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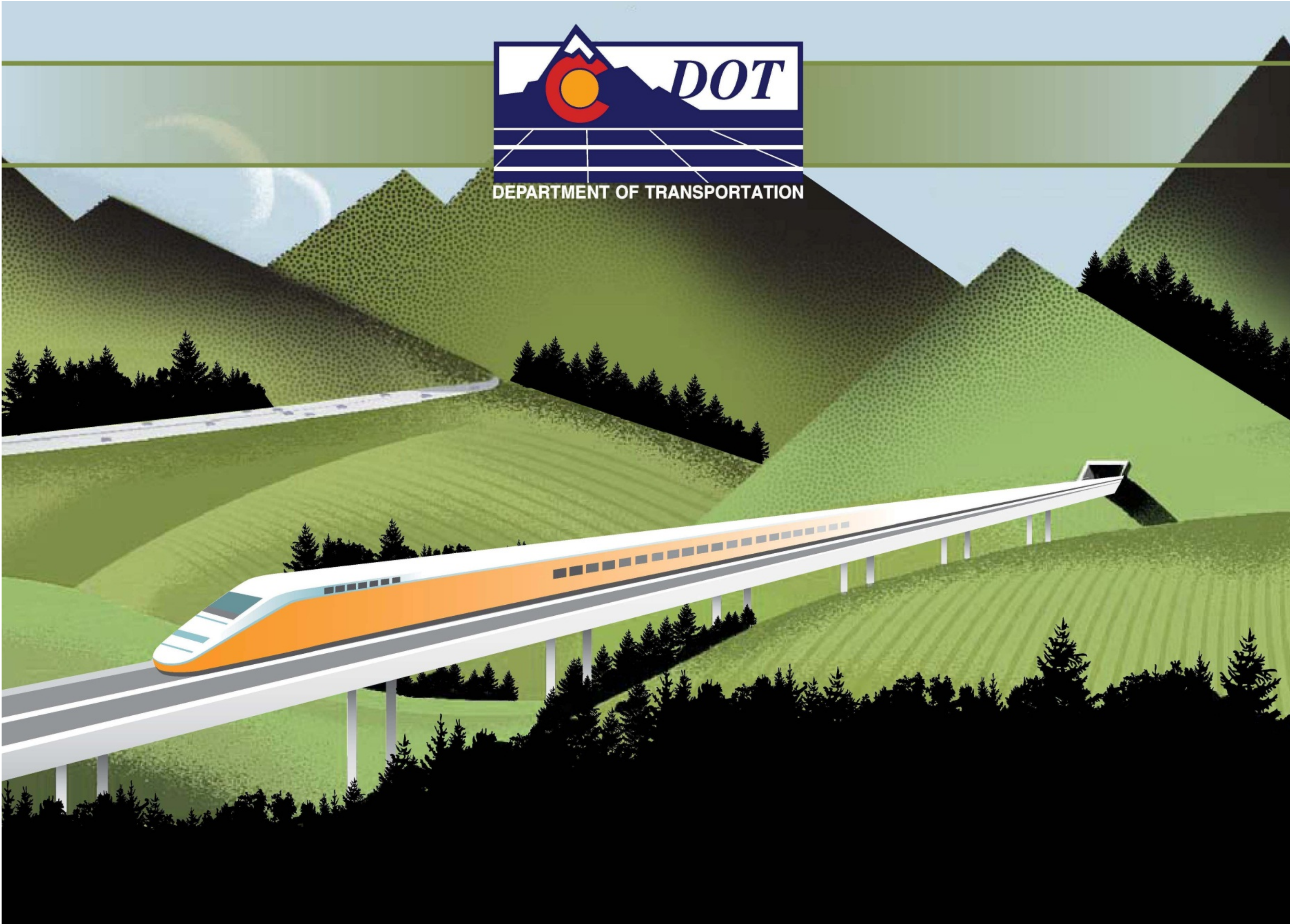

ADVANCED GUIDEWAY SYSTEM (AGS)
FEASIBILITY STUDY

APPENDIX F
CAPITAL COST ESTIMATION

Cost Estimation

Introduction

Because of the close relationship between capital investments and operating characteristics, a nominal operating scenario was adopted for this effort. It is recognized that alternative operating scenarios will probably be developed as the project advances. These might include shorter headways between vehicle consists, longer vehicle consists, movement of heavy freight, changes to alignments, addition of stations, etc. Each of these types of changes will result in changes to the cost estimates. However, the nominal operating scenario was used for this effort.

Background

Much has been done to try to quantify the costs for various technologies that might be applied to the I-70 Mountain Corridor. These efforts predate the current study. However, as the project has advanced to this point, more has been learned about possible route alignments, geology, stakeholder preferences for stations, feedback from possible technology-providers, and other factors.

One of the important points in the data collection and project understanding process was the interaction with the technology-providers in October 2012. This effort collected Statements of Technology Information (SOTIs) from technology-providers that wished to be considered for further analysis in this study process. A fuller description of the SOTI process can be found in Chapter 2.

Information found in the SOTI documents included infrastructure elements, design standards, vehicles, safety issues, costs and other data. The other important point in the data collection and project understanding process was the two-day presentations by select technology-providers on December 13-14, 2012. A description of this event can be found in Chapter 5.

One of the things that became obvious to the AGS Team and project stakeholders from these presentations was that the cost terms, basis, assumptions, and potential accuracy between data developed by technology-providers meant that the comparison of costs could not be relied upon, based on the raw data generated by the technology-providers.

The AGS Team contacted a select number of technology-providers to follow up on those items that could impact cost estimates. This centered on the determination of the infrastructure components of each system proposed by these technology providers. It also provided the AGS Team with a better understanding of the technology proposed, system elements, and technology maturity.

In many cases, it was recognized that the technology-provides may have had good information about their own proprietary items (vehicles, communications systems, propulsion systems, etc.), but did not necessarily have good cost information about track/guideway, foundations, columns, and similar items necessary to be built in the I-70 Mountain Corridor. Cost estimates developed by the technology-providers were set aside with the strategy of having the AGS Team generate its own independent costs for these items. Therefore, the AGS Team determined that it would develop its own cost estimates using as detailed information as was available at this time.

Approach and Basic Assumptions

Cost estimates were developed for the I-70 Mountain Corridor alignments and technology alternatives, following these steps:

Plans and profiles were developed by the AGS Team for the Maglev/Rail technologies for four alignments.

- I-70 alignment
- Hybrid alignment
- High Speed Maglev alignment
- High Speed Rail alignment

Each alignment was developed to fit with a specific technology in order to maximize the cost-effectiveness and efficiency of each alignment/technology pairs. Thus, the following the technology/alignment pairs were initially developed (see Table F-1):

Table F-1: Preliminary Alignment/Technology Pairs

	Alignment	Technology
1	I-70	120 MPH Maglev
2	Hybrid	120 MPH Maglev
3	High Speed Maglev	High Speed Maglev
4	High Speed Rail	High Speed Rail

More information about these alignments can be found in Chapter 3. More information about these technologies can be found in Chapter 2.

Based on further analysis and refinements, the I-70 alignments with the 120 mph maglev technology was set aside, and, for comparative purposes, the high speed maglev technology was tested (for cost purposes) on the Hybrid alignment. Therefore, the final cost estimate alignment/technology pairs were as shown in Table F-2. Tables F-3 and F-4 show the alignment lengths, tunnel lengths and ratios for the full system and the minimum operating segment (MOS) (partial system, Golden to Breckenridge).

