English Channel tunnel in challenging submarine cross-border at the upper end . The English Channel tunnel total project costs was 12 Billion English Pounds, and ran 80% over original costs, some of which is attributed to redesign of the vehicles and systems required late in the program. The English Channel tunnel is the marker for the highest range as it includes three parallel submarine tunnels and landside underground cavern works. Other simpler ICE and TGV rail tunnels have been built in a more convention twin tunnel configuration. Their completed costs are trending between $25,000 and $30,000 per linear foot for tunnel with a diameter of 24-27 feet. These values are based on recent rail tunnel costs from ICE Simplon Tunnel, the East Side Access tunnels in Manhattan, Lyon to Turin TGV tunnels. The costs are given as total project costs, which we assume to include the systems.

Review of the recent large bore tunnels with a diameter of 45-51 ft (14-15 m) cost from $27,000 to $50,000 per linear ft. Most of these tunnels have been constructed to accommodate double stack roadways but the cost of the tunneling would dominate the cost compared to the relative cost differences in the road pavement, or rail and systems. To date, none of these large bores have been used for high speed rail systems, no doubt due to operational and safety concerns. The large bore tunnels built to date are mostly accommodate stacked 2 to 3 lane highways (e.g. Malaysia or Madrid) or stack metro lines and station platforms (e.g. Barcelona)

Tunnel Design and Construction:

Determination of the methods of excavation and support and final lining depends on the geotechnical site investigation and the testing of samples retrieved from the exploratory borings. Because of the rough terrain and depth of cover over many tunnels in mountainous terrain, the engineers rely on fewer borings and on small scale geologic maps and outcrop maps to project and interpolate the types of rock, the degree of fracturing and the amount and pressure of inflow

Figure 9. English Channel Tunnel showing concrete segmental lining, utilities and systems strung on sides and single track with walkway

of groundwater. Fault zones and the ground conditions within and approaching the faults often present the greatest challenges to tunneling because of the presence of high water pressures and highly fractured to soft "gouge" materials that can be unstable and require special support and approaches.

Understanding both overburden pressures and groundwater pressures are significant to the advance rate and ultimate completion of the tunnels. Until recently, small diameter pilot tunnels were recommended where exploratory borings are too deep or terrain to rugged. Pilot tunnels continue to be used today, and are often converted to use as a service or ventilation tunnel built in parallel to the existing tunnel. Alternatively, the pilot tunnels were excavated in the crown of the larger tunnel and enlarged to full size with the design to account for the conditions revealed in the pilot tunnel excavation. Exploratory tunnels were used in Cumberland Gap Tunnels, H3 Tunnels in Hawaii and the Mt. MacDonald Rail Tunnel.

With continued sophisticated developments of technology and mechanical designs, tunnel boring machines (TBMs) have extended the realm of tunneling to provide safer, faster, and more continuous mining compared to the drill and blast, muck and support, and final lining installation cycles used since the earliest tunneling. For long tunnels, as envisioned here, one or more tunnel boring machines would provide a faster, safer operation. These machines are designed based on the size, permanent liner design, and most importantly based on an assessment of the types and properties of rock anticipated along the alignment. Similarly, newer shielded pressure face machines provide control the inflow of the groundwater and the ability to change into and out of pressure mode.

Temporary and/or permanent liner systems can be erected immediately behind the cutterhead of the tunnel boring machine in a "continuous" mining, mucking and lining operation. As the cutterhead bores one stroke (about 3-5 feet), then either rock bolts or precast concrete liner segments are erected to form a ring of final lining and support. A final shotcrete lining or cast in place liner can be installed at some distance behind the tunnel boring machine if ground conditions warrant. Many rail tunnels across the US have been operating decades without concrete lining when stable rock conditions allowed. This would be a

Figure 10. Drill jumbo drilling holes in face for drill and blast excavation. Temporary shotcrete is visible on the sidewalls.

significant cost savings on the project. Estimates of ground support would result from the geologic mapping and site investigation and tunnel design efforts.

Tunnel construction methods:
Tunneling for the high speed rail tunnels could be done by one or a combination of the following common methods:

Drill and Blast: Drill and blast techniques are used to loosen and excavate rock. Advances are accomplished in 3-5 ft long "rounds" or length, with a number of drill holes-loaded with dynamite are detonated with a short delay sequence. After the bad air is ventilated, the fractured rock is loaded onto a muck truck or train and hauled out of the tunnel. Rock bolts or steel sets or shotcrete are applied to support the ground and allow for the drilling of the next round. The rockbolts are often used in combination with shotcrete as either temporary or permanent lining, depending on the final use of the tunnel, need to water proof and consider aesthetics.

For large diameter tunnels, the heading may be divided into smaller openings to excavate and support smaller more stable openings.

© Mechanical Excavation: Tunnel boring machines have evolved in the last 20 years to provide tunnels of various sizes, and to allow continuous excavation and installation of the final liner in one continuous operation, and to also allow long tunnels of various sizes to be excavated and lined in one continuous operation. Machines are designed to excavate soils or rock or a mixture in the extreme cases. Immediately behind the advancing face, temporary and permanent support systems are installed to protect the workers and to allow for final fitting out of the liner behind the machine or after the machine has been extracted. Average advance rates of these continuous tunneling range from 30 to 50 feet per day with days completing 100 feet or more per day common.

For short tunnels, portal and TBM launch tunnels, shaft, and difficult ground, we recommend the Sequential Tunneling Method (SEM): As the name implies, the SEM allows for partial excavation of portions of the tunnel to provide a safe and secure opening in soils, or fractured rock, and for large caverns, and tunnel openings of irregular shape. The ground is temporarily supported by sprayed shotcrete as soon as achievable following excavation. A final liner may be installed or additional shot crete depending on the functional, aesthetic, and maintenance requirements.   The method has been used in a number of metro tunnels in the Washington Area to control settlement, and for short tunnel segments. This method has also been used throughout Europe.

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H Grade Options for I-70: 4% vs. 7%

H.1 Context[1]

For the "FRA Developed Option," the Steering Committee raised a number of questions regarding the consulting team's inclusion of a 4% grade option via Pando rather than 7% grades on Vail Pass. This Appendix documents the rationale for that choice. The consulting team has recommended that 4% grade options developed in this study be retained for detailed analysis in the Environmental evaluation. 7% grades could technically work, but including them would significantly add implementation risk and raise equipment capital and operating costs. In contrast, 4% grades are manageable using off-the-shelf rail or maglev technology, and would lower operating costs.

This study has not screened or eliminated any of the original 7% alignments from further evaluation in the environmental process. As background, the current study has only examined *representative routes* and *generic technology options*, to determine whether *any* of them could satisfy the economic criteria that have been established by the U.S. Federal Railroad Administration (FRA). As a result, at least *eight* different combinations of routes and technologies that have been identified (see Exhibit H-1) could meet these criteria, and have thus been determined as economically "Feasible" alternatives.[2]

Exhibit H-1: RMRA Routes and Technology Combinations Found Feasible

Feasible Option	Type	Routing	Source
Option 2: 110-mph diesel rail in the I-25 corridor	Truncated network	I-25 Only/ No I-70	Exhibit 9-5
Option 4: 150-mph electric rail in both I-25 and I-70	Truncated network	Pando	Exhibit 9-5
Option 5: 220-mph electric rail in both I-25 and I-70	Truncated network	Vail Pass	Exhibit 9-5
Option 7: 110-mph diesel rail in I-25 and 220-mph Electric Rail on I-70	Hybrid network	Vail Pass	Exhibit 9-8
Option 8: 150-mph electric rail in I-25 with 220-mph Electric Rail on I-70	Hybrid network	Vail Pass	Exhibit 9-8
Option 9: 110-mph diesel rail in I-25 with 300-mph Maglev on I-70	Hybrid network	Vail Pass	Exhibit 9-8
Option 5W: 220-mph electric rail in both I-25 and I-70	Western Extensions	Vail Pass	Exhibit 9-11
Option 9W: 110-mph diesel rail in I-25 with 300-mph Maglev on I-70	Western Extensions	Vail Pass	Exhibit 9-11

[1] Developed in response to Comments Matrix Questions 1 and 6
[2] Capital cost rollups for each of these eight alternatives are detailed in Appendix E.

In Exhibit H-1 reflecting results of the preliminary screening, six of the feasible options used 7% grades on Vail Pass, and one option used 4% grades via Pando. It can be seen that either Vail Pass or Pando routings are "feasible," meaning they could meet FRA's economic criteria. Since *both* the 7% and 4% electric rail options were also found feasible, presumably many mix-and-match combinations of these route and two technology options could also be found feasible. This was the basis for defining the "FRA Developed Option," in addition to the original eight shown in Exhibit H-1.

Rather than screening alternatives the goal of the current study has been to identify and carry forward into the NEPA analysis as many feasible alternatives as possible. Given a wide range of possible technology and route choices, the ability to make minor or local adjustments to routes and stations provides the capability to reasonably accommodate local environmental concerns, without fear that the economics of the whole project would be undermined.

H.2 The "FRA Developed" Alternative[3]

In the initial screening Option 5, a 220-mph technology option produced the best Cost Benefit Ratio of 1.28, satisfying FRA requirements. However, since there is a +/- 30% error range associated with feasibility level projections, this Cost Benefit ratio is not quite high enough to exclude the possibility of a negative result. A result of 1.50 or better is needed to ensure the result remains positive even with a +/- 30% error range. (e.g. 1.50 * 0.7 = 1.05; 1.50 * 1.3 = 1.95, so that with a nominal value of 1.50, the true Cost Benefit ratio is likely to lie in the range of 1.05 to 1.95.)

There are multiple feasible options, and this study makes no determination as to preferred combination. However, TEMS was directed by the Steering Committee to develop an "FRA Developed" Option to form the basis of a more detailed business plan. In development of this alternative, Option 5 was used as the starting point, with the aim of improving the Cost Benefit ratio. A "Mix and Match" analysis was performed to develop a combination of I-70 Highway and off-Highway segments that would be likely to improve performance. This reflected the input received from the RMRA Steering Committee, Public Input meetings and from members of the I-70 Coalition, as well as the recommendations of the consulting team. Other factors considered in route selection were potential environmental concerns (e.g. avoiding Clear Creek canyon) and retaining system flexibility (e.g. diesel operations from Aspen, Steamboat and Glenwood Springs potentially as far east as Frisco, Dillon and Silverthorne.)

While some segments of both the original 7% and 4% alignments were included in the "FRA Developed" network, a major goal was to reduce the amount of costly tunneling that was recommended in the original 4% alignment, while still preserving direct rail service to the resort areas and communities. Some of the tunnels eliminated were on the suggested southern corridor past Lake Dillon. By using the I-70 corridor from Keystone to Silverthorne to Frisco to Copper

[3] Developed in response to Comments Matrix Question QS1

Mountain, not only were the tunnels avoided but access to the local communities was also improved. These changes improved the Cost Benefit ratio.

Another goal was to minimize the environmental intrusiveness of the rail system, resulting in selection of the El Rancho 7% alternative rather than Clear Creek canyon for inclusion in the FRA Developed Alternative. However, the operational analysis clearly found that the 4% Clear Creek alignment would be both faster and less costly to operate than the 7% grade over El Rancho. Furthermore, it is expected that more exhaustive engineering and environmental studies could develop alternative 4% grade options across El Rancho or even along Clear Creek that would be acceptable. For this reason it is suggested that the Clear Creek alignment be retained in the NEPA process, until an alternative practical 4% option can be identified to take its place.

An important third goal articulated by the Steering committee was to minimize construction impacts on the existing I-70 highway. To reduce maintenance-of-traffic impacts, the consulting team was directed at the August 22, 2008 Steering Committee meeting to develop an I-70 "Unconstrained" alternative that would remain independent of the I-70 Highway Right of Way. This was further documented on page 12 of the September 26, 2008 Steering Committee meeting as Corridor Scoping Team input to the Study, confirming an "Explicit desire to not limit alignment options to highway routes" for the same reason.

Going via Pando has lower capital costs, lower grades, preserves the diesel option for a local transit system (all the way from Summit County to Steamboat, Aspen and Grand Junction) and minimizes construction impacts on the I-70 highway. Minimizing grades reduces risks associated with equipment procurement and rail operations. The proposed FRA Developed option including Pando was presented to the Steering Committee on May 22, 2009, and approved.