Table F-2: Final Alignment/Technology Pairs

	Alignment	Technology
1	Hybrid	120 MPH Maglev
2	Hybrid	High speed maglev
3	High Speed Maglev	High Speed Maglev
4	High Speed Rail	High Speed Rail

Table F-3: Alignment Metrics (Full System)

Alignment	System Length (feet)	System Length (miles)	Tunnel Length (feet)	Tunnel Length (miles)	Tunnel length as % of Total Length
Hybrid	636,401	120.5	82,737	15.7	13.0%
High Speed Maglev	625,538	118.5	211,956	40.1	33.9%
High Speed Rail	575,097	108.9	343,045	65.0	59.6%

Table F-4: Alignment Metrics (Minimum Operating Segment)

Alignment	System Length (feet)	System Length (miles)	Tunnel Length (feet)	Tunnel Length (miles)	Tunnel length as % of Total Length
Hybrid	324,001	61.4	42,398	8.0	13.1%
High Speed Maglev	306,693	58.1	136,720	25.9	44.6%
High Speed Rail	320,866	60.8	199,541	37.8	62.2%

Note that the tunnel lengths compared to the total alignment lengths are substantial for the High Speed Maglev and High Speed Rail alignments, both for the full system and the minimum operating segment (MOS). These tunnel lengths allow for straighter routes and less significant grades (and grade changes). However, these tunnels come with a hefty price. It might also be argued that having 45% to 62% of the system length underground may not be desirable for those that want to view the Colorado scenery.

The AGS Team interacted with the AGS PLT and the Technical Committee (see Chapter 8) to determine possible station locations and size. This was entered in the alignment analysis for each technology. Alignments were then mapped out for each technology by the AGS Team. These were influenced on the design standards for the paired technology. Lengths for various types of elements were estimated (e.g., standard elevated track/guideway, very high guideway sections, tunnels, bridges, and other items). Detailed estimates were made for types of guideway, types of tunnels, types and height of bridges. The AGS Team developed a full range of appropriate bridge, tunnel, and guideway types for each technology. Quantity sheets from the plans and profiles were prepared as an input to capital cost estimating. This was based on technology types and alignments.

The operating scenario for costing purposes was determined to be:

- 18-hour operating days
- 365-day operating years
- 30-minute headways between trains or vehicle consists
- About 5-car train sets or maglev consists (with some exceptions)
- Station numbers and location determined by technology and alignment

- For all alignments/technology pairs, the east end station was at the C-470/I-70/US 6 interchange in Golden and the west end station was at ECRA for the full system
- For all alignments/technology pairs, the east end station was at the C-470/I-70/US 6 interchange in Golden and the west end station was at Breckenridge for the MOS

Costs for vehicles, propulsion, power, communications, energy supplies, and operations control technology systems; and operation & maintenance facilities were heavily influenced by proprietary information and costs from technology providers. Independent estimates for these items were used where possible, but were difficult to determine.

Experience in types of bridges, tunnels, and other infrastructure elements were used by the AGS Team in determining the tunnel and bridge options. Additional input was secured from a local contractor (Lawrence Construction of Littleton, Colorado) for costing columns, foundations, bridges, guideway structures, steel, concrete, and similar items. Quantities were estimated, as well. This was based on their experience in the I-70 Mountain Corridor and provided an independent cost estimate for these items. Quantities and costs were independently derived by the AGS Team. These infrastructure elements were derived from drawings and photos of the system infrastructure provided by technology providers.

The tunnel and bridge types were developed by TYPSA personnel based on EU rail experience. Initial estimates for the tunnels and bridges were produced by TYPSA. However, these costs were based on European experience in terms of materials, equipment, labor, and construction process. However, this did not reflect methods and processes used in the US. Thus, additional input was secured from Jacobs Engineering through their Senior Lead Estimator for their Tunnel practice in order to determine an independent cost estimate. This included detailed tunnel estimates for a range of tunnel types used for the costing effort. The tunnel experts from Jacobs also refined the tunnel types and costs per linear foot included labor, equipment, disposal, and related items.

Contingency costs were intentionally kept high due to the early stage of the analysis, the lack of a full engineering design, number and size of remaining uncertainties, etc. For some cost elements, the contingencies were higher than others due to the potential for additional costs for those items and the construction location in the I-70 Mountain Corridor.

Initial costing sheets were based on previous experience by the AGS Team on various high speed rail and maglev projects (e.g., Southern California maglev projects, Anaheim to Las Vegas Maglev project). These costing spreadsheets were refined based on the technologies involved in this study and special needs for the I-70 Mountain Corridor.

The cost spreadsheets were developed in order to be as interactive as possible (i.e., relationships were built in to the spreadsheet formulas so that changes could be seem quickly by entering limited alterations). Costing refinements were also made due to high speed rail, right-of-way, contingencies and related items. This was done in order to make the cost categories comparable to those of the ICS corridor.

Maglev and High Speed Rail Cost Components

The following section discusses the methods and assumptions used to develop capital cost estimates, including associated contingency, project implementation, and environmental mitigation. In general, each Maglev/Rail technology subsystem includes the design, manufacture, factory commissioning, transport to the site, installation, and commissioning of the subsystem itself. The planning, engineering, project management, overall commissioning, training, and testing required to develop the entire system are defined as program implementation costs. The following sections contain an overview of the elements included in the cost estimates of the various subsystems.

The maglev or high speed rail capital cost estimates consist of 12 major elements and are based on the unit costs outlined in the attached cost estimate spreadsheets. The cost components and related assumptions are described in the following pages.

Vehicles

Maglev - Each high speed maglev consist will be five (5) cars coupled semi-permanently. The two types of cars (sections) are end sections and intermediate sections. The end sections are aerodynamically styled to be the leading (or trailing) end of the train and contain certain on-board control systems. Some end sections would be configured to accommodate airline luggage and other cargo in uniform containers, probably uniform loading devices (ULDs). The intermediate sections contain seating and related passenger amenities. For the lower speed maglev, the consist is a 2-car “married pair.” Each section includes the following major subassemblies: car body, interior furnishings, vehicle on-board operation control system (end sections only), diagnostics, vehicle location system (end sections only – high speed maglev), HVAC, and magnetic suspension (undercarriage).

The number of vehicles was estimated based on the operating scenario and round-trip time for technology and alignment, the 30-minute service headway, the capacity of the standard five-car train set (high speed maglev), and the peak passenger load for each alternative, to determine whether multiple train sets would have to be couple to provide sufficient capacity. Spares are included in the estimated number of vehicles. Five (5) high speed maglev consists were estimated. One high speed (5 car) consist was estimated for the spare. For the 120 mph maglev technology, each consist is a 2-car married pairs. The total estimate for this technology is 18 pairs (or 36 total single vehicles), including spares.

High speed Rail - High speed trains (for purposes of this effort) are multi-car consists, including locomotive units and passenger cars. The number of high speed train vehicles was estimated based on the round-trip time for operating scenarios, the 30-minute service headway, the capacity of the standard train set, and the peak passenger load for each alternative. Spares are included in the estimated number of vehicles. Multiple train sets were needed to provide sufficient capacity, increasing the number of high speed trains and causing the size of the stations and maintenance facilities (see above) to increase. Six (6) multi-car consists were estimated, including a spare.

Table F-5 provides information about the various technologies speeds, capacities, energy usage and maximum running grade.

Table F-5: Technology Data

Technology	Speed	Capacity	Energy[a]	Maximum Running Grade
High Speed Rail (Talgo 250)	155 mph	450 passengers (10 passenger coaches with 3 traction units, one intermediate and one at each end)	36.0 kWh/mile at 155 mph or 80 Wh/seat-mile (demonstrated)	3% (and only for short distances)

High Speed Maglev (Transrapid - TRI)	150-300 mph	82 passengers per vehicle (probably run as 5-car consists)	22.5 kWh per consist/mile (5-car consist) at 170 mph constant speed or about 50 Wh per seat-mile (demonstrated)	10% (est.)
120 mph Maglev (American Maglev - AMT)	120-150 mph	186 passengers per vehicle ("married pair" of two cars)	2.9 kWh/mile for levitation and propulsion per vehicle at 120 mph or 15.6 Wh per seat-mile (claimed)	10% (est.)

a – Lower speed will result in lower energy use per km

Propulsion System

This includes such items as substation civil structures, substation propulsion blocks, wayside equipment, power systems, and similar items. This cost area is unique to maglev technology. The propulsion systems for rail systems are integral in the locomotive units. And, it is different for each maglev technology provider.

The number of substations and their size is based on the determined by the technology, operating schedule, train fleet size, route layout (double-, single-track), and route performance and characteristics (trip time, grades and curves, etc.). The wayside equipment is the propulsion equipment along the route. These wayside elements include switch stations, power rails, and radio antennas. The trackside equipment (transformer stations, etc.) and supply cabling (located in the same trench/way as the propulsion feeder cables) are required to safely and reliably provide power to the wayside components along the route.

Energy Supply

This includes such items as energy supply substations, operating facilities, wayside equipment, energy supply at passenger stations, and similar items. This cost area is unique to high speed maglev technology and high speed rail systems. For high speed rail, it would include overhead contact systems, third rail, or other power transfer systems. For lower-speed maglev, the energy systems are integral in the propulsion and vehicle systems. The energy supply system includes:

Power Substations: Site preparation, foundations, cable trenches, fencing, electrical equipment and all other costs of substation construction. Transmission lines from the substation to the local power source are included.

Power Distribution: Catenary poles and foundations, catenary wires and supports, tensioning devices, power feeders, transformers, and other associated items.

Operation Control Technology (OCT)

The *Operation Control Technology* (OCT) is the safety-related portion of the operation control system. The operation control technology includes: operation control/safety technology, stationary data transmission, radio data transmission, and vehicle location components (guideway mounted digital flags). The following operation control technology equipment is included in the maglev vehicle control system: vehicle operation control system, mobile radio transmission equipment, and vehicle location system. For the high speed rail systems, this item includes signaling systems, electronic interlockings (SIL 4) with all its elements, track circuits with electrical joints, wayside equipment, cables, signals, switches, etc.), and ATP system ERTMS-2 with back up ATP system and auxiliary operation elements (falling objects, hot axle detectors, etc.), integrated CTC and secure energy for these installations. The OCT includes:

Signaling: Wayside, on board, and central control software and hardware for the overall signaling system.

Communications/Control Technology

This element consists of emergency system, closed circuit television, public information and address systems, and other monitoring and detection devices needed for safe and efficient operation. Site preparation, foundations, cable trenches, electrical equipment, and all other costs of substation construction are included in the cost estimates. This cost area is unique to high speed maglev technology and high speed rail systems. For low-speed maglev, these functions are integral in the operation control technology. For high speed maglev, this includes such items as energy supply control equipment, building control equipment, operations communications, passenger communications, etc. For high speed rail, this includes both data / voice networks, GSM-R network, (BTS’S, MSC’S, BSC’S, etc.), communication nodes with redundant equipment, fixed redundant optical fiber layout, video surveillance, etc. Some of these items might be employed by other technologies.

Communications: Includes telephones and radios for operators, maintenance, and emergencies, closed circuit television, public information and address systems, and other monitoring and detection devices needed for safe and efficient operation.

Guideway and Track Infrastructure

The **guideway** infrastructure for maglev technologies consists of the following major elements: guideway beams, guideway switches, and guideway equipment. The guideway costs are estimated for a double-track (with some single-guideway areas, including stations) guideway, based on an average for guideway superstructures, assuming the Transrapid design for guideway beams, (Type I beams), and for concrete elements (Type III on bridges and in tunnels).

Track items for high speed rail include ballast, rails, ties, fasteners, and special track work such as sidings and turnouts. All track costs are for dual-tracked alignment. Direct fixation track has been assumed for elevated and tunnel areas, while ballasted track is used for at-grade sections.

Sound Walls along the outside of the guideway are intended to reduce noise from passing train sets. An allowance for sound walls has been made along the entire alignment.

Safety Fencing and Landscaping has been assumed along the full length (surface and elevated sections, and at stations and facilities) of the alignment.

Special Civil Structures - Structures, Bridges and Tunnels

The system infrastructure consists of structures that carry guideways, straddle bent crossings (of I-70) special foundations/caissons, support columns, special civil structures (bridges, viaducts), and tunnels.

The guideway structure costs are estimated for a double- and single-track guideway. The structure cost per route length for track depends on column height and construction complexity. The AGS Team developed 28 different bridge and viaduct options for costing maglev structures, including viaduct, high viaduct, and long span. The team developed 16 different bridge and viaduct options for costing high speed rail structures.

Aerial structures: Prestressed, reinforced concrete duel lane aerial structures, including abutments, excavation costs for abutments, wing walls, and transition slabs. All foundation work and associated earthwork is also included within the unit costs. Structures are defined as viaduct, high viaduct and long span.

Tunnels: Tunnel structure work includes boring/drilling/digging costs, ventilation systems, limited spoils disposal, and tunnel electrical systems (lighting, fans, et cetera). The team developed 12 tunnel options including a “cut & cover” option for costing both high speed rail and maglev systems.

Earthwork: The earthwork category includes the excavation and grading of earth in cuts (removal of earth) and fills (addition of earth).

Drainage: Drainage structures, including culverts and under drains, are estimated at 5% of the gross earthwork costs.

Stations and Maintenance Facilities

Stations: Each station includes platforms, circulation, lighting, security measures, and auxiliary spaces. Spaces are provided for ticket sales, passenger information, station administration, baggage handling, and commercial space. Many station designs show a two-story building with circulation on the first (ground) floor and transport platforms (high speed rail or maglev, or low-speed maglev). However, designs could alter for locations, demand, and terrain.

For the **Hybrid alignment**, stations would be located at Eagle, Avon, Vail, Copper Mountain, Breckenridge, Keystone, Idaho Springs, and Golden.

For the **High speed maglev alignment**, stations would be located at Eagle, Avon, Vail, Breckenridge, Keystone, Idaho Springs, and Golden.

For the **High speed rail alignment**, stations would be located at Eagle, Vail, Lake Hill, Georgetown, and Golden, with a spur from the Lake Hill station to connect Breckenridge.

The station cost estimates include the station building, station interior/equipment with HVAC, platform doors (automatic doors for passenger boarding/debarking and manual doors for emergency use), ADA provisions and requirements, site development access roads, parking, ticketing, landscaping, lighting, and preparation of site, and control and safety equipment. The size of the station depends on the number of passengers using each station. End-stations were assumed to be bigger than mid-stations. If power supplies or electrical substations are located at stations, they are costed out separately, and not included in Station costs. Joint development is possible at stations. However, these joint development costs are not included.

Operations and Maintenance Facilities

The operation and maintenance facilities consist of the facilities and equipment required for the operation and maintenance of the maglev or rail system (operation control center, maintenance facilities, and maintenance vehicles). The *Operations Control Center* (OCC) is assumed to be part of the central maintenance facility, assumed to be near Golden. A secondary maintenance facility is assumed near Eagle County Regional Airport.

The *Central Maintenance Facility* would house the vehicle maintenance equipment and personnel required for major periodic, scheduled vehicle maintenance and for repair of exterior or interior damage. It will also be a home base for route maintenance personnel and equipment (guideway, propulsion, etc.). It will include multiple bays for vehicle repair and maintenance work, and storage space for spare parts. Individual bays will be provided for vehicle integration, major periodic maintenance, and vehicle washing. This facility would likely be the home-based for most administrative and management functions.

The *Secondary Maintenance Facility* would house vehicle maintenance equipment and personnel required for daily and unscheduled maintenance, and vehicle washing. Parking tracks for out-of-service vehicles would be located Eagle County Regional Airport. The facility would be housed in a freestanding building with one track for vehicle maintenance work, storage space for spare parts, and areas for personnel.

The additional reason for having a maintenance facility at each end of the system would reduce deadhead distances at the beginning or end of the operating day, and increase repair or emergency response times.

Construction Support

This would include special construction equipment such as gantries, and one time beam fabrication facilities that are outside of commercial construction or fabrication vendors.

Right-of-Way and Utilities

Right-of-way: This includes costs associated with the purchase of land or easement rights, including relocation assistance, demolition costs, acquisition services, and the cost of purchase.

Each alignment has a different amount of public versus private lands. And, each alignment has a different amount of tunnel segments versus elevated and surface guideway/track segments. These factors directly affect the cost of right-of-way. Table F-6 provides the right-of-way requirements for each alignment/technology pair.