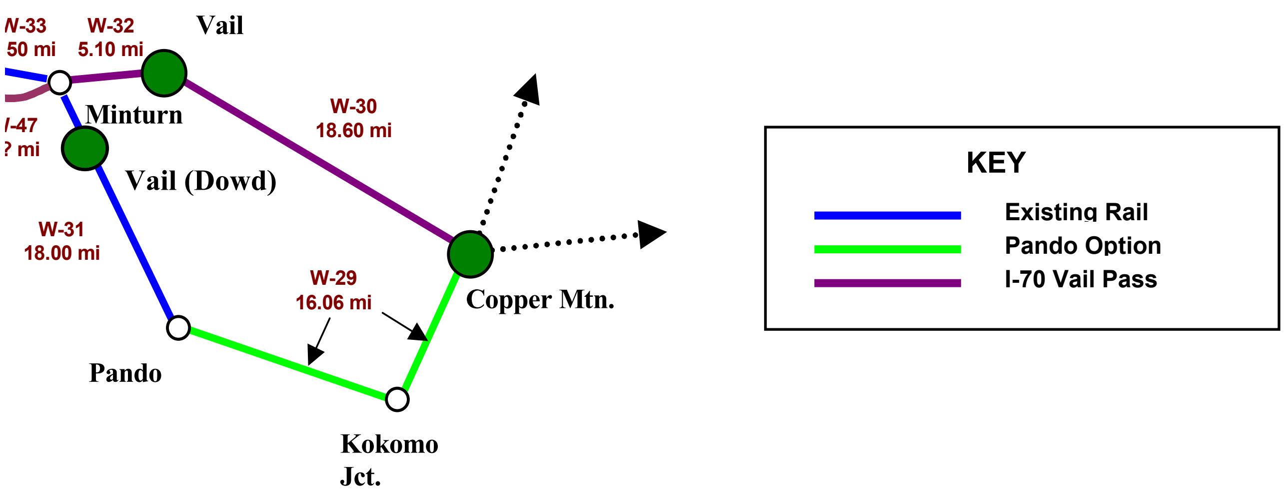
A phased implementation plan was developed identifying specific timing of Capital cash flows, and detailed year-by-year operating projections. The choices made resulted in an improved Cost Benefit ratio of 1.49 for the FRA Developed Alternative.

There is nothing necessarily optimal (in engineering or environmental terms) about this particular selection, however it is likely that it produces the best or close to the best possible Cost Benefit results of any option likely to be considered. The main concern of this study has been to evaluate the economic feasibility of High-Speed Rail and Maglev options, and specifically if a comfortably positive Cost Benefit ratio could be achieved for any representative route. This objective was achieved.

H.3 Capital Costs[4]

Exhibit H-2 shows a portion of the Costing Segments schematic showing the two possible alignments from Copper Mountain to Dowd Junction. The Vail Pass option consists of two segments: W-32 and W-30; while Pando consists of W-29 and W-31.The Pando option utilized in the FRA Developed Alternative does not include a spur into Vail, as agreed with the Steering Committee: the Vail station would be at Dowd Junction for this alternative, and downtown Vail for the Vail Pass (I-70) option.

Exhibit H-2: Copper Mountain to Vail via Pando or Vail Pass Showing Alternative Vail



The Vail Pass route comprises:

W-30	$ 1,808.9 M
W-32	$ 275.0 M
TOTAL COST	$ 2,083.9 M

The Pando route comprises:

W-29	$ 818.8 M
W-31	$ 911.4 M
TOTAL COST	$ 1,730.2 M

The Pando route is $354 million less expensive than the Vail Pass alignment. While there is potential to "Optimize" the Vail Pass route, it should be recognized that because of maintenance of traffic concerns on I-70, difficult topography and adjacent commercial/residential development, the implementation of this alignment will be very challenging. Starting at Copper Mountain, the topography is very difficult for 16 miles. The Vail Pass alignment would be elevated in this area.

[4] Developed in response to Comments Matrix Q116 and Q130

SATO's rail alternative (page 2-27 of the Tier 1 Final PEIS) is also elevated. For the last few miles into Vail, the SATO alignment went to ground. However, we rechecked the topography and we believe that it is better to stay elevated through Vail. The roadway is constrained by topography and commercial/ residential development. Ultimate resolution of this issue will need a detailed Environmental Study.

The Pando alternative and Tennessee Pass rail alignment does have some serious constraints. These were included in the costing of those segments. For W-31 (Pando to Minturn) an 18 miles segment, this included 25,000 ft of double-track elevated structure and an additional 8 miles of retained fill structure due to the very constrained conditions. About 70 % of this segment is constrained. There is also a need for 1000 ft of high level structure and two major river crossings included in the costing for this segment.

Overall, Pando would be $353.7 Million cheaper and has much more manageable grades. The grades can be less because the route is slightly longer in mileage. Grades via Pando are mostly only 2-3% with only short stretches of 4%.

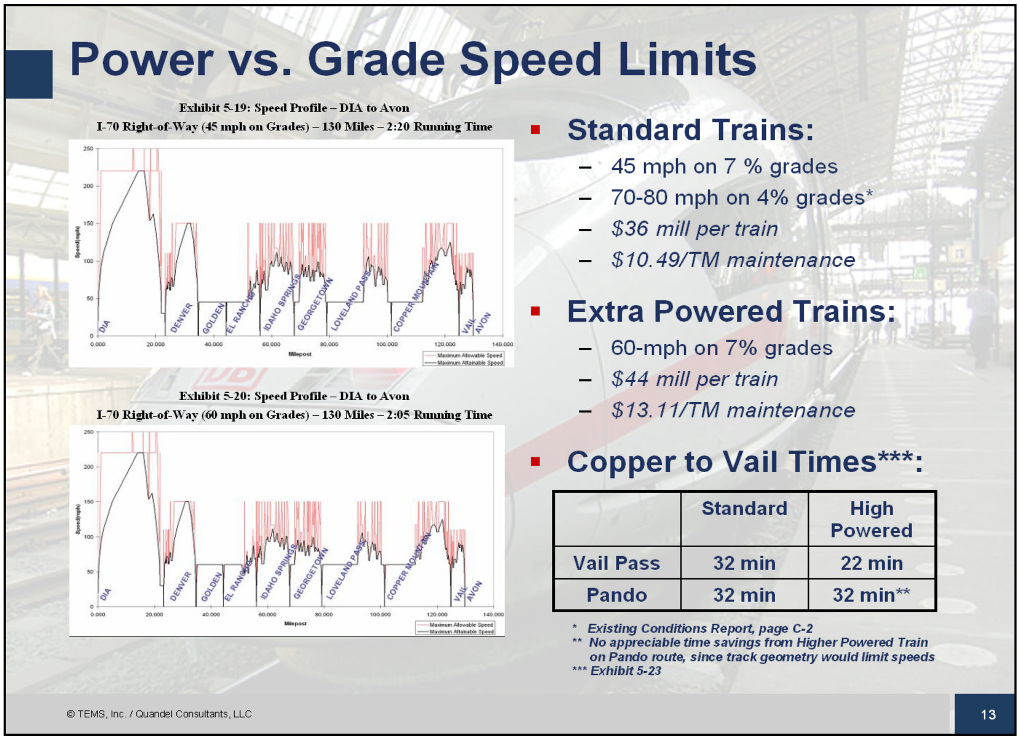
H.4 Operating Costs[5]

Exhibit H-3 shows that if 7% grades via Vail Pass were included in addition to those over El Rancho, there would be a need to buy substantially more costly trains because of the need for the added power. Standard trains could operate on 7% grades, but the best they could do would be 45-mph. Added power could boost speeds to 60-mph, which is the maximum the curves would allow. However, as shown in Exhibit H-3, adding power is expensive: raising capital cost from $36 to $44 million per train costing $400 million; and train maintenance costs from $10.49 to $13.11 per train-mile, costing $510 million over a 30-year life of the system.

While the Vail route is shorter than Pando, schedule times of 32 minutes via either route would be the same for standard trains. A 10-minute savings is possible using Vail Pass if high-powered trains, which will cost more money than those assumed for the Pando alignment, are used. This results in a trade off: Pando is less expensive using standard trains for the same timetable. Vail Pass has higher operating costs, infrastructure and vehicle capital. However, it would be slightly faster than Pando if high-powered trains were used and could directly serve downtown Vail. These options should be explored in a future study.

[5] Developed in response to Comments Matrix Q100, Q102, Supp A Gonzales pg 9-22, Supp G Hall alt calc

Exhibit H-3: Equipment Trade Offs for 4% vs. 7% Grade Options



H.5 Station and Route Selection[6]

Final route and station selection should be a product of the next step, i.e. the Environmental analysis process. As such, we assume that the route through Vail Pass and a potential station in downtown Vail will all be considered. However, given the agreed assumption of a Vail station at Dowd Junction, the Tennessee Pass line via Pando option costs less, and works best to support the improved 1.49 Cost Benefit ratio calculation.

We have no doubt that, if environmentally acceptable, the Vail Pass option might be quicker (if high-powered trains are used that can go 60-mph in the grades); but selection of a 7% option may also preclude the development of a single-seat commuting option from areas farther west (such as Glenwood Springs) into Summit County stations using 110-mph diesel technology. Given the shortage of labor and established commuting patterns, as well as the potential for local trips between resorts in this area, it is likely that such a service would be viable, and ought to be at least evaluated as part of the proposed Western Extensions study before the potential for it is foreclosed. This would provide a significant regional benefit to parts of western Colorado that at present are not served by the truncated system. However, both the Pando and Vail pass options remain potentially viable, and both ought to be carried into any future Environmental process.

[6] Developed in response to Comments Matrix, Supp H. Dale 5 5.2.1

In conjunction with the Pando alternative, the FRA Developed Alternative includes a stop at Vail (Dowd Junction) to avoid the need for building the expensive and difficult-to-operate branch line into Vail. Since many of the riders at Vail are destination (multi day) travelers it is likely they will need to use local transportation to reach their hotels or timeshares. A minority of riders, primarily day-trippers, would go directly to the slopes, and the local free Vail bus system could be used to provide internal circulation within the resort. The Steering Committee agreed that a Vail (Dowd Junction) station was an acceptable planning assumption in conjunction with the Pando option.

The potential use of Copper Mountain as an option for accessing Vail is actually a positive for the Pando option, since it provides another option for day-trippers to go directly to Vail without having to actually construct a rail line over the Pass. Alternatively, multi-day travelers with luggage are less sensitive to minor differences in rail travel time, and much more sensitive to comfort, ride quality and convenience factors. We believe that these riders will probably still find the Hotel shuttles and related local transportation more convenient at a Dowd Junction station. In either case however, whether a rider chooses Copper or Dowd, the system still captures the ridership and revenue. This is a relatively minor distributional issue for predicting the actual pattern of station usage, which can certainly be addressed in future studies.

H.6 Grade Speed Limits[7]

Assumed timetable comparisons depend on the speed capability of the trains, both ascending and descending the 7% grades. Our concerns regarding selection of 7% alignments apply equally to either rail or maglev technologies, since they primarily relate to in-vehicle forces experienced by standing passengers on such alignments and the need to meet FRA passenger safety regulations, particularly under emergency braking conditions. As such our concerns are independent of vehicle technology, since passengers will experience the same dynamic forces regardless of the type of vehicle they are riding in.

For the train performance runs, speeds have been capped at 60-mph reflecting the maximum capacity of the train's electrical system to both power the train uphill and also to brake the train in regenerative mode going downhill. However, achieving this speed potential on 7% grades requires application of substantially more electrical equipment than is ordinarily used on either 220-mph electric or maglev trains.

While the normal operating mode going downhill would be to use regenerative braking, additional disk, eddy current and/or magnetic track brakes can also be added to shorten the train's stopping distance. From a perspective of being able to stop a train on 7% descending gradient, there is no real question of the capability for installing a braking system that is powerful enough to do it. Light Rail (LRT) vehicles use magnetic track brakes, which gives them an outstanding emergency braking capability.

[7] Developed in response to Comments Matrix, Q80, Q82

Automobiles routinely descend 7% grades at 60-mph, but their occupants are seat-belted. The real question is not the ability to stop a train, but rather what may happen to standing passengers in case of a full emergency braking application. This concern of "passenger dynamics" and "forces exerted on the occupants of a vehicle" for non-seat belted passengers, restrains the maximum allowable acceleration, braking and banking capabilities of both Rail and Maglev vehicles. Irrespective of the selection of Rail or Maglev vehicle types, it is the comfort factor, and the limitation of on-board dynamic forces within safe ranges, that will fundamentally determine the quality of the customer's on-board experience.

Because of the LRT precedent for using a back-up magnetic track brake system for emergency use, a 60-mph speed has been assumed to be safe for descending as well as ascending gradients. Consistent assertions of Maglev vendors regarding the downhill speed capabilities of their vehicles have also been accepted without prejudice.

In can be seen that while 7% grades may be technically feasible for a rail system, it would require highly specialized purpose-built equipment. Including such grades would add to both the economic and technical risk factors associated with implementation of the system.