Table F-6: Right-of-Way Requirements

Alignment	**% on Private Properties**	**% on Public Lands**
Hybrid (AMT and TRI)	42.30%	57.70%
High Speed Maglev (Transrapid - TRI)	55.20%	44.80%
High Speed Rail (Talgo 250)	57.70%	42.30%
High Speed Rail Spur (To Breckenridge)	60.50%	39.50%
Right-of-Way Width		
Maglev (AMT and TRI)	40 feet wide	
High Speed Rail (Talgo 250)	75 feet wide	

The sum of $1/SF for all public land (tunnel or surface or elevated) was used. The sum of $5/SF for private subsurface rights, and $22/SF for private surface and elevated segments were used. The high speed rail right-of-way cost is higher than for maglev because it has a wider footprint, even though the high speed rail alignment has more tunnel length (i.e., more subsurface length). The analysis was done by system segment for each corridor scenario. The percent of public versus private land was applied to all corridor segments for each individual scenario, lacking any more detailed data by route segment.

Utility Relocation: Major utility relocations include overhead power lines, and underground facilities such as pipelines, water and sewer mains, and underground duct banks and vaults. Costs for utility relocation are estimated using the land use categories from the right-of-way estimates. More densely built-up areas would be expected to have more utility conflicts with a new transportation system. This cost is the actual cost related to moving utilities, and not professional services.

Contingencies, Project Implementation and Environmental Mitigation

Professional Services Costs include the cost for the management, procurement, controlling, and overhead costs associated with planning, engineering, and realization of the project. This includes the cost for the technical planning and approval of the project prior to and during construction, manufacturing, installation, commissioning, certification, and acceptance.

Utility Relocation is the cost for professional services related to planning, design and implementation of this effort.

Environmental Impact Mitigation is an allowance added to the construction cost estimates to account for a variety of mitigation treatments that would be identified during the formal environmental study process. These treatments would deal with site-specific environmental impacts, and include such items as replacement of displaced natural, recreational or cultural resources, removal of hazardous materials, replacement of habitat, etc.

Design and Construction Contingencies are an allowance added to construction cost estimates at the conceptual planning/engineering stage, to account for design details not available at this level of engineering, and to allow for quantity and unit cost variances that arise during later phases of project development.

- Standard Contingency – This is a standard 10% contingency related to project elements which have uncertainties and mountain construction (expect switches)
- Switch Contingency – This is special 20% contingency related to maglev switches due to the uncertainty in these items
- ROW Contingency – This is special 20% contingency related to right-of-way due to the uncertainty in land prices across lengthy alignments in the corridor
- Tunnel Contingency – This is special 30% contingency related to tunnel construction due to the uncertainty in preliminary design, geology, and other risk items
- Emergency Tunnel Contingency – This is special 20% contingency related to tunnel construction related to the need for escape shafts and corridors, and other emergency items which will be detailed during the design phase
- Overall Contingency – This is special 30% contingency related to the entire cost estimate; during the design and construction phases more details will be available and the costs will be dramatically refined

Capital Cost Estimates

Capital cost estimates were developed for each alignment/technology pair. They are shown in Table F-7 through F-10.

Table F-7: Capital Cost Estimate, Hybrid/120 MPH Maglev

Cost Category	**Hybrid - 120 MPH Maglev (AMT)**	
Vehicles	$240,000,000	
Propulsion System	$156,000,000	
Energy Supply	$0	
Operation Control Technology	$198,000,000	
Communication/Control Technology	$0	
Guideway/Track Infrastructure	$3,723,688,279	
Guideway/Track		$1,065,325,171
Bridges & Viaducts		$208,721,824
Tunnels		$2,227,678,781
Other		$221,962,502
Stations	$140,000,000	
Operations and Maintenance Facilities	$15,200,000	
Construction Support	$50,000,000	
Right of Way and Corridor	$329,494,912	
Subtotal - Basic Cost	**$4,852,383,191**	**45%**
Standard Contingency	$49,942,422	
Switch Contingency	$10,880,000	
Right of Way Contingency	$65,898,982	
Tunnel Contingency	$668,303,634	
Emergency Tunnel Contingency	$434,397,362	
Professional Services	$1,581,270,000	
Utility Relocation	$547,360,000	
Environmental Mitigation	$152,050,000	
Overall Contingency	$2,508,740,000	
Subtotal - Contingency and Support	**$6,018,842,402**	**55%**
Grand Total	**$10,871,220,000**	

Table F-8: Capital Cost Estimate, Hybrid/High Speed Maglev

Cost Category	**Hybrid - High Speed Maglev (TRI)**	
Vehicles	$240,200,000	
Propulsion System	$748,300,000	
Energy Supply	$235,000,000	
Operation Control Technology	$115,557,991	
Communication/Control Technology	$7,653,800	
Guideway/Track Infrastructure	$4,217,078,206	
Guideway/Track		$1,558,715,098
Bridges & Viaducts		$208,721,824
Tunnels		$2,227,678,781
Other		$221,962,502
Stations	$140,000,000	
Operations and Maintenance Facilities	$49,000,000	
Construction Support	$50,000,000	

Cost Category	Hybrid - High Speed Maglev (TRI)	
Right of Way and Corridor	$329,494,912	
Subtotal - Basic Cost	**$6,132,284,908**	**46%**
Standard Contingency	$149,773,601	
Switch Contingency	$10,880,000	
Right of Way Contingency	$65,898,982	
Tunnel Contingency	$668,303,634	
Emergency Tunnel Contingency	$434,397,362	
Professional Services	$1,940,000,000	
Utility Relocation	$671,540,000	
Environmental Mitigation	$186,540,000	
Overall Contingency	$3,077,880,000	
Subtotal - Contingency and Support	**$7,205,213,581**	**54%**
Grand Total	**$13,337,490,000**	

Table F-9: Capital Cost Estimate, High Speed Maglev

Cost Category	High Speed Maglev (TRI)	
Vehicles	$240,200,000	$2,027,004
Propulsion System	$748,300,000	$6,314,768
Energy Supply	$235,000,000	$1,983,122
Operation Control Technology	$114,701,631	$967,946
Communication/Control Technology	$7,653,800	$64,589
Guideway/Track Infrastructure	$8,683,531,941	$73,278,751
Guideway/Track		$1,711,594,292
Bridges & Viaducts		$118,329,180
Tunnels		$6,636,376,201
Other		$217,232,268
Stations	$140,000,000	
Operations and Maintenance Facilities	$49,250,000	
Construction Support	$50,000,000	
Right of Way and Corridor	$223,904,348	
Subtotal - Basic Cost	**$10,492,541,720**	**41%**
Standard Contingency	$319,272,890	
Switch Contingency	$17,920,000	
Right of Way Contingency	$44,780,870	
Tunnel Contingency	$1,990,912,860	
Emergency Tunnel Contingency	$1,294,093,359	
Professional Services	$3,681,480,000	
Utility Relocation	$1,274,360,000	
Environmental Mitigation	$353,990,000	
Overall Contingency	$5,840,810,000	
Subtotal - Contingency and Support	**$14,817,619,980**	**59%**
Grand Total	**$25,310,170,000**	

Table F-10: Capital Cost Estimate, High Speed Rail

Cost Category	High Speed Rail (Talgo 250)	
Vehicles	$180,000,000	
Propulsion System	$0	

Cost Category	High Speed Rail (Talgo 250)	
Energy Supply	$280,463,479	
Operation Control Technology	$219,112,093	
Communication/Control Technology	$61,351,386	
Guideway/Track Infrastructure	$11,766,531,034	
Guideway/Track		$1,032,256,862
Bridges & Viaducts		$652,490,948
Tunnels		$9,743,773,973
Other		$338,009,250
Stations	$110,000,000	
Operations and Maintenance Facilities	$49,250,000	
Construction Support	$50,000,000	
Right of Way and Corridor	$268,005,695	
Subtotal - Basic Cost	**$12,984,713,687**	**40%**
Standard Contingency	$253,958,263	
Switch Contingency	$6,400,000	
Right of Way Contingency	$53,601,139	
Tunnel Contingency	$2,923,132,192	
Emergency Tunnel Contingency	$1,900,035,925	
Professional Services	$4,711,680,000	
Utility Relocation	$1,630,970,000	
Environmental Mitigation	$453,050,000	
Overall Contingency	$7,475,260,000	
Subtotal - Contingency and Support	**$19,408,087,519**	**60%**
Grand Total	**$32,392,800,000**	

Tables F-11 through F-14 show the costs per segment for the various technology/alignment pairs. These are arrayed from west to east. As one would assume, segments in the more mountainous areas (eastern segments toward Keystone and Golden) are more costly due to the need for special structures and tunnels.