For this reason the Consultant team continues to recommend the retention of 4% gradient as well as 7% grade options into the NEPA process. All these 4% options are well within the proven capabilities of existing off-the-shelf rail and maglev vehicles (e.g. 4% gradients exist on the Yamanashi Maglev Test Line in Japan, and 3.5% gradients are used in the English Channel Tunnel and elsewhere on existing international HSR networks.) It should also be noted that Japan Central Railway, who is in the process of introducing both rail and maglev technologies into the U.S. market[8], has recommended limiting gradients to 4% which is the maximum they employ on the Yamanashi Maglev Test Line. They have said that although their maglev technology is technically capable of operating on higher grades, in commercial operation they would tunnel to avoid gradients over 4% and in fact have done so on the Yamanashi line.

H.7 Train Timetables and Running Times[9]

Travel times from Denver to Vail are practically the same on the I-70 7% "Constrained" or 4% "Unconstrained" alignments. However, the trains needed to achieve this performance are not the same:

- The 7% alignment needs a very high-powered train that approaches the maximum power that could possibly be packed into a train, using today's technology.
- The 4% alignment uses a standard off-the-shelf High-Speed train.

Exhibit 5-23 of the main report shows the results of an exacting, final analysis of detailed alignment data. This analysis revealed that the two alignments have offsetting differences: While the Clear

[8] See: http://www.dailyfinance.com/story/bullet-trains-in-the-u-s-japan-central-says-all-aboard/19284146/
[9] Developed in response to Comments Matrix, Q76, Q78, Q83, Supp H. Dale 5 .2.1 pg 5-25

Creek canyon is 10 minutes faster, Pando is 10 minutes slower than Vail Pass (assuming a 60-mph top speed with high-powered trains on the 7% grades) so the overall running time for either of the original alignments would be the same. These results are summarized in Exhibit H-4.

As a sensitivity, a 45-mph top speed analysis (shown in Exhibit H-3) was developed. The 7% grade option over El Rancho is slower even at 60-mph than the 4% Clear Creek canyon alternative. The Vail Pass route is faster than Pando at 60-mph, but it is slower at 45-mph. This risk factor on equipment performance could cause the Vail Pass route to lose its speed advantage. In an "apples to apples" comparison using off-the-shelf High-Speed trains with a 45-mph speed on the grades, the 7% alignment would be 10-15 minutes slower than the 4% alignment if an were used.

Since the hybrid alignment used for the FRA Developed Alternative uses El Rancho combined with Pando, the schedule for the Developed Alternative is 10 minutes longer than either of the original "pure" 4% or 7% alignments. This running time has been reflected in the ridership forecast, but still maintains a finding of feasibility for the FRA Developed Alternative.

Exhibit H-4: Running Time Summary by Technology and Segment

	220-mph EMU 4% Unconstrained	220-mph EMU 4% Unconstrained w/o Clear Creek Canyon	220-mph EMU 7% Highway Alignment	300-mph Maglev 7% Highway Alignment
DIA to Denver	12 min. 23 miles 115 mph	12 min. 23 miles 115 mph	12 min. 23 miles 115 mph	12 min. 23 miles 115 mph
Denver to Golden	10 min. 12 miles 69 mph	10 min. 12 miles 69 mph	10 min. 12 miles 69 mph	9 min. 12 miles 80 mph
Golden to Floyd Hill	17 min. 17 miles 60 mph	25 min. 17 miles 41 mph	25 min. 17 miles 41 mph	23 min. 17 miles 44 mph
Floyd Hill to Loveland Pass	23 min. 29 miles 77 mph	23 min. 29 miles 77 mph	25 min. 28 miles 67 mph	21 min. 28 miles 80 mph
Loveland Pass to Copper Mtn	24 min. 22 miles 55 mph	24 min. 22 miles 55 mph	25 min. 22 miles 52 mph	22 min. 22 miles 60 mph
Copper Mtn to Minturn	32 min. 34 miles 64 mph	32 min. 34 miles 64 mph	22 min. 23 miles 65 mph	19 min. 23 miles 73 mph
Minturn to Avon	7 min. 5 miles 43 mph	7 min. 5 miles 43 mph	7 min. 5 miles 44 mph	5 min. 5 miles 60 mph
TOTAL	2hrs. 5 min. 142 miles 68 mph	2hrs. 13 min. 142 miles 64 mph	2hrs. 6 min. 130 miles 62 mph	1hr. 51 min. 130 miles 70 mph

H.8 Conclusion

The goal or objective of this study has not been to select or determine either an “Optimal” route or an “Optimal” technology. Rather, its purpose has simply been to identify Feasible options that could be carried forward into a detailed NEPA analysis. The Feasibility Study has accomplished this goal, while leaving local route and station siting details to be resolved in future work.

This study has found that either alternative via Pando or Vail Pass can satisfy the FRA Feasibility Criteria, so either option can remain “in play” in the upcoming Environmental evaluation.

I Colorado Springs Alignment

The original I-25 greenfield option developed a new rail alignment on the eastern plain, about 10 miles east of the existing rail line and I-25 highway corridor. However, as the study progressed it became clear that there was a community desire to shift the greenfield back towards the I-25 highway corridor where more people lived. Even though such an alignment would directly serve more people, the geometry might not have been as good and the alignment would be more difficult to construct, operate and maintain.

For shifting the greenfield back towards I-25 and for providing a Monument train station, representatives of El Paso County suggested the following alignment be considered in a future study. This route would not require sharing or abandonment of the current freight train alignments. Most of the route is undeveloped and would cause very little disturbance to built areas. This route would also avoid the controversial and perhaps project stopping proposal to route the Greenfield alignment through the Black Forest:

1. The line should have a stop in Lone Tree where riders can transfer to light rail going to other Denver destinations or to DIA.
2. From Lone Tree, the line follows I-25 to Castle Rock and continues south to the Larkspur exit.
3. At Larkspur the line hugs the west side of I-25 and crosses over Monument Pass. The Larkspur exist is the only location on this alignment that may need attention to separate it from other rail lines.
4. Rail line then proceeds south on the Westside of I-25 and goes behind (to the west of the southbound truck weigh station).
5. The line runs between the commercial development and I-25 to the parcel of land between 3rd street and 2nd Street and between HWY 105 and the storage units. This property could be used as a rail stop and parking structure. This stop is located across the overpass which connects the existing park and ride to the new station.
6. From a stop in Monument, the rail runs south through undeveloped land on the west of I-25 past Baptist Road and through the AFA.
7. Line crosses to east side of I-25 at or around the Interquest interchange and follows east to the proposed Powers right-of-way.
8. From here the line follows Mark Shuffle alignment to the Colorado Springs Airport.

For station locations, the original study assumption was a northern station in Monument, a central Colorado Springs station serving the central business district, and a southern station serving Fort Carson and Fountain. However, representatives of El Paso County suggested the following for consideration in future detailed studies. If RMRA uses a conceptual "greenfield" alignment through the far eastern side of the City of Colorado Springs; then:

1. There should be a station site serving the northern part of El Paso County and the City of Colorado Springs (at or north of Woodmen Rd). The demographic center of El Paso County is north of Cimarron Hills. Because Woodmen Road and Briargate Parkway are designed as 6-lane east west expressways that go from I-25 to Falcon, locating the northern Colorado Springs stations at one of these crossings may be the most logical site.
2. There should also be a station site serving the Colorado Springs Airport terminal area (with a direct local transit mode to/from the Downtown Colorado Springs CBD rather than high-speed rail). This provides an easier track construction access because of the large undeveloped area on the east side of the airport. It also equalizes airport access with the other major Front Range airport. Placing the station at the airport provides easy access from southern El Paso County as well.
3. If the northbound RMRA line goes west from the east side of Colorado Springs, there should be a stop in the Monument area.
4. There should be direct routing from the south directly to the Downtown Denver CBD – and then only indirectly to DIA.
5. Future public involvement and consideration will be needed at time of project planning (EA, or EIS, ETC).

Or, if it were determined that using the existing freight rail track alignment is possible, then:

1. A northern station should be located in or near Monument.
2. A central station should be located in north Colorado Springs (near Woodmen Rd).
3. A southern station should be located in the Downtown Colorado Springs CBD area (with a local transit connection to the Colorado Springs Airport).

J AGS Technology Performance Criteria: I-70 Coalition Technical Committee Recommendations

The I-70 Coalition requested that its Technical Committee develop a list of performance criteria that could be useful in the effort to screen potential Advanced Guideway System technologies, both existing in and research and development phase technologies. These criteria are not meant to be a detailed, specific and definitive list, but merely a basic screening tool for general purposes of the Coalition and its partners.

CRITERIA

NOISE – This criterion has two separate factors to consider, both external (system) noise and internal (cabin noise) should be considered as important factors for consideration.

External – should be less than existing highway noise levels.

Internal – ability to hold a conversation without raising one's voice (current research indicates this is approximately decibel levels of about 50 db).

ELEVATED – The intent is for the AGS to be capable of being elevated for more than just for short spans like bridges, in an effort to avoid environmental (especially wildlife) impacts and to minimize the footprint of the system. Pre-fab structures for cost containment and deployment, as well as those constructed in sections offsite using steel and/or concrete should be considered. Design must follow context sensitive solutions guidelines to accommodate local community desires and needs.

WEIGHT – This criterion refers to a minimum/maximum freight carrying capacity (consumer freight) and also anticipates average per passenger as well as freight only capacity. The discussion regarding freight capacity is included in slightly more detail below. The basic guideline is for the AGS to accommodate passengers, luggage (and recreational paraphernalia) as well as some measure of containerized or consumer freight.

TRAVEL TIME – This category also has two components to consider since the intent is for the AGS to accommodate both local and express traffic simultaneously. This implies a need for off-line stations since it would not be feasible to allow for both local and express traffic on a single line with on-line stations.

Express – as least as fast as unimpeded vehicle on highway between Denver and Vail (speeds likely approaching greater than 65 mph)

Local - as least as fast as unimpeded vehicle on highway (including station dwell time), equivalent of local transit now (Summit Stage, Eco-Transit, etc.) between local locations (i.e., Silverthorne to Copper Mountain). This implies that speed of AGS would need to exceed 65 mph if station dwell time is going to be incorporated in transit time.

GRADE – **AGS** must accommodate demand between Denver and Glenwood Springs without significant degradation of speed and efficiency. That may mean ability to climb grades of 7% or greater over long stretches (10 miles or more) without significant decrease in speed.

SAFETY – This is a critical factor which includes both passenger safety (which has implications for g-forces for acceleration and deceleration, lateral stability and smoothness of ride) as well as safety for traffic/pedestrian crossings and potential wildlife crossings. Elevation of AGS should accommodate grade separated crossings and alleviate wildlife crossing concerns.

WEATHER – AGS should be capable of operating in all weather conditions and accommodate severe weather events with minimal interruption or delays in service. This includes tolerances for extremes of heat, cold, wind, ice.

WIND – Technology and network must be able to withstand windshear in excess of extreme alpine wind storms such as those frequently experienced at Georgetown and throughout the corridor.

SCALABILITY – Expansion of alignments and carrying capacity (within hours) should be able to address both growth in demand over time as well as peak demand vs off-peak demand. This criterion will have vehicle design ramifications as well as storage requirements for the system.

PASSENGER COMFORT AND SAFETY – While not "scientific" and quantifiable, the following observations are important factors to consider in evaluation of any technology on the I-70 corridor:

Ability to have a cup of coffee on board without concern for spilling it.
Work on laptop
Ride comfort - ability to move around without being slammed against a wall
Acceleration
Restroom capable
Seating for all passengers
ADA compliant

BAGGAGE CAPACITY – For most riders, there will be a need to accommodate gear, luggage, outdoor gear, "stuff". Loading of such accoutrements must have minimal impact on station dwell and boarding times. In general, the intent is to be able to carry anything one could carry in or on a passenger vehicle.

LIGHT FREIGHT – commercial freight during off hours (Consumer Freight). This criterion is still being discussed, but the intent is to accommodate UPS/FedEx type of freight as well as restaurant and lodging types of commodities.

ENERGY EFFICIENCY – Technology should be capable of incorporating green technology for power sources such as wind and solar power. Ideally it should accommodate such power sources on-line.

GROWTH – ability to accommodate 50 years of growth in demand

ACCOMMODATE LOCAL AND EXPRESS TRAFFIC SIMULTANEOUSLY

TUNNELS – if needed, the technology should minimize the need for tunneling as an expensive alternative to other routes. However, there is recognition that in certain circumstances, tunneling may be a viable option and even desirable to mitigate other factors.

ADAPTIBILITY – the system should be able to incorporate or evolve to future technological developments without scrapping the entire system.

RELIABILITY – consistent, predictable travel times in all weather conditions is a mandatory feature of any AGS proposed for the I-70 Corridor.

FREQUENCY – head-way times capable of addressing peak period demands is a necessity for this system.

ALIGNMENT – the system should not be limited to the current CDOT I-70 highway R.O.W. if a more efficient, more direct, more reliable and potentially less expensive alignment is possible. The AGS alignment should optimize ridership potential and minimize environmental impacts to both the corridor's natural and built environments, including impact to corridor communities and the current highway operation. In addition, alignment location considerations should include minimizing the impact to the current I-70 highway operation during the construction of the AGS.

OPERATIONAL EFFICIENCIES AND LOW MAINTENANCE COSTS

EQUIPMENT DESIGN FLEXIBILITY – the system should be able to accommodate multiple needs for passengers, freight, passenger "stuff", possibly even cars (based on European models). It should allow for private entities (UPS) to build specific needs vehicles (proprietary) to meet very specialized cargo needs. This may include a need for different vehicle configurations to accommodate low demand travel times and locations as well as the high demand, peak travel times and destinations.

CONTEXT SENSITIVE SOLUTIONS – CSS principles will apply for environmental and community considerations in construction and operations in all locations, the development of transit stations of all designs and for all types of technologies.

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K Novel Technologies

A key requirement of this study is that all proposed technologies should be proven and capable of receiving required regulatory approvals within the implementation time scales of the project. The study has assessed proven technology options and their potential speed, focusing on existing technologies that have been proven in actual revenue service. Proposed "Novel" or new technologies that are still under development cannot be considered practical for this study unless they can show that they can be implemented within a 5-10 year time horizon. This includes meeting FRA/FTA safety regulatory requirements as well as demonstrating the practical capability to commercially operate in the Colorado environment. Accordingly, and consistent with the scope of the I-70 Draft PEIS, it has focused on rail and Maglev-based technologies.

Various groups have advocated new or "novel" technologies for potential application to the Colorado corridors. However, the RMRA funding grant from the Colorado Department of Transportation specifically excluded detailed consideration of "novel" technologies from this study, restricting application of funds only to proven technologies:

1. The CDOT Transportation Commission Resolution Restricting Front Range Commuter Rail Study passed 6 to 1 in November 2006.
2. DMU, EMU, Diesel Locomotive Hauled or Magnetic Levitation are the only technologies allowed by the Transportation Commission because of work done previously in I-70 Draft PEIS.

Per this direction from the RMRA and CDOT, "novel" technologies cannot be evaluated at the same level as "proven" technologies. Nonetheless, a survey was conducted that includes novel technologies so we can understand their development potential for possible long-run implementation. This includes identifying how and when they might become part of Colorado's rail plan process.

K.1 Definition of a "Novel" Technology

The I-70 Draft PEIS evaluated rail and maglev (AGS) technologies, so for consistency those same two technologies were used for development of the RMRA Business Plan. The operative definition here for a "Novel" technology is anything that lies outside the range of technologies that were evaluated by the I-70 Draft PEIS. The Executive Summary (page ES-11) of the I-70 PEIS defines AGS as follows:

> "The Advanced Guideway System (AGS) alternative would be a fully elevated system that would use new or emerging technologies providing higher speeds than the other transit technologies under study. The AGS is based on an urban magnetic levitation (maglev) system researched by the Federal Transit Administration (FTA). The system uses High-Speed Surface Transportation (HSST) vehicles developed in Japan over the past 25 years,

with a history of proven performance and certification by the Japanese government, but would need to be heavily modified to meet the constraints of the Corridor. Another system considered under AGS, a monorail system, was proposed by the former Colorado Intermountain Fixed Guideway Authority and has not been tested to verify its performance. Nevertheless, either system serves as an example of the types of systems to be evaluated if the AGS alternative were to be identified as the preferred alternative."

K.2 Definition of a "Generic" Technology

The I-70 PEIS, like the current RMRA Business Plan, adopted a "Generic Technology Grouping" approach. That is, by characterizing its alternative as "AGS" the category was intended to cover a whole range of technology classifications, not just the Japanese HSST. In addition the I-70 PEIS did not base its evaluation on the existing HSST, but rather the I-70 PEIS was based on a performance specification that had been developed by the 2004 Colorado Maglev Study. While definitions of technology groups may be influenced by the capabilities of existing or proposed trains, in point of fact such evaluations are based on a broad set of assumptions regarding the general capabilities of each technology group. In this way the analysis can develop general conclusions regarding whole technology categories that are independent of any single manufacturer's train.

The current Business Plan has adopted the same general framework as the I-70 PEIS by also relying on a "Generic Technology" approach. The basic structure of the Business Plan is the same as the I-70 PEIS since it develops both Rail and Maglev based alternatives. However, the Generic Technologies evaluated by the RMRA business plan are actually more refined than those assumed by the I-70 PEIS. For example:

- Instead of having only a single AGS technology group, the maglev options have been subdivided into two groups: "low speed" 125-mph systems, primarily represented by the HSST concept, and "high-speed" 300-mph systems represented by Transrapid.
- Similarly the single "Rail" technology group used by the I-70 PEIS has been subdivided into four distinct rail technology types: 79 mph, 110 mph, 150 mph and 220 mph. The first two are diesel options that were evaluated only in the I-25 corridor. The last two are electric rail options with the primary distinction being that the 150-mph technology is locomotive-hauled, whereas the 220-mph technology is self-propelled, or Electric Multiple Unit (EMU.)

Thus, it can be seen that the Generic Technology groups utilized in the RMRA Business Plan analysis are consistent with, but more refined, than the groups that were utilized by the I-70 PEIS.

K.2.1 Incorporation of Maglev Technologies into "Generic" Groupings

Regarding Maglev, specific vendors' products (proposed or under development) offer performance capabilities that fall within the two Maglev generic technology groups already defined:

- **The "low speed" 125-mph category** is a generic group that covers concepts evolved from Urban Maglev or People Mover systems. Of these, the proposed American Maglev appears to be most similar to the HSST concept that formed the primary basis for the definition of this group. Both American Maglev and HSST would be LIM-powered vehicles that place the motor on board the vehicle rather than in the guideway. However, General Atomics has proposed a low-speed urban maglev for Pittsburgh that would use a LSM motor in the guideway (like Transrapid's) rather than an LIM motor on the vehicle. These systems differ in some details of levitation and control, but the 125-mph class evaluated in this study also reasonably reflects the likely performance capabilities of the American Maglev and General Atomics systems as well.

- **The "high-speed" 300-mph category** is a generic grouping that covers High-Speed maglev concepts. This category is primarily based on the Transrapid since that system is proven in revenue service in Shanghai. However, the performance of the proposed "Guideway 21" concept that was developed for the Colorado Intermountain Fixed Guideway Authority would also place that concept in to 300-mph category. It consists of a high-speed monorail that uses maglev technology for propulsion. Originally the maglev motor was proposed on top of the guideway, where it could provide partial or even complete levitation as vehicle speed increased. In later designs the maglev motors were moved to the side of the guideway, so the lifting effects would cancel each other out and the vehicle would not be levitated. The proposed "Guideway 21" is the only maglev design known to include an active tilting capability. This extreme tilting capability would in theory allow the vehicle to go through sharp curves on the mountain corridor faster than conventional trains or maglev vehicle could. The "Guideway 21" monorail is clearly intended as a competitor to the high-speed Transrapid, since it is a concept that was developed from the start for high-speed intercity application – it is not an adaptation of a lower-speed technology. However, "Guideway 21" has not benefited from the large Research and Development budget that has been invested in Transrapid. Accordingly "Guideway 21's" performance would be most closely reflected using the 300-mph forecast.

In spite of minor differences in the operating characteristics of individual vendors' trains, a "lead technology" has been designated for each group. This designation is based on the characteristics of technology that has actually achieved implementation in revenue service.

- For the 125-mph group it is the HSST technology that is operating in Nagoya, Japan;
- For the 300-mph group it is the Transrapid technology that is operating in Shanghai, China.

American Maglev and General Atomics vehicles exist on a test track but have not yet attained revenue service. Some components of "Guideway 21" such as the mag-lift motor have been tested individually. But as a system concept, "Guideway 21" has not yet been proven on a test track. Therefore, it is reasonable that those technologies that are operational in revenue service were given greater weighting in the definition of the characteristics of each generic technology group.

The two categories of maglev technology defined for this study incorporate all the critical technology aspects, particularly related to top speed, normal banking capability and propulsion system capability (LIM versus LSM drive.) These can be used to derive insights with respect to the potential applicability of specific variants of maglev technology. In particular, Chapter 7 gives a comparison of the energy efficiency of rail (220 mph) versus LIM-maglev (125 mph) and LSM-maglev (300 mph) technology classes. It can be seen in Exhibit 7-3 of the main report, that the energy costs for LSM propulsion and rail systems are roughly the same, but that the electrical inefficiency of the LIM drive wastes up to 30% of the energy fed into it as heat.

This results in much higher energy costs for the LIM drive as opposed to LSM drive or steel wheel technology. This effect is amplified on steep mountain grades because of the added energy required to go up the hills. With such inefficiency the regenerative braking going back down the hill also fails to recover much of the energy that could otherwise be fed back into the power transmission system, wasting much of the energy needed to go both up and down hills in the form of heat.

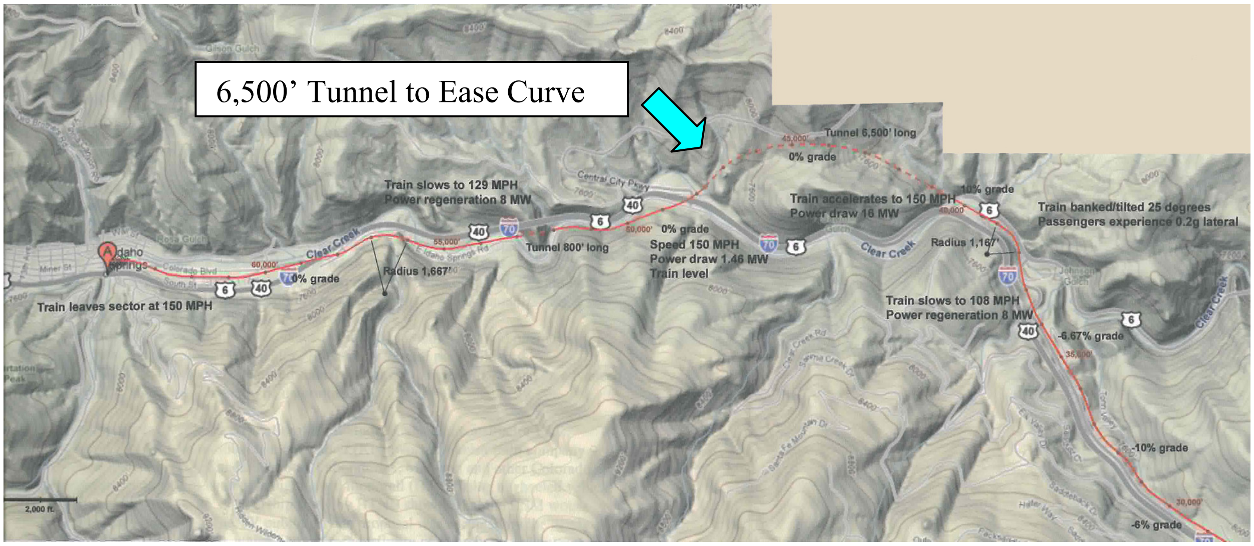
"Guideway 21" claims only 70-75% electrical efficiency[10] in the same range as standard LIM drive, whereas the electrical efficiency of LSM drive is 90-95%, almost as good as a standard electric traction motor. (However, another source[11] claims that "Guideway 21" would have better energy efficiency than Transrapid.) This poor electrical efficiency results in a blatant waste of energy. Trains that go fast or tackle heavy grades need increasing amounts of energy. LIM propulsion works adequately for low speeds but as speeds or grades go up, the wasted energy rises to the point where it becomes a substantial share of operating cost. Accordingly, LIM-based maglev can hardly be characterized as a "Green" technology for the I-70 corridor. However, the two Maglev systems that use LSM drives, Transrapid and General Atomics, would not have this problem since they have about the same energy efficiency as rail.

"Guideway 21" proposes up to 25° of tilt. The use of high degree of tilt would likely restrict passengers to their seats and require use of seat belts. It would not be possible to walk about the train to use rest room facilities, offer food cart or bistro service, or provide other kinds of comforts and amenities that passengers expect and have become accustomed.

To correct any misperception that it is possible to go around sharp curves at a high rate of speed, Exhibit K-1 shows a portion of the proposed "Guideway 21" alignment that was used to estimate a 5-minute running time from Genesee to Idaho Springs. Even "Guideway 21" is incapable of going around the sharp curve at the bottom of Floyd Hill at full speed. A 6,500′ tunnel was assumed to ease the curve.