Table F-11: Capital Cost Estimate by Segment, Hybrid/120 MPH Maglev

Segment	Stations	Segment Cost
Segment 1	Eagle	$ 1,590,227,527
	Avon	
Segment 2	Avon	$ 693,476,591
	Vail	
Segment 3	Vail	$ 1,607,701,781
	Copper	
Segment 4	Copper	$ 1,435,264,415
	Breckenridge	
Segment 5	Breckenridge	$ 1,259,980,487
	Keystone	
Segment 6	Keystone	$ 2,039,111,254
	Idaho Springs	
Segment 7	Idaho Springs	$ 2,245,465,217

	Golden	
		$ 10,871,220,000

Table F-12: Capital Cost Estimate By Segment, Hybrid/High Speed Maglev

Segment	Stations	Segment Cost
Segment 1	Eagle	$ 2,094,427,584
	Avon	
Segment 2	Avon	$ 858,226,718
	Vail	
Segment 3	Vail	$ 2,013,023,249
	Copper	
Segment 4	Copper	$ 1,569,981,039
	Breckenridge	
Segment 5	Breckenridge	$ 1,483,979,909
	Keystone	
Segment 6	Keystone	$ 2,675,421,152
	Idaho Springs	
Segment 7	Idaho Springs	$ 2,642,436,323
	Golden	
		$ 13,337,490,000

Table F-13: Capital Cost Estimate by Segment, High Speed Maglev

Segment	Stations	Segment Cost
Segment 1	Eagle	$ 3,772,410,843
	Avon	
Segment 2	Avon	$ 1,572,607,724
	Vail	
Segment 3	Vail	$ 3,979,894,250
	Copper	
Segment 4	Copper	$ 1,843,519,765
	Breckenridge	
Segment 5	Breckenridge	$ 480,664,083
	Keystone	
Segment 6	Keystone	$ 6,449,829,285
	Georgetown	
Segment 7	Georgetown	$ 7,211,233,260
	Golden	
		$ 25,310,170,000

Table F-14: Capital Cost Estimate by Segment, High Speed Rail

Segment	Stations	Segment Cost
Segment 1	Eagle	$ 8,309,163,067
	Vail	
Segment 2	Vail	$ 5,074,098,165
	Lake Hill	
Segment 3	Lake Hill	$ 7,538,967,858
	Georgetown	
Segment 3b (Spur)	Lake Hill	$ 1,854,484,113

	Breckenridge	
Segment 4	Georgetown	$ 9,616,088,003
	Golden	
		$ 32,392,800,000

Figures F-1 to F-4 show the segment costs for each technology/alignment pair. Again, costs usually increase as the system moves east from Eagle County Regional Airport to Golden. Tunnel and special structure costs are the driving factor in this process.