[10] Hopkins, *Guideway 21, A Guideway Standard for the 21st Century*, page 2, November 17, 2008.
[11] Hopkins, Silva, Marder, Turman and Kelley, *Maglift Monorail*, Presented to High Speed Ground Transportation Assoication, Seattle, June 6-9, 1999.

Exhibit K-1: 6,500′ Tunnel in the proposed "Guideway 21" Alignment at the Bottom of Floyd Hill

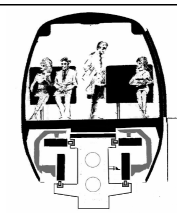


Current RMRA study alignments did not include the 6,500′ tunnel at the bottom of Floyd Hill that was suggested by the "Guideway 21" evaluation. Had that tunnel been included, it would have improved the performance of conventional rail and maglev technologies as well. A tunnel in this location could be a viable route enhancement option that should be looked at again as part of the NEPA process.

For evaluation of novel technologies like "Guideway 21" it is essential to ensure that any technology comparison is based on comparable routes and alignments. Otherwise what is fundamentally an alignment characteristic may be mistakenly attributed to the vehicle technology.

Exhibit K-2 shows Maglev technologies that were aggregated into the existing Generic Technology groupings. As described above, the performance of these particular technologies has been characterized under either the "low speed" or "high-speed" maglev categories evaluated by the current study.

Exhibit K-2: Specific Technologies Incorporated into the Generic Maglev Categories

Technology Group	Technology Name	Photo	Likely Development Time Frame
Low-Speed 125 mph	HSST		5-10 Years
	American Maglev		5-10 Years
High-Speed 300 mph	Transrapid		0 Years
	Guideway-21		15-20 Years

In terms of meeting the development time frames required for this study, both the HSST and American Maglev concepts are operational today at low speeds. HSST is operational in revenue service, whereas American Maglev is on a test track. To develop a higher speed, these systems need extensive redesign and testing. Most certainly it would require development of longer test track facilities than now exist, probably in a closed-loop formation like Transrapid's track in Emsland, Germany, to verify system operation and performance. For both of the 125-mph maglev technologies, minimum required time frames to develop a test track facility and to modify, verify and fine-tune the 125-mph technology, and to obtain required regulatory approvals and certifications, has been estimated at 5-10 years.

For 300-mph Maglev technology, Transrapid technology has completed testing and is in revenue service today in Shanghai, China. Its development time has been assessed at zero years, since the technology is available today for immediate implementation and has already received necessary FRA approvals.

Guideway-21 development, in contrast, lags behind any of the other available maglev technologies, since it has not yet even been deployed on a test track. In addition to this, Guideway-21's goal for supporting 300-mph operations is very aggressive compared to more conservative 125 mph for the lower-speed systems; this will undoubtedly take more time to develop. The mechanical complexity of the concept with its active tilting mechanism, suggests a minimum 15-20 year development period before such technology could be available for commercial implementation.

K.3 Other Novel Technologies

Exhibit K-3 shows technologies based on other approaches to vehicle guidance or propulsion. Some of these are based on adaptations of urban people mover systems, while others reflect truly new and innovative means for providing intercity passenger transportation.

K.3.1 Historical Development Lead Time Experience for New Systems

Our assessment of system development lead times is informed by historical experience for developing and implementing improvements to rail and maglev systems. In particular:

- The first Japanese Shinkansen or "bullet" train operated at 136 mph in 1964, a speed that today we would find unremarkable; the "300-series" trains introduced in 1992 were still only capable of 168 mph. 186-mph trains were not introduced in Japan until 1995, fully 30-years after the first line opened.
- Similarly, the French TGV from Paris to Lyon initially achieved only 168 mph in 1978, and its break-in period was far from trouble-free, requiring over 15,000 modifications to the original design.[12] 186-mph operations were not achieved until the opening of TGV-Atlantique in 1988, ten years later. This top speed of 186 mph remained the High-Speed Rail standard for nearly 20 years until TGV-East opened in 2007. This new line is designed for a top speed of 220 mph, ushering in a new generation of High-Speed travel, but generally operates at 200-mph.
- Tilt systems took a similarly long time to develop. The first successful European tilting train design was the Talgo in Spain, developed in the 1950s. This train was tried in the United States in 1957-1958 but because of the New Haven Railroad's financial difficulties at the time, the technology was set aside. Meanwhile tilt systems continued to develop with the

[12] "On 28 July 1978, two pre-production TGV trainsets left the Alsthom factory in Belfort. These would later become TGV Sud-Est trainsets 01 and 02, but for testing purposes they had been nicknamed "Patrick" and "Sophie", after their radio callsigns. In the following months of testing, over 15,000 modifications were made to these trainsets, which were far from trouble-free. High-speed vibration was a particularly difficult problem to root out: the new trains were not at all comfortable at cruising speed! The solution was slow in coming, and slightly delayed the schedule. Eventually it was found that inserting rubber blocks under the primary suspension springs took care of the problem. Other difficulties with highspeed stability of the trucks were overcome by 1980, when the first segment of the new line from Paris to Lyon was originally supposed to open. The first production trainset, number 03, was delivered on 25 April 1980." From: http://www.trainweb.org/tgvpages/history.html

introduction of active tilt by British Rail on its Advanced Passenger Train (APT) in 1981. The APT however was never reliable enough to go into service and the project was scrapped, although the Pendolino group purchased some of the APT technology, including the tilt mechanisms. Pendolino and Asea then successfully implemented tilt technology[13] on their ETR 450 and X-2000 trainsets in 1989. Since then, these trains have demonstrated over 20 years of reliable service, but the tilt technology itself took over 30 years to develop and mature.

- The development of maglev technology also has a long history. Planning of the Transrapid system started in 1969 at which time the first maglev prototype vehicle, the TR-01, was constructed. After this the technology developed through a series of prototypes until the Emsland test facility was completed in 1987. The TR-07 became operational the next year in 1988, the TR-08 in 1999[14], and the TR-09 in 2008. The first revenue application of Transrapid technology became operational in Shanghai in 2002. From 1969 until 2002 it took 33 years to reach the first revenue application of maglev technology, and by now over 40 years of research and development have been invested in this technology.

It can be seen that the development lead times for introduction of new rail technology are typically significant, in the order of 20-30 years for all of the key innovations that we take for granted today. Given the early development stage of many of the proposed "Novel" technology concepts, it would be a reasonable expectation that commercialization would require at least 15-20 years of development and testing effort – and will succeed only if backed by a sizeable research budget, sufficient to support a sustained, uninterrupted and consistent effort over those years.

Aside from this there are technical concerns regarding the potential viability of many of the system concepts that will be outlined below.

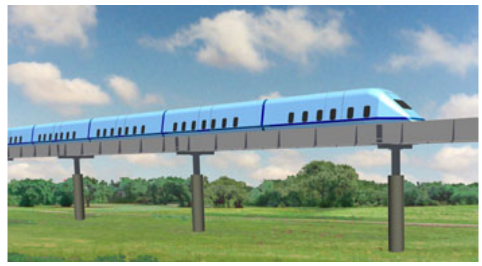
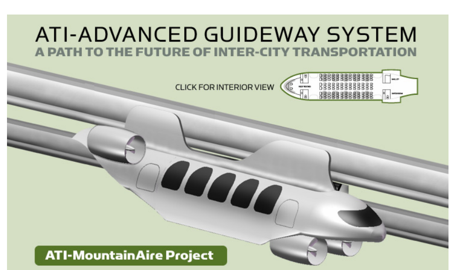
K.3.2 Novel Technologies Reviewed

As shown in Exhibit K-3, five different non-Maglev technologies have been reviewed for potential application to the RMRA system. All five technologies are in their very early development stages, leading to an assessment of 15-20 years minimum development lead time, before any of them could realistically be ready for commercial deployment. As shown in Exhibit K-3:

- **Megarail** has proposed a rubber-tire based, elevated system based on a concept for very low initial cost of ultra-light, automated production guideways.

[13] See: http://www.uctc.net/papers/113.pdf
[14] See: http://www.thyssenkrupp-transrapid.de/download/HMB2_e.pdf

Exhibit K-3: Novel Technologies Based on other Means of Guidance or Propulsion

Technology Name	Photo	Likely Development Time Frame
Megarail: www.megarail.com		15-20 Years
Lashley Bi-Rail Systems (LABIS): http://www.labistrain.com/		15-20 Years
Advanced Transit Solutions	(Photo Not Available)	15-20 Years
Suntram: www.suntram.net		15-20 Years
Air Train Global: http://www.airtrainglobal.com/		15-20 Years

- **Lashley Bi-Rail Systems** proposes a wide bodied, light elevated system that would run at high-speed and would pick up and drop passengers along the way without stopping**.** A shuttle would move through a given city picking up passengers at several conveniently located points then wait on a side-track until the train passes. Then the shuttle will overtake the moving train and dock with it.
- **Advanced Transit Solutions** has proposed a monorail system that would be powered by wind turbines. Very few other details about the proposed technology are available.
- **Suntram** has proposed a high-speed aerial tramway using a vehicle stabilized by aerodynamic controls.
- **Air Train Global** has proposed a vehicle using a combination of Motor-In-Hub traction wheels and Ducted-Thrust-Fan technology to move along an elevated guideway.

A wide range of alternative vehicle technologies has been proposed. Some technologies, such as those proposed by Megarail, are clearly evolved from urban people-mover applications. The others were proposed as new high-speed transportation modes. The technologies would use a variety of different means for propulsion and guidance.

Technical concerns regarding some of the technologies are as follows:

- Rubber tires as proposed by Megarail use more energy than steel wheel vehicles do, and the wheels have poorer traction, limited weight-bearing capacity and tend to overheat at high-speeds resulting in a need for frequent tire replacement.
- Vehicle stability and the ability to operate at high-speed over a suspended cable are potential concerns regarding the Suntram technology.
- Existing trains could do the docking maneuver proposed by Lashley. Rail systems already uncouple helper locomotives at speed, but the proposed coupling operation is potentially dangerous and it is not clear how it can be safely managed. The joining section would also have to accelerate to a speed *faster* than that of the main section in order to catch up with it, which limits the speed of the main section. It is not clear that limiting train speed in this way really provides an advantageous concept.
- The LIM vehicles proposed by the *2004 Colorado Maglev* study would have their propulsion units on-board. It is not clear how all this LIM electrical equipment could be brought on board the vehicle, and still produce a vehicle that is as lightweight, roomy and comfortable as Transrapid's existing LSM vehicle, which has the propulsion equipment built into the guideway. This analysis has assumed that the LIM vehicle must be heavier than the equivalent LSM vehicle for the same level of passenger comfort and capacity. It is not clear then, except for the cost of the embedded coils, how the heavier LIM vehicle can claim a lower-cost guideway structure than Transrapid's.
- In addition, high energy costs continue to be a concern for LIM propulsion in high-speed/high gradient applications. LIM has much poorer electrical efficiency than LSM propulsion. Moreover, LSM propulsion is available today in proven maglev systems that are ready for immediate commercial implementation. So it is not clear why one would want to

invest in developing a technology that is likely to cost more to operate than an off-the-shelf solution.

K.4 Novel Technologies and the myth of the "Low Cost Guideway"

A common theme seemingly underlying development all the "Novel" technology proposals (which was also shared by the *2004 Colorado Maglev Study*) is the concept of the "low cost guideway." The presumption appears to be that by deployment of smaller or lighter vehicles, a substantial sum could be saved through construction of lighter guideways. However, whenever it has been tested, *this theory has not been supported by detailed Engineering analysis*. For example:

- The proposed *2004 Colorado Maglev* system proposed guideway costs of only $10.7-13.8 million per mile (Table C-1 on page 48) coming to a total system cost of $5.8 Billion for a 157-mile system ($37 Mill/mile) from DIA to Eagle Airport. American Maglev has proposed similar costs.
- However, the I-70 PEIS, adopted a much higher cost of $6.15 Billion for the AGS alternative from C-470 to Eagle Airport (only 115 miles at $53.5 Million per mile, up 45% from the Colorado Maglev estimate.) This compares to $4.92 Billion in the I-70 PEIS for the rail option.

Both the I-70 PEIS and the current RMRA Business Plan agree that rail is less expensive than Maglev, while offering a very similar performance capability.

Recent accidents on the *Transrapid* maglev test track and very recently *Washington Metro* have shown, that even maglev and supposedly fail-safe, highly automated rail systems are not totally immune to the risk of accidents. The German ICE train suffered an accident in Eschede, Germany[15] when a fatigue crack in a wheel failed, causing the train to derail and slam into a bridge. The cars telescoped into one another exacerbating the death toll. The U.S. FRA and others have cited this train accident as justifying a tightening of vehicle crashworthiness standards.[16] Accordingly, long distance travel requires a substantial vehicle, in order to maintain not only passenger safety at high speeds but also comfort. A key requirement is the ability for passengers to get up and move freely around the vehicle, for access to bathroom facilities, food service, social/recreational purposes or simply the ability to exercise and stretch ones' legs.

The kinds of comforts and amenities that characterize the level of service associated with intercity rail travel simply cannot be provided on a small tram-like vehicle adapted from an urban people mover. Comfortable vehicles are necessary to attract riders from the automobile in a competitive mode environment. These vehicles will be substantial enough to exert heavy forces on a guideway structure.

Dynamic loadings exerted by higher speed vehicles necessitate rigid guideway structures that can maintain tight geometry tolerances under load. Lighter structures might technically carry the load

[15] See: http://en.wikipedia.org/wiki/Eschede_train_disaster
[16] C*rashworthiness Design and Evaluation on the Leading-cab structure of Rolling Stock using Topology Optimization* at http://resources.metapress.com/pdf-preview.axd?code=h10w62nq5p087078&size=largest

but deform too much to maintain the required geometry. A flimsy guideway structure would impose significant speed restrictions on both speed and ride quality. In addition over time a lightweight structure would tend to fatigue leading soon to safety concerns, and its need for premature replacement.

The likelihood of intercity service requirement being compatible with a lightweight and flimsy guideway structure seems rather remote. Unfortunately there is no “free lunch.” For the time being it appears that these vehicle and guideway parameters are inextricably linked.

For the current RMRA study as well as the earlier I-70 PEIS, guideway costs have been estimated based on known costs for the kinds of rail and maglev systems that have been proven in revenue service. These guideways are estimated to cost between $75-100 million per mile rather than the $20-40 million cited by some suppliers. The evaluation is based on technologies that are known to meet the comfort, safety, speed and other service parameters of the intercity passenger market. The vehicle technologies that are needed are available today and could be deployed in an operational Colorado system by 2025.

L FRA Developed Option: Train Schedules

A set of preliminary train schedules was developed for the FRA Developed Option. All schedules include 5% slack time over and above the minimum running time, reflecting an allowance for minor operational variances and schedule recovery on a dedicated track system.

A highly connected route structure was developed that offers direct train service options in all major travel markets. This resulted in the development of nine different schedule pairings whose timings had to be coordinated across the network. Trains from the south headed up the I-70 mountain corridor do not go to downtown Denver, but rather turn directly west at the I-25/US-6 junction. From this junction through downtown Denver north to 96th Avenue, Fort Collins trains share the alignment with the DIA Airport service. By coordinating the times at the junction based on the use of predefined time slots, conflict-free schedules could be developed for the whole system reflecting the target train frequencies established for each route in the Spider Web diagram.

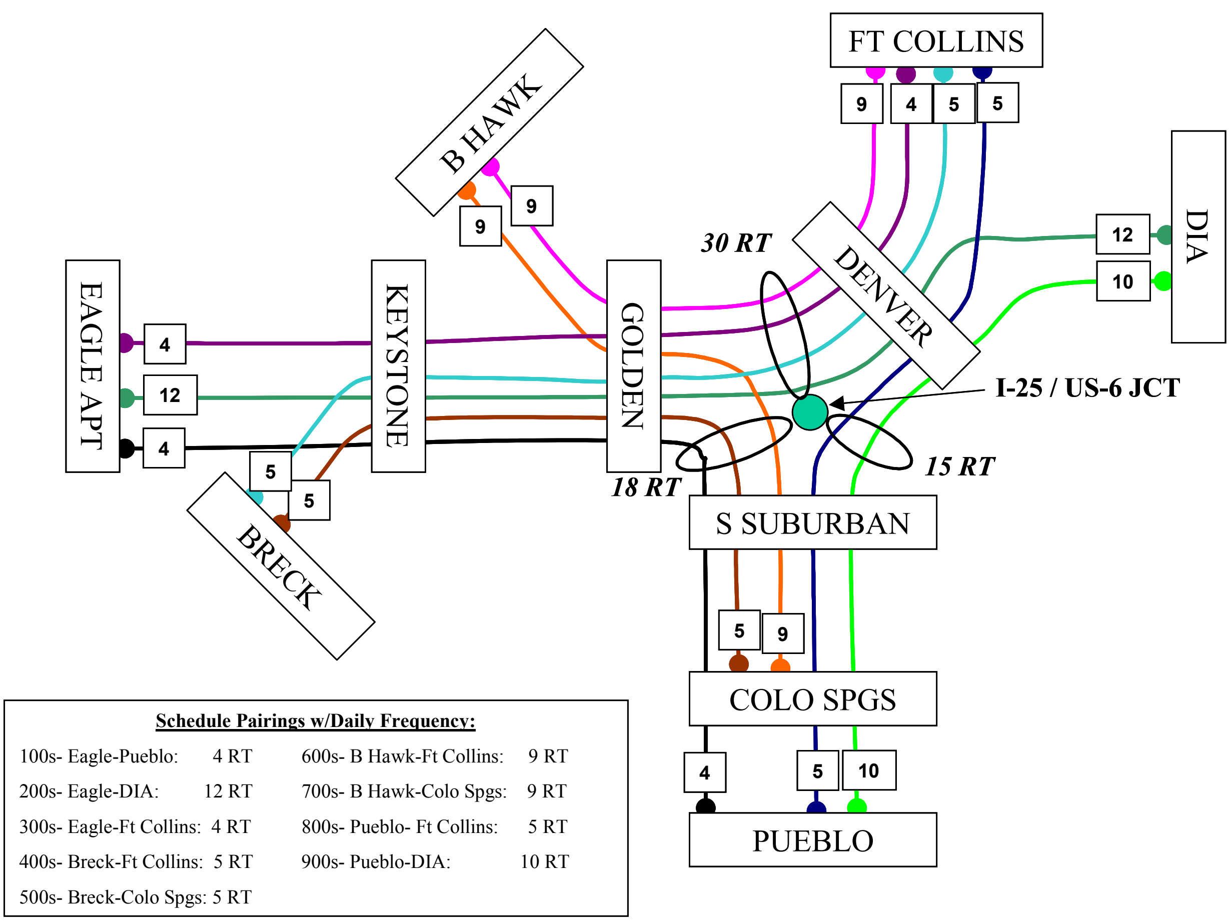
Train frequencies, times and stopping patterns are preliminary and subject to further refinement and optimization in future study phases. In addition current branch line schedules are all oriented for service to downtown Denver; they do not accommodate "backwards" flows such as from Black Hawk to Breckenridge, or from Breckenridge to Eagle Airport without a transfer. Additional schedule pairings for providing direct train service in such markets, for adding additional local stops along the corridors, developing Express/Local train services, further improving the match of train timings to individual market demands, and for minimizing equipment turn times at route termini to optimize equipment utilization, may all be developed as refinements in future study phases.

A highly peaked travel pattern is characteristic of "day trippers" but not "destination" or multi-day travelers, whose demand tends to be spread out more evenly across the day. The rail service is designed to accommodate both kinds of travel, but equipment utilization and operating efficiency considerations suggest that a system geared primarily to serving peak weekend demands of day trippers - would suffer poor equipment utilization and very high unit costs. Accordingly, an "all day" service is proposed based on fairly uniform service throughout the entire day with some capacity added in peak hours, that will give riders a lot of flexibility to travel at anytime they want to, rather than only at peak hours.

In the following train schedules, the gray highlighted areas show the various arrival departure times, with the train number (indicating the route to which the train is associated) at the top of each schedule. Some trains appear on more than one schedule, for example, train #500 starts at Colorado Springs at 5:36am and arrives at the I-25/US-6 Junction at 6:26am (see the Pueblo to Fort Collins schedule in L.5). The train continues west on the I-70 corridor arriving Breckenridge at 7:55am (see the DIA to Eagle Airport schedule in L.2). The yellow highlighted entry at the junction point shows that it is a linked schedule; where the train switches from one segment to the next, continuing to its final destination on another page of the schedule book. The yellow times at the junction along with the train numbers can be used, if desired to match the two segments of the train schedule together for those trains that switch between the I-70 and I-25 corridors.

On I-25 south of Colorado Springs, demand drops off. To better match capacity to demand and avoid running empty trains south of Colorado Springs, some trains are proposed to turn back there. To minimize the need for transfers, two short-distance routes to Black Hawk and Breckenridge would be turned at Colorado Springs, while longer distance routes to Eagle, Fort Collins and DIA would run through to Pueblo. The Colorado Springs-Black Hawk train would serve the southern suburbs of Denver, and provide a competitive option for Colorado Springs residents as well.

L.1 Spiderweb Train Schedule Diagram



L.2 DIA to Eagle Airport Train Schedule

Train Number	300	100	400	500	600	700	402	502	302	602	702	102	604	200	704	202	606
	(hh:mm)	(hh:mm)	(hh:mm)	(hh:mm)	(hh:mm)	(hh:mm)	(hh:mm)	(hh:mm)	(hh:mm)	(hh:mm)	(hh:mm)	(hh:mm)	(hh:mm)	(hh:mm)	(hh:mm)	(hh:mm)	(hh:mm)
DIA														9:32		10:17	
Denver - Union Station	5:59		6:14		6:29		7:44		7:59	8:29			9:29	9:44		10:29	10:44
US-6 JUNCTION	*6:04*	*6:11*	*6:19*	*6:26*	*6:34*	*7:41*	*7:49*	*7:56*	*8:04*	*8:34*	*8:41*	*8:56*	*9:34*	*9:49*	*10:11*	*10:34*	*10:49*
Suburban West	6:10	6:17	6:25	6:32	6:40	7:47	7:55	8:02	8:10	8:40	8:47	9:02	9:40	9:55	10:17	10:40	10:55
El Rancho	6:23	6:30	6:38	6:45	6:53	8:00	8:08	8:15	8:23	8:53	9:00	9:15	9:53	10:08	10:30	10:53	11:08
Black Hawk					7:31	8:38				9:31	9:38		10:31		11:08		11:46
Idaho Springs	6:37	6:44	6:52	6:59			8:22	8:29	8:37			9:29		10:22		11:07	
Loveland Pass	6:57	7:04	7:12	7:19			8:42	8:49	8:57			9:49		10:42		11:27	
Keystone	7:07	7:14	7:22	7:29			8:52	8:59	9:07			9:59		10:52		11:37	
Breckenridge			7:48	7:55			9:18	9:25									
Copper Mountain	7:25	7:32							9:25			10:17		11:10		11:55	
Vail Station	7:59	8:06							9:59			10:51		11:44		12:29	
Avon	8:07	8:14							10:07			10:59		11:52		12:37	
Eagle Airport	8:30	8:37							10:30			11:22		12:15		13:00	

Train Number	706	204	608	708	206	610	710	504	208	404	612	712	210	304	614	714	212
	(hh:mm)	(hh:mm)	(hh:mm)	(hh:mm)	(hh:mm)	(hh:mm)	(hh:mm)	(hh:mm)	(hh:mm)	(hh:mm)	(hh:mm)	(hh:mm)	(hh:mm)	(hh:mm)	(hh:mm)	(hh:mm)	(hh:mm)
DIA		11:17			12:17				13:17				14:17				15:17
Denver - Union Station		11:29	11:44		12:29	12:59			13:29	13:44	13:59		14:29	14:44	14:59		15:29
US-6 JUNCTION	*11:11*	*11:34*	*11:49*	*12:11*	*12:34*	*13:04*	*13:11*	*13:26*	*13:34*	*13:49*	*14:04*	*14:26*	*14:34*	*14:49*	*15:04*	*15:26*	*15:34*
Suburban West	11:17	11:40	11:55	12:17	12:40	13:10	13:17	13:32	13:40	13:55	14:10	14:32	14:40	14:55	15:10	15:32	15:40
El Rancho	11:30	11:53	12:08	12:30	12:53	13:23	13:30	13:45	13:53	14:08	14:23	14:45	14:53	15:08	15:23	15:45	15:53
Black Hawk	12:08		12:46	13:08		14:01	14:08				15:01	15:23			16:01	16:23	
Idaho Springs		12:07			13:07			13:59	14:07	14:22			15:07	15:22			16:07
Loveland Pass		12:27			13:27			14:19	14:27	14:42			15:27	15:42			16:27
Keystone		12:37			13:37			14:29	14:37	14:52			15:37	15:52			16:37
Breckenridge								14:55		15:18							
Copper Mountain		12:55			13:55				14:55				15:55	16:10			16:55
Vail Station		13:29			14:29				15:29				16:29	16:44			17:29
Avon		13:37			14:37				15:37				16:37	16:52			17:37
Eagle Airport		14:00			15:00				16:00				17:00	17:15			18:00