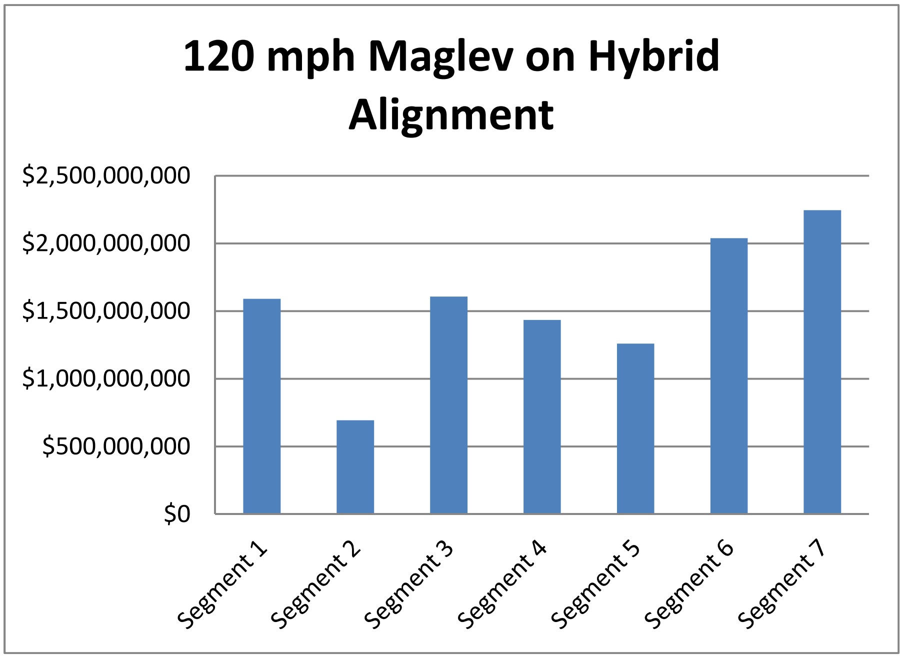

Figure F-1: Costs by Segment: Hybrid/120 MPH Maglev

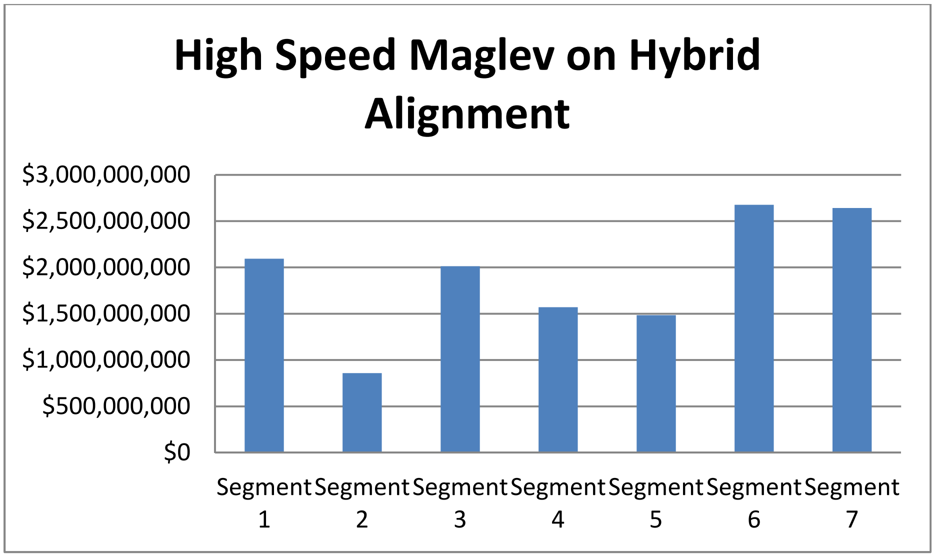

Figure F-2: Costs by Segment: Hybrid/High Speed Maglev

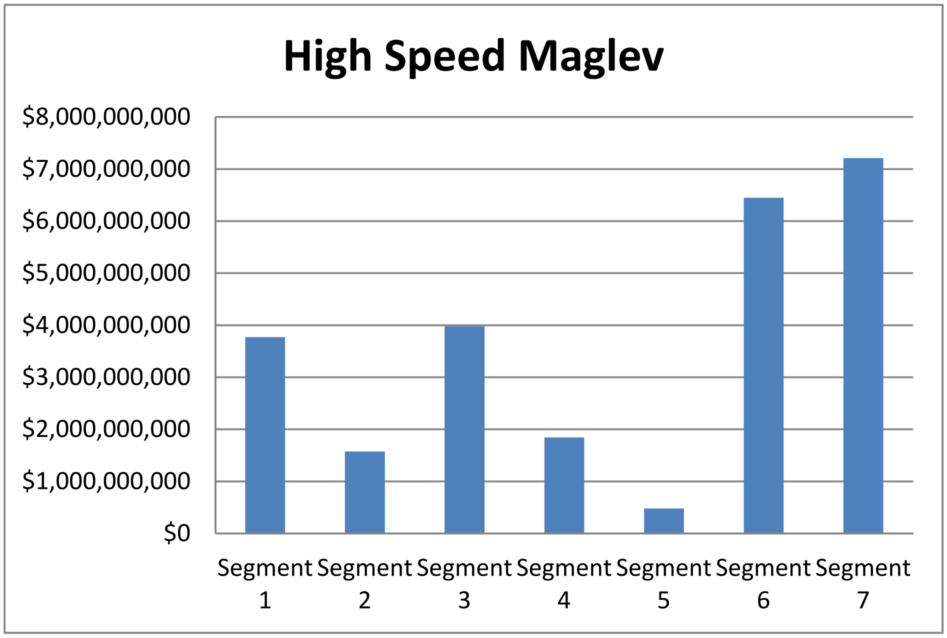

Figure F-3: Costs by Segment: High Speed Maglev

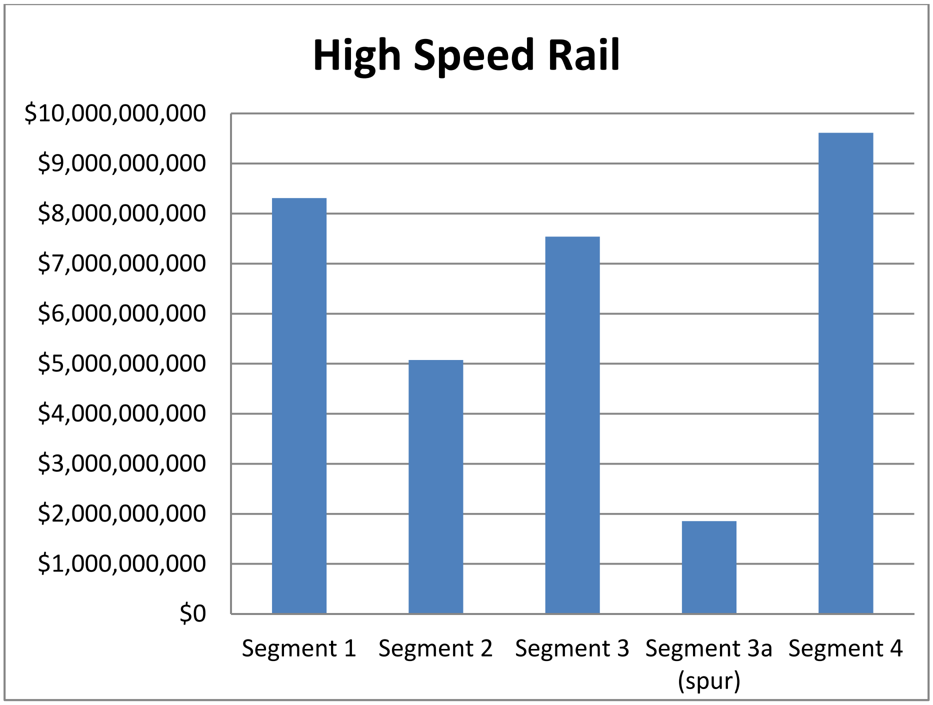

Figure F-4: Costs by Segment: High Speed Rail

Table F-15 shows that tunnels account for between 17% and 30% of the total system capital costs (including contingencies and support costs). The guideway or track cost come in a distant second in the capital costs.

Table F-15: Capital Costs by Cost Category

Cost Category	Hybrid - 120 MPH Maglev	Hybrid - High Speed Maglev	High Speed Maglev	High Speed Rail
Vehicles	2%	2%	1%	1%
Propulsion System	1%	6%	3%	0%
Energy Supply	0%	2%	1%	1%
Operation Control Technology	2%	1%	0%	1%
Communication/Control Technology	0%	0%	0%	0%
Guideway/Track	10%	12%	7%	3%
Bridges & Viaducts	2%	2%	0%	2%
Tunnels	20%	17%	26%	30%
Other	2%	2%	1%	1%
Stations	1%	1%	1%	0%
Operations and Maintenance Facilities	0%	0%	0%	0%
Construction Support	0%	0%	0%	0%
Right of Way and Corridor	3%	2%	1%	1%
Professional Services	15%	15%	15%	15%

Cost Category	Hybrid - 120 MPH Maglev	Hybrid - High Speed Maglev	High Speed Maglev	High Speed Rail
Utility Relocation	5%	5%	5%	5%
Environmental Mitigation	1%	1%	1%	1%
Other Contingencies	11%	10%	14%	16%
Overall Contingency	23%	23%	23%	23%
	100%	100%	100%	100%

Minimum Operating Segment

The Minimum Operating Segment (MOS) is the portion of the total system that needs to be built in order to meet requirements laid out in the ROD or effectively operate as an independent system. The ROD requires the feasibility of the AGS to be identified from the Front Range to a point west of the Continental Divide. For the purposes of this study, the MOS is defined as Golden to Breckenridge. A cost estimate was analyzed for this MOS portion for each alignment/technology pair. This could be important information so that the affordability for the first starter segment can be determined.

The MOS represents between 51% and 59% of the total system capital cost, whereas the MOS represents between 49% and 56% of the MOS system length (see Table F-16). This is understandable since these portions of the total system alternatives are in the eastern part of the system where the topography is most challenging and higher costs can be found for items such as tunnels and special structures.

Table F-16: Minimum Operating Segment Cost Comparison

	Hybrid - 120 MPH Maglev	Hybrid - High Speed Maglev	High Speed Maglev	High Speed Rail
Total System Cost (all segments)	$10,871,220,000	$13,337,490,000	$25,310,170,000	$32,392,800,000
Minimum Operating Segment Cost	$5,544,560,000	$6,801,840,000	$14,141,730,000	$19,009,540,000
MOS as % of Total Cost	51.00%	51.00%	55.90%	58.70%
MOS as % of Total Length	50.40%	50.40%	49.20%	56.00%

Operations and Maintenance Costs

Operating and maintenance (O&M) costs are the annual costs associated with operating, maintaining and administering a transit system. O&M costs include employee earnings and fringe benefits, contract services, materials and supplies, utilities, and other day-to-day expenses.

The methodology for O&M costing of the AGS Feasibility Study alternatives is based on the principal assumption that annual operating and maintenance costs vary according to labor productivity, consumption rates, and system characteristics related to service and facilities.

In order to estimate annual O&M costs for the AGS alternatives, a cost allocation model was developed to estimate costs under three functional areas:

- **Operations.** Includes Administration, Train Operations and Station Operations.
- **Maintenance.** Includes Administration, Vehicle Maintenance, and Right-of-Way (ROW) Maintenance.
- **General Administration.** Represents the Rail Director and staff supporting overall program functions such as Legal, Accounting, Finance, Human Resources, Marketing, Customer Service, IT, Purchasing, Safety and Risk Management.

Each of these functional areas identifies separate Labor and Non-Labor line items.

Costs for each line item are driven by system characteristics related to service and facilities. For the AGS O&M cost model, nine such characteristics are identified:

- Annual revenue train-hours
- Annual revenue train-miles
- Annual revenue car-miles
- Fixed guideway route miles
- Number of major stations (where particularly high volumes of passengers and/or connections to other major transportation services occur)
- Number of minor stations (the majority of the AGS stations are identified under this category)
- Number of peak cars (maximum number of vehicles operated simulataneously on a typical day)

Typical development of an O&M cost model would involve developing productivity ratios based on actual expenses and system characteristics from established systems. Very scant information is available due to the limited application or lack of AGS study technologies currently operating revenue service in the United States. Therefore, the O&M cost model builds on actual O&M costs and data available for more traditional rail systems, tailoring specific line items to account for technology differences. Information on traditional rail systems included Utah Transit Authority for their commuter rail service, as they have been able to maintain lower O&M costs relative to other properties. Information provided by Transrapid International-USA, Inc. (TRI) and American Maglev Technology, Inc. (AMT) was incorporated as applicable.