Train Number	**104**	**214**	**616**	**406**	**716**	**216**	**306**	**506**	**218**	**408**	**220**	**106**	**508**	**222**
	(hh:mm)	(hh:mm)	(hh:mm)	(hh:mm)	(hh:mm)	(hh:mm)	(hh:mm)	(hh:mm)	(hh:mm)	(hh:mm)	(hh:mm)	(hh:mm)	(hh:mm)	(hh:mm)
DIA		16:17				17:17			18:17		19:17			20:17
Denver - Union Station		16:29	16:44	17:14		17:29	18:14		18:29	19:14	19:29			20:29
US-6 JUNCTION	*16:26*	*16:34*	*16:49*	*17:19*	*17:26*	*17:34*	*18:19*	*18:26*	*18:34*	*19:19*	*19:34*	*19:56*	*20:26*	*20:34*
Suburban West	16:32	16:40	16:55	17:25	17:32	17:40	18:25	18:32	18:40	19:25	19:40	20:02	20:32	20:40
El Rancho	16:45	16:53	17:08	17:38	17:45	17:53	18:38	18:45	18:53	19:38	19:53	20:15	20:45	20:53
Black Hawk			17:46		18:23						20:31			
Idaho Springs	16:59	17:07		17:52		18:07	18:52	18:59	19:07	19:52	20:07	20:29	20:59	21:07
Loveland Pass	17:19	17:27		18:12		18:27	19:12	19:19	19:27	20:12	20:27	20:49	21:19	21:27
Keystone	17:29	17:37		18:22		18:37	19:22	19:29	19:37	20:22	20:37	20:59	21:29	21:37
Breckenridge				18:48				19:55		20:48	21:03		21:55	
Copper Mountain	17:47	17:55				18:55	19:40		19:55		20:55	21:17		21:55
Vail Station	18:21	18:29				19:29	20:14		20:29		21:29	21:51		22:29
Avon	18:29	18:37				19:37	20:22		20:37		21:37	21:59		22:37
Eagle Airport	18:52	19:00				20:00	20:45		21:00		22:00	22:22		23:00

L.3 Eagle Airport to DIA

Train Number	601	701	703	401	301	201	705	403	203	707	501	205	709	303	503	207	101
	(hh:mm)	(hh:mm)	(hh:mm)	(hh:mm)	(hh:mm)	(hh:mm)	(hh:mm)	(hh:mm)	(hh:mm)	(hh:mm)	(hh:mm)	(hh:mm)	(hh:mm)	(hh:mm)	(hh:mm)	(hh:mm)	(hh:mm)
Eagle Airport					6:10	6:25			7:10			8:10		8:55		9:10	9:18
Avon					6:33	6:48			7:33			8:33		9:18		9:33	9:41
Vail Station					6:41	6:56			7:41			8:41		9:26		9:41	9:49
Copper Mountain					7:15	7:30			8:15			9:15		10:00		10:15	10:23
Breckenridge				7:18				8:18			9:26				10:26		
Keystone				7:44	7:59	8:14		8:44	8:59		9:52	9:59		10:44	10:52	10:59	11:07
Loveland Pass				7:54	8:09	8:24		8:54	9:09		10:02	10:09		10:54	11:02	11:09	11:17
Idaho Springs				8:14	8:29	8:44		9:14	9:29		10:22	10:29		11:14	11:22	11:29	11:37
Black Hawk	6:13	6:36	8:06				9:06			10:06			11:06				
El Rancho	6:51	7:14	8:44	9:06	9:21	9:36	9:44	10:06	10:21	10:44	11:14	11:21	11:44	12:06	12:14	12:21	12:29
Suburban West	7:04	7:27	8:57	9:19	9:34	9:49	9:57	10:19	10:34	10:57	11:27	11:34	11:57	12:19	12:27	12:34	12:42
US-6 JUNCTION	*7:11*	*7:34*	*9:04*	*9:26*	*9:41*	*9:56*	*10:04*	*10:26*	*10:41*	*11:04*	*11:34*	*11:41*	*12:04*	*12:26*	*12:34*	*12:41*	*12:49*
Denver - Union Station	7:15			9:30	9:45	10:00		10:30	10:45			11:45		12:30		12:45	
DIA						10:12			10:57			11:57				12:57	

Train Number	209	405	211	603	213	711	505	305	103	215	713	605	217	607	219	715	507
	(hh:mm)	(hh:mm)	(hh:mm)	(hh:mm)	(hh:mm)	(hh:mm)	(hh:mm)	(hh:mm)	(hh:mm)	(hh:mm)	(hh:mm)	(hh:mm)	(hh:mm)	(hh:mm)	(hh:mm)	(hh:mm)	(hh:mm)
Eagle Airport	10:10		11:10		12:10			12:40	12:48	13:10			14:10		15:10		
Avon	10:33		11:33		12:33			13:03	13:11	13:33			14:33		15:33		
Vail Station	10:41		11:41		12:41			13:11	13:19	13:41			14:41		15:41		
Copper Mountain	11:15		12:15		13:15			13:45	13:53	14:15			15:15		16:15		
Breckenridge		12:03					13:56										16:56
Keystone	11:59	12:29	12:59		13:59		14:22	14:29	14:37	14:59			15:59		16:59		17:22
Loveland Pass	12:09	12:39	13:09		14:09		14:32	14:39	14:47	15:09			16:09		17:09		17:32
Idaho Springs	12:29	12:59	13:29		14:29		14:52	14:59	15:07	15:29			16:29		17:29		17:52
Black Hawk				14:13		14:51					16:06	16:13		17:13		17:51	
El Rancho	13:21	13:51	14:21	14:51	15:21	15:29	15:44	15:51	15:59	16:21	16:44	16:51	17:21	17:51	18:21	18:29	18:44
Suburban West	13:34	14:04	14:34	15:04	15:34	15:42	15:57	16:04	16:12	16:34	16:57	17:04	17:34	18:04	18:34	18:42	18:57
US-6 JUNCTION	*13:41*	*14:11*	*14:41*	*15:11*	*15:41*	*15:49*	*16:04*	*16:11*	*16:19*	*16:41*	*17:04*	*17:11*	*17:41*	*18:11*	*18:41*	*18:49*	*19:04*
Denver - Union Station	13:45	14:15	14:45	15:15	15:45			16:15		16:45		17:15	17:45	18:15	18:45		
DIA	13:57		14:57		15:57					16:57			17:57		18:57		

Train Number	**407**	**221**	**105**	**609**	**223**	**307**	**409**	**509**	**611**	**107**	**613**	**717**	**615**	**617**
	(hh:mm)	(hh:mm)	(hh:mm)	(hh:mm)	(hh:mm)	(hh:mm)	(hh:mm)	(hh:mm)	(hh:mm)	(hh:mm)	(hh:mm)	(hh:mm)	(hh:mm)	(hh:mm)
Eagle Airport		16:10	16:33		17:10	17:25				18:03				
Avon		16:33	16:56		17:33	17:48				18:26				
Vail Station		16:41	17:04		17:41	17:56				18:34				
Copper Mountain		17:15	17:38		18:15	18:30				19:08				
Breckenridge	17:18						19:03	19:11						
Keystone	17:44	17:59	18:22		18:59	19:14	19:29	19:37		19:52				
Loveland Pass	17:54	18:09	18:32		19:09	19:24	19:39	19:47		20:02				
Idaho Springs	18:14	18:29	18:52		19:29	19:44	19:59	20:07		20:22				
Black Hawk				19:13					20:28		20:43	20:51	20:58	21:13
El Rancho	19:06	19:21	19:44	19:51	20:21	20:36	20:51	20:59	21:06	21:14	21:21	21:29	21:36	21:51
Suburban West	19:19	19:34	19:57	20:04	20:34	20:49	21:04	21:12	21:19	21:27	21:34	21:42	21:49	22:04
US-6 JUNCTION	*19:26*	*19:41*	*20:04*	*20:11*	*20:41*	*20:56*	*21:11*	*21:19*	*21:26*	*21:34*	*21:41*	*21:49*	*21:56*	*22:11*
Denver - Union Station	19:30	19:45		20:15	20:45	21:00	21:15		21:30		21:45		22:00	22:15
DIA		19:57			20:57									

L.4 Fort Collins to Pueblo

Train Number	300	400	600	800	701	802	402	302	602	804	703	604	900	705	606	902	707
	(hh:mm)	(hh:mm)	(hh:mm)	(hh:mm)	(hh:mm)	(hh:mm)	(hh:mm)	(hh:mm)	(hh:mm)	(hh:mm)	(hh:mm)	(hh:mm)	(hh:mm)	(hh:mm)	(hh:mm)	(hh:mm)	(hh:mm)
Fort Collins	5:16	5:31	5:46	6:08		6:53	7:01	7:16	7:46	7:53		8:46			10:01		
North Front Range	5:22	5:37	5:52	6:14		6:59	7:07	7:22	7:52	7:59		8:52			10:07		
North Suburban	5:42	5:57	6:12	6:34		7:19	7:27	7:42	8:12	8:19		9:12			10:27		
DIA													9:39			10:39	
Denver - Union Station	5:59	6:14	6:29	6:51		7:36	7:44	7:59	8:29	8:36		9:29	9:51		10:44	10:51	
US-6 JUNCTION	*6:04*	*6:19*	*6:34*	*6:56*	*7:34*	*7:41*	*7:49*	*8:04*	*8:34*	*8:41*	*9:04*	*9:34*	*9:56*	*10:04*	*10:49*	*10:56*	*11:04*
Suburban South				7:04	7:42	7:49				8:49	9:12		10:04	10:12		11:04	11:12
Lone Tree				7:10	7:48	7:55				8:55	9:18		10:10	10:18		11:10	11:18
Castle Rock				7:20	7:58	8:05				9:05	9:28		10:20	10:28		11:20	11:28
Colorado Springs				7:45	8:23	8:30				9:30	9:53		10:45	10:53		11:45	11:53
Colorado Springs South				7:55		8:40				9:40			10:55			11:55	
Pueblo				8:15		9:00				10:00			11:15			12:15	

Train Number	501	608	904	709	503	101	906	610	404	908	612	304	910	614	711	912	505
	(hh:mm)	(hh:mm)	(hh:mm)	(hh:mm)	(hh:mm)	(hh:mm)	(hh:mm)	(hh:mm)	(hh:mm)	(hh:mm)	(hh:mm)	(hh:mm)	(hh:mm)	(hh:mm)	(hh:mm)	(hh:mm)	(hh:mm)
Fort Collins		11:01						12:16	13:01		13:16	14:01		14:16			
North Front Range		11:07						12:22	13:07		13:22	14:07		14:22			
North Suburban		11:27						12:42	13:27		13:42	14:27		14:42			
DIA			11:39				12:39			13:39			14:39			15:39	
Denver - Union Station		11:44	11:51				12:51	12:59	13:44	13:51	13:59	14:44	14:51	14:59		15:51	
US-6 JUNCTION	*11:34*	*11:49*	*11:56*	*12:04*	*12:34*	*12:49*	*12:56*	*13:04*	*13:49*	*13:56*	*14:04*	*14:49*	*14:56*	*15:04*	*15:49*	*15:56*	*16:04*
Suburban South	11:42		12:04	12:12	12:42	12:57	13:04			14:04			15:04		15:57	16:04	16:12
Lone Tree	11:48		12:10	12:18	12:48	13:03	13:10			14:10			15:10		16:03	16:10	16:18
Castle Rock	11:58		12:20	12:28	12:58	13:13	13:20			14:20			15:20		16:13	16:20	16:28
Colorado Springs	12:23		12:45	12:53	13:23	13:38	13:45			14:45			15:45		16:38	16:45	16:53
Colorado Springs South			12:55			13:48	13:55			14:55			15:55			16:55	
Pueblo			13:15			14:08	14:15			15:15			16:15			17:15	

Train Number	**103**	**616**	**914**	**713**	**406**	**916**	**306**	**715**	**806**	**507**	**918**	**408**	**808**	**105**	**509**	**107**	**717**
	(hh:mm)	(hh:mm)	(hh:mm)	(hh:mm)	(hh:mm)	(hh:mm)	(hh:mm)	(hh:mm)	(hh:mm)	(hh:mm)	(hh:mm)	(hh:mm)	(hh:mm)	(hh:mm)	(hh:mm)	(hh:mm)	(hh:mm)
Fort Collins		16:01			16:31		17:31		18:08			18:31	18:53				
North Front Range		16:07			16:37		17:37		18:14			18:37	18:59				
North Suburban		16:27			16:57		17:57		18:34			18:57	19:19				
DIA			16:39			17:39					18:54						
Denver - Union Station		16:44	16:51		17:14	17:51	18:14		18:51		19:06	19:14	19:36				
US-6 JUNCTION	*16:19*	*16:49*	*16:56*	*17:04*	*17:19*	*17:56*	*18:19*	*18:49*	*18:56*	*19:04*	*19:11*	*19:19*	*19:41*	*20:04*	*21:19*	*21:34*	*21:49*
Suburban South	16:27		17:04	17:12		18:04		18:57	19:04	19:12	19:19		19:49	20:12	21:27	21:42	21:57
Lone Tree	16:33		17:10	17:18		18:10		19:03	19:10	19:18	19:25		19:55	20:18	21:33	21:48	22:03
Castle Rock	16:43		17:20	17:28		18:20		19:13	19:20	19:28	19:35		20:05	20:28	21:43	21:58	22:13
Colorado Springs	17:08		17:45	17:53		18:45		19:38	19:45	19:53	20:00		20:30	20:53	22:08	22:23	22:38
Colorado Springs South	17:18		17:55			18:55			19:55		20:10		20:40	21:03		22:33	
Pueblo	17:38		18:15			19:15			20:15		20:30		21:00	21:23		22:53	