For purposes of designing a methodology that would distinguish major differences among alternative modes, some expense items are modeled with consistent unit cost assumptions that apply regardless of mode:

- Operations Administration and Maintenance Administration
- Train crews (one operator and one train attendant, calculated based on the number of train-hours of service)
- Station operations and maintenance costs (calculated based on the number of stations)
- On-board and station security (assumed to be contracted services)
- Vehicle cleaning (assumed to be a contracted service)
- General Administration

Fringe benefits are set at 40% of all wages and salaries, and for all study modes. For expenses with consistent unit costs based directly on a system or service variable, the line item totals may differ by alternative, but only because the number of driving units change (e.g., more or fewer stations, route miles).

While a number of areas are treated consistently, there are other elements of the O&M cost model where line items reflect differences among alternative modes:

- Propulsion Power: driven primarily by route miles (distribution) as opposed to usage (consumption)
- Vehicle Maintenance (labor and non-labor)
- ROW maintenance (labor and non-labor)

The O&M cost model provides a low-range and a high-range cost estimate. The low-range cost estimate is based on applying the supply variable unit cost rate to the alternative's statistics related to the identified driving variable for each line item. The total estimated low-range annual O&M cost is calculated by summing all line items.

The high-range cost estimate applies uncertainty factors to the low-range cost estimate, in acknowledgement that with few actuals available to base cost productivities, there may be a notable variance from the base estimates. An uncertainty factor is assigned to each line item, with the highest uncertainty assigned to propulsion and insurance for high speed steel wheel and maglev technologies. Again, the total estimated high-range annual O&M cost based on integrating the uncertainty factor is calculated by summing all line items.

After establishing appropriate unit costs, an O&M cost model requires the development of operating statistics that are based on service plans for each alternative. For the AGS Project, there basically are two alternatives to evaluate for each mode: a Full-Build alternative and a Minimum Operating Segment (MOS). The HS Rail alternative has a different alignment, operating plan and travel speed than the Maglev alternatives. The two Maglev alternatives have different runtimes and an added station for the 120 mph Maglev due to differences in achievable maximum speeds and corresponding differences in curvature/alignment.

All alternatives are based on an 18-hour daily span of service, seven days a week. For highest-demand days (considered Thursday through Sunday for the AGS corridor), hourly service is assumed for 12 hours of the day and 30-minute frequencies during six hours of the day. For lighter days (Monday through Wednesday), an hourly frequency is assumed for the bulk of the day.

- Full-Build Maglev: This alignment is assumed to operate between Golden (Suburban West) and Eagle County Regional Airport, with intermediate stations at Idaho Springs, Keystone, Breckenridge, Copper Mountain (for 120 mph maglev only), Vail, and Avon. The basic operating plan assumes 24 round trips daily from Thursday through Sunday, and 15 round trips daily from Monday through Wednesday.
- Full-Build Maglev to DIA: For this alternative, the alignment operates between DIA and Eagle County Regional Airport, thereby adding stations at DIA and I-76/72nd Avenue in the metro Denver area. The operating plan assumes 24 round trips daily from Thursday through Sunday, and 15 round trips daily from Monday through Wednesday.

- Full-Build HS Rail: The HS Rail alternative is only able to serve Breckenridge with a separate branch so there are two line patterns. The main line serves Jefferson County, Idaho Springs, Lakeside, and Vail, terminating at Eagle County Regional Airport. The spur line proceeds from Jefferson County Station to Idaho Springs, Lakeside and Breckenridge. There would be 24 round trips operated Thursday through Sunday (18 on mainline, 6 on branch), and 15 round trips Monday through Wednesday (9 on mainline, 6 on branch).
- MOS: This alignment would operate between Suburban West and Breckenridge. There would be four stations for all modes. For the basic operating plan, Thursday through Sunday trains would operate 24 round trips and Monday through Wednesday 15 round trips would be provided.

Differences among the modes include the capacity of passenger cars and the make-up of train consists, both of which have implications for annual operating costs. In an attempt to be as consistent as possible for cost estimating, train consist assumptions were made as follows:

- High Speed Steel Rail would operate 10 passenger cars per train, providing a capacity of 450 passengers per train.
- High Speed Maglev would operate five passenger cars per train, providing a capacity of 410 passengers per train.
- 120-mph Maglev trains operate as two-car married pairs with a capacity of 186 passengers per married pair train. Two scenarios were evaluated for 120-mph Maglev: 24 trips per day, Thursday through Sunday, for ***equivalent level of train service*** as other alternatives, and 48 trips per day, Thursday through Sunday, for ***comparable passenger capacity*** as the other alternatives.

The following tables summarize the O&M cost model results for the full corridor alternatives as well as the MOS alternatives. A complete description of the O&M cost model and O&M costs for the various alignment/technology pairs can be found in Appendix G.

Table F-17: Operation & Maintenance Cost Estimates

	Hybrid - 120 MPH Maglev 15 Minutes	Hybrid - 120 MPH Maglev 30 Minutes	High Speed Maglev	High Speed Rail
Full System - Low Cost	$52,694,000	$45,213,000	$47,209,000.00	$55,382,000.00
Full System -High Cost	$69,473,000	$60,440,000	$62,762,000.00	$72,882,000.00

MOS - Low Cost	$29,485,000	$26,072,000	$27,258,000.00	$36,191,000.00
MOS - High Cost	$39,230,000	$35,103,000	$36,466,000.00	$47,704,000.00

- For service from Golden to ECRA, operating costs range from $45 million to $73 million annually when accounting for low versus high estimates. The highest O&M operating costs are associated with the high speed steel rail alternative.
- Due to its greater mileage and associated longer travel time, the high speed maglev alternative from DIA to ECRA has an annual O&M cost ranging from $59 million to $78 million.
- For the MOS options from Golden to Breckenridge, O&M costs range from $26 million to $48 million. Again, the highest O&M operating cost estimates are associated with the high speed steel rail alternative.

In the O&M cost model, the 120-mph Maglev assumes the same labor rates as High Speed Maglev for vehicle and track maintenance. Information provided by AMT indicates that rates could be significantly lower, thus reducing costs for 120-mph Maglev.

Finally, it should be noted that O&M costs are based on the defined service plan that assumes 24 round trips per day on high-volume days. Preliminary analysis suggests that more frequent service may be needed during peak use. While much of the demand can be accommodated by scheduling more of the 24 round trips during peak periods, it may be advisable to add more trips overall, thereby increasing the estimated O&M costs.

<u>Capital Cost Estimate Worksheets</u>

The following pages provide the backup information used to develop the capital costs for the various alignment/technology pairs.