L.5 Pueblo to Fort Collins

Train Number	100	901	500	801	601	903	700	803	502	905	702	805	102	907	401	301	704
	(hh:mm)	(hh:mm)	(hh:mm)	(hh:mm)	(hh:mm)	(hh:mm)	(hh:mm)	(hh:mm)	(hh:mm)	(hh:mm)	(hh:mm)	(hh:mm)	(hh:mm)	(hh:mm)	(hh:mm)	(hh:mm)	(hh:mm)
Pueblo	4:51	4:59		5:44		5:59		6:29		6:59		7:29	7:36	7:59			
Colorado Springs South	5:11	5:19		6:04		6:19		6:49		7:19		7:49	7:56	8:19			
Colorado Springs	5:21	5:29	5:36	6:14		6:29	6:51	6:59	7:06	7:29	7:51	7:59	8:06	8:29			9:21
Castle Rock	5:46	5:54	6:01	6:39		6:54	7:16	7:24	7:31	7:54	8:16	8:24	8:31	8:54			9:46
Lone Tree	5:56	6:04	6:11	6:49		7:04	7:26	7:34	7:41	8:04	8:26	8:34	8:41	9:04			9:56
Suburban South	6:02	6:10	6:17	6:55		7:10	7:32	7:40	7:47	8:10	8:32	8:40	8:47	9:10			10:02
US-6 JUNCTION	*6:11*	*6:19*	*6:26*	*7:04*	*7:11*	*7:19*	*7:41*	*7:49*	*7:56*	*8:19*	*8:41*	*8:49*	*8:56*	*9:19*	*9:26*	*9:41*	*10:11*
Denver - Union Station		6:23		7:08	7:15	7:23		7:53		8:23		8:53		9:23	9:30	9:45	
DIA		6:35				7:35				8:35				9:35			
North Suburban				7:25	7:32			8:10				9:10			9:47	10:02	
North Front Range				7:45	7:52			8:30				9:30			10:07	10:22	
Fort Collins				7:51	7:58			8:36				9:36			10:13	10:28	

Train Number	909	403	706	911	708	913	303	710	915	504	405	917	712	603	919	714	305
	(hh:mm)	(hh:mm)	(hh:mm)	(hh:mm)	(hh:mm)	(hh:mm)	(hh:mm)	(hh:mm)	(hh:mm)	(hh:mm)	(hh:mm)	(hh:mm)	(hh:mm)	(hh:mm)	(hh:mm)	(hh:mm)	(hh:mm)
Pueblo	8:59			9:59		10:59			11:59			12:59			13:59		
Colorado Springs South	9:19			10:19		11:19			12:19			13:19			14:19		
Colorado Springs	9:29		10:21	10:29	11:21	11:29		12:21	12:29	12:36		13:29	13:36		14:29	14:36	
Castle Rock	9:54		10:46	10:54	11:46	11:54		12:46	12:54	13:01		13:54	14:01		14:54	15:01	
Lone Tree	10:04		10:56	11:04	11:56	12:04		12:56	13:04	13:11		14:04	14:11		15:04	15:11	
Suburban South	10:10		11:02	11:10	12:02	12:10		13:02	13:10	13:17		14:10	14:17		15:10	15:17	
US-6 JUNCTION	*10:19*	*10:26*	*11:11*	*11:19*	*12:11*	*12:19*	*12:26*	*13:11*	*13:19*	*13:26*	*14:11*	*14:19*	*14:26*	*15:11*	*15:19*	*15:26*	*16:11*
Denver - Union Station	10:23	10:30		11:23		12:23	12:30		13:23		14:15	14:23		15:15	15:23		16:15
DIA	10:35			11:35		12:35			13:35			14:35			15:35		
North Suburban		10:47					12:47				14:32			15:32			16:32
North Front Range		11:07					13:07				14:52			15:52			16:52
Fort Collins		11:13					13:13				14:58			15:58			16:58

Train Number	104	605	716	607	506	807	407	809	106	609	508	307	409	611	613	615	617
	(hh:mm)	(hh:mm)	(hh:mm)	(hh:mm)	(hh:mm)	(hh:mm)	(hh:mm)	(hh:mm)	(hh:mm)	(hh:mm)	(hh:mm)	(hh:mm)	(hh:mm)	(hh:mm)	(hh:mm)	(hh:mm)	(hh:mm)
Pueblo	15:06					17:44		18:29	18:36								
Colorado Springs South	15:26					18:04		18:49	18:56								
Colorado Springs	15:36		16:36		17:36	18:14		18:59	19:06		19:36						
Castle Rock	16:01		17:01		18:01	18:39		19:24	19:31		20:01						
Lone Tree	16:11		17:11		18:11	18:49		19:34	19:41		20:11						
Suburban South	16:17		17:17		18:17	18:55		19:40	19:47		20:17						
US-6 JUNCTION	*16:26*	*17:11*	*17:26*	*18:11*	*18:26*	*19:04*	*19:26*	*19:49*	*19:56*	*20:11*	*20:26*	*20:56*	*21:11*	*21:26*	*21:41*	*21:56*	*22:11*
Denver - Union Station		17:15		18:15		19:08	19:30	19:53		20:15		21:00	21:15	21:30	21:45	22:00	22:15
DIA																	
North Suburban		17:32		18:32		19:25	19:47	20:10		20:32		21:17	21:32	21:47	22:02	22:17	22:32
North Front Range		17:52		18:52		19:45	20:07	20:30		20:52		21:37	21:52	22:07	22:22	22:37	22:52
Fort Collins		17:58		18:58		19:51	20:13	20:36		20:58		21:43	21:58	22:13	22:28	22:43	22:58

M RMRA Public Involvement Process

M.1 RMRA Public Involvement Process

A unique component of this feasibility study was the commitment made by the Rocky Mountain Rail Authority (RMRA) to an extensive and transparent public involvement process. Key stakeholders were engaged throughout each phase of the evaluation process and their input helped inform the decision-making process.

The objectives of the public involvement program were to:

- Closely collaborate with state, regional and local policy-makers and senior planning staff on issues related to public/political acceptance and local planning efforts
- Gather targeted input at each phase of the study to help inform the decision-making process
- Keep the general public informed throughout the process

M.2 Elements of the Public Involvement Process

Considering the level of detail and decision-making needed for a feasibility study, the RMRA focused its public involvement efforts on deeply informing and engaging key decision makers from both corridors. There were also opportunities for the general public to get information and engage in the study.

Corridor Input Teams

Three Corridor Input Teams were formed:

- *I-70 Corridor Input Team* – This team focused on issues specific to the I-70 Corridor west of the Denver metropolitan area. It included representation from the I-70 Coalition, the towns/cities/counties/transit operators/resorts in the corridor as well as the corridor's various Transportation Planning Regions (TPRs) and Metropolitan Planning Organizations (MPOs). Meetings were coordinated through the I-70 Coalition with dial-in meeting locations in Steamboat Springs and Grand Junction.
- *Denver Metro Input Team* – This team focused on issues specific to the Denver Metro area and the convergence of the two rail lines. All members of the Denver Regional Council of Governments (DRCOG) were invited to participate. In addition, this team included representation from the Regional Transportation District (RTD) and Denver International Airport (DIA).

- *I-25 Corridor Input Team* – This team focused on issues specific to the I-25 Corridor north and south of the Denver metropolitan area. It included representation from the towns/cities/counties in the corridor as well as the various TPRs and MPOs. Joint meetings, connected by teleconference and/or web-conference, were held in Fort Collins and either Colorado Springs or Pueblo.

Each Corridor Input Team met three times:

- *Scoping (September 2008)* – Summarized the scope of the study, the evaluation criteria and evaluation methodology. Gathered input on local needs and desires within the scope of the feasibility study.
- *Alternatives Selection (December 2008)* – Summarized the alternatives that were going to be evaluated as well as the evaluation process. Gathered input on local preferences related to the alternatives under consideration.
- *Alternatives Analysis (April 2009)* – Summarized the preliminary results of the Alternatives Analysis and Feasibility Determination. Gathered input to inform the optimization of the recommended alternative.

Study Workshops

Two all-day workshops were held at critical milestones in the study: Alternatives Selection and Alternatives Analysis. Each of these workshops had attendance from more than 50 individuals representing municipalities and organizations throughout both corridors. The workshops provided participants with a deeper understanding of the methodology and rationale being used in the study so they could provide more informed input into the development, evaluation and refinement of alternatives.

General Public Outreach

As part of the study, the RMRA sought to engage the general public through various efforts including:

- *Project Web Site* – An entire section of the RMRA web site was devoted to the feasibility study and engaging the general public. All presentations, fact sheets and other project information were made available on the site. In addition, the comment and stakeholder database was integrated into the site, allowing members of the general public to register for updates and/or submit comments. Email blasts were developed and distributed to the stakeholder database to encourage stakeholders to access information and provide input.
- *Community Partnership Program* – Provided business, civic and other organizations with articles, maps and other information at key milestones in the study. These organizations republished this content in their newsletters, web sites and other communications vehicles.

This effort resulted in broader dissemination of study information from a more diverse group of information sources.

- *Media Relations* – An aggressive media relations program was used to generate broad coverage of the study. Significant statewide print, television, radio and online media coverage was achieved. The media coverage resulted in increased visits to the project web site and comments submitted to the team.
- *Community Presentations* – In coordination with partners in the Community Partnership Program and separate requests, members of the RMRA delivered presentations to third-party organizations throughout the study.

M.3 Input Gathered

At each decision milestone, input was gathered from the Corridor Input Teams. Input from these teams, as well as general public input, was reported to the RMRA Rail Feasibility Study Steering Committee for their consideration before developing recommendations that were brought to the RMRA Board of Directors. Below is a high-level summary of the input received during each phase of the study.

Phase One: Scoping Input

- General agreement with the study approach and process, particularly with regard to the types of technology and the range of speeds under consideration;
- Desire to study non-high-speed rail options that may be perceived to be easier to build due to existing infrastructure and right-of-way;
- Emphasis on the importance of this study to work with ongoing and past studies;
- Recommendation that the study consider local land-use and development plans in relation to station location options; and
- The issue of system interoperability between corridors (e.g. having one technology versus various technologies) was identified as an important trade-off to consider.

Phase Two: Alternatives Selection Input

- General support for the range of alternatives under consideration;
- Concerns about existing rail rights-of-way routes due to freight-capacity constraints and controversy/cost of freight rail relocation;
- Interest in a 470 route around Denver was raised;
- Importance of local-transit (both rail and bus) connections;
- Some recommendations about station locations to add, remove or relocate were offered; and

- Interest in non-stop "direct-service" options between major destinations (e.g. DIA to Vail, Colorado Springs to Denver) was identified.

Phase Three: Alternatives Analysis Input

- General support for initial phase of the system to be truncated at Fort Collins, Pueblo and Eagle County Airport.
  - The second phase of the system would evaluate extending the I-70 Corridor to Grand Junction, Steamboat, Aspen and Leadville and the I-25 Corridor to Cheyenne and Trinidad
  - Some questions were raised about grouping all routes west of Eagle County Airport (to Grand Junction, Aspen and Craig) as one segment in the truncation analysis
- Strong desire to optimize the best performing alternative:
  - Explore sections of the I-70 Corridor where the 4% alignment evaluated for other technologies could improve the 220-mph technology
  - Evaluate costs/benefits associated with reducing/avoiding the use of freight rail rights-of-way
  - Evaluate costs/benefits of being able to operate the existing, non-FRA compliant version of the 220-mph technology
- A few comments brought up earlier continued to be important
  - Interoperability to allow for a one-seat trip between corridors
  - Close integration with FasTracks stations and other local transit options

M.4 Public Involvement Summary

The public involvement approach for the study proved effective at engaging a diverse array of policy makers and other leaders throughout the process. The effort proved to be very effective in helping identify and resolve those issues that could be resolved. For those issues that couldn't be resolved or are not appropriate to resolve at this early stage of the planning effort, the issues were identified and documented so that future work can address them.