By: F. Sherkow 6/7/2013
Chk: J. Callicott 6/7/2013

Route: Hybrid - 120 mph Maglev

Hybrid - 120 mph Maglev

WBS Code			Description	Unit	Unit Cost	Quantity	Adjustment Increase %	Total Cost	Percent of Total	Segment 1 Eagle	Segment 1 Avon	Segment 2 Avon	Segment 2 Vail	Segment 3 Vail	Segment 3 Copper	Segment 4 Copper	Segment 4 Breck	Segment 5 Breck	Segment 5 Keystone	Segment 6 Keystone	Segment 6 Idaho Springs	Segment 7 Idaho Springs	Segment 7 El Rancho	Segment 8 El Rancho	Segment 8 Golden	TOTAL	
100			System Delivery																								
	110		Vehicles					$ 240,000,000	2.2%																		
	111.3		AMT Cars	2-Car Married	$8,000,000	18		$ 240,000,000		2	$16,000,000	2	$16,000,000	3	$24,000,000	2	$16,000,000	2	$16,000,000	2	$16,000,000	2	$16,000,000	3	120,000,000	18.000	$240,000,000
			Subtotal					*$ 240,000,000*																			
			Contingency and Currency Fluctuation			*0%*		*$ -*																			
			Total					*$ 240,000,000*																			
	120		Propulsion System					$ 171,600,000	1.6%																		
	121.3	AMT	Power System	EA	$156,000,000	1	0%	$ 156,000,000		0.207419568	$ 32,357,452.66	0.05743443	$ 8,959,771.05	0.17574756	$ 27,416,619.39	0.05028395	$ 7,844,295.46	0.0801411	$ 12,502,011.74	0.242800314	$ 37,876,849.03	0.099459	$ 15,515,604.19	0.08671408	$ 13,527,396.49	1.000	$156,000,000
			Subtotal					*$ 156,000,000*		0	$ -	0	$ -	0	$ -	0	$ -	0	$ -	0	$ -	0	$ -	0	$ -	0.000	$0
			Contingency			*0%*	*10%*	$ 15,600,000		0.207419568	$ 3,235,745.27	0.05743443	$ 895,977.10	0.17574756	$ 2,741,661.94	0.05028395	$ 784,429.55	0.0801411	$ 1,250,201.17	0.242800314	$ 3,787,684.90	0.099459	$ 1,551,560.42	0.08671408	$ 1,352,739.65	1.000	$15,600,000
			Total					*$ 171,600,000*																			
	140		Operation Control Technology					$ 198,000,000	1.8%																		
	141.3	AMT	Operation Controls & Safety Technology	EA	$198,000,000	1.0	0%	$ 198,000,000		0.207419568	$ 41,069,074.52	0.05743443	$ 11,372,017.10	0.17574756	$ 34,798,016.91	0.05028395	$ 9,956,221.16	0.0801411	$ 15,867,937.98	0.242800314	$ 48,074,462.22	0.099459	$ 19,692,882.24	0.08671408	$ 17,169,387.86	1.000	$198,000,000
			Subtotal					*$ 198,000,000*																			
			Contingency				*10%*	*$ -*		0.207419568	$ -	0.05743443	$ -	0.17574756	$ -	0.05028395	$ -	0.0801411	$ -	0.242800314	$ -	0.099459	$ -	0.08671408	$ -	1.000	$0
			Total					*$ 198,000,000*																			
	160		Guideway Infrastructure					$ 4,871,490,000	44.8%																	Total (FT)	
	166.1.2	TRI/AMT	High column areas with standard Maglev guideway – double track (height greater than 30' usin	FT	$9,144		0%	$133,502,400		0.000	-	3300.000	30,175,200	2800.000	25,603,200		-		-	6000.000	54,864,000	1250.000	11,430,000	1250.000	11,430,000	14600.000	$133,502,400
	162.3	AMT	AMT Standard Guideway - Double Track - At Grade	FT	$600.00			$106,298,340		27347.000	16,408,200	10317.323	6,190,394	27070.906	16,242,543	19017.748	11,410,649	13551.869	8,131,121	29502.339	17,701,403	26268.798	15,761,279	24087.919	14,452,751	177163.900	$106,298,340
	164.3	AMT	AMT Standard Guideway - Double Track - Elevated	FT	$1,797.60			$825,524,431		104655.000	188,127,828	26234.000	47,158,238	84775.000	152,391,540	12983.000	23,338,241	37450.000	67,320,120	125016.000	224,728,762	37027.000	66,559,735	31097.000	55,899,967	459237.000	$825,524,431
	168		Misc.																								$0
	168.2		Safety Fencing and K-Rail - Type 7 Rail (special) including pavement between rails	FT	$95			$2,683,757		3000.000	286,410	1549.000	147,883	5600.000	534,632	0.000	-	0.000	-	6311.000	602,511	4993.000	476,682	6658.000	635,639	28111.000	$2,683,757
	168.3		Maglev Guideway Switches																								$0
	168.3.1	TRI/AMT	Low Speed	EA	$3,400,000	16.000	0%	$54,400,000		2.000	6,800,000	2.000	6,800,000	2.000	6,800,000	2.000	6,800,000	2.000	6,800,000	2.000	6,800,000	2.000	6,800,000	2.000	6,800,000	16.000	$54,400,000
	170		Special Civil Structures																								
	171		Bridges & Viaducts																								
	171.2	TRI/AMT	Straddle Bent Crossings over I-70 (or other facilities) - Double Guideway	FT	$3,271		0%			3000.000	9,813,000	1549.000	5,066,779	5600.000	18,317,600		-		-	6311.000	20,643,281	4993.000	16,332,103	6658.000	21,778,318	28111.000	$91,951,081
	172.2	TRI/AMT	- B-2: Double track bridge. Standard column height. Column spacing: 45 m. Direct Found	FT	$4,267		0%			1500.000	6,400,800	0.000	-	269.000	1,147,877		-		-		-	773.000	3,298,546		-	2542.000	$10,847,222
	172.3	TRI/AMT	- B-3: Double track bridge. Standard column height. Column spacing: 60 m. Direct Found	FT	$3,879		0%			3000.000	11,637,818	0.000	-	973.000	3,774,532		-		-	712.000	2,762,042	1509.000	5,853,823	358.000	1,388,780	6552.000	$25,416,995
	172.7	TRI/AMT	- B-7a: Double track bridge. Viaduct (higher columns, longer spans, etc) 100m	FT	$5,554		0%			9456.000	52,519,469		-	1810.000	10,052,902		-		-		-	1743.000	9,680,778	1486.000	8,253,377	14495.000	$80,506,525
																											$0
	172		Tunnels																								$0
			- T-4a: Single tube tunnel (length>8km). 13.9 m Excavation width. Soil/Poor quality rock.	FT	$31,890		0%				-			1627.297	51,894,488	19015.748	606,412,205		-	803.806	25,633,366		-		-	21446.850	$683,940,059
			- T-5a: Single tube tunnel (length>8km). 13.9 m Excavation width. Average quality rock. F	FT	$30,116		0%							4878.609	146,926,138			13549.869	408,073,268	7237.533	217,968,433					25666.010	$772,967,839
			- T-7: Single tube tunnel (length<1km). Excavation width 14 m. Soil/Poor quality rock.	FT	$43,099		0%				-	587.270	25,310,764		-		-		-		-	872.703	37,612,644	209.974	9,049,659	1669.948	$71,973,068
			- T-8: Single tube tunnel (length<1km). Excavation width 14 m. Average quality rock.	FT	$40,841		0%				-	3330.052	136,002,674		-		-		-		-	2181.759	89,105,200	1190.945	48,639,380	6702.756	$273,747,254
			- T-9: Single tube tunnel (length<1km). Excavation width 14 m. Good quality rock.	FT	$34,719		0%				-				-		-		-		-	1312.336	45,562,992		-	1312.336	$45,562,992
			- T-10: Cut & cover section for both tracks. Standard cover.	FT	$14,630		0%			7389.000	108,101,070		-	3511.000	51,365,930		-		-	2125.000	31,088,750	6629.000	97,128,570	6275.000	91,803,250	25929.000	$379,487,570
	173		Tunnel Subtotal					$ -																			
			Escape Side Passage (if required)	15% of tunnel cost			20%	$434,397,362			21,079,709		31,456,120		48,786,378		118,250,380		79,574,287		53,564,657		52,534,834		29,150,996		$434,397,362
	175		Stator Packs including machining	FT	$259		0%	$ -			34,199,078		9,469,717		28,977,037		8,290,754		13,213,564		40,032,611		16,398,675		14,297,309		$164,878,745
			Subtotal					*$3,723,688,279*		132002.000	$434,293,674	36551.323	$266,321,649	111845.906	$514,028,420	32000.748	$656,251,848	51001.869	$503,538,073	154518.339	$642,825,160	63296.798	$422,001,027	55184.919	$284,428,430	636400.900	$3,723,688,279
			Std. Contingency (10% of all expect switches)				*10%*	*$34,222,422*		0.116629976	$3,991,360.20	0.07152093	$2,447,619.48	0.138042817	$4,724,159.60	0.17623705	$6,031,258.87	0.13522562	$4,627,748.45	0.172631302	$5,907,861.38	0.11332877	$3,878,385.17	0.07638352	$2,614,029.19	1.000	$34,222,422
			Switch Contingency (20% of switches)				*20%*	*$10,880,000*		0.12500	$1,360,000.00	0.12500	$1,360,000.00	0.12500	$1,360,000.00	0.12500	$1,360,000.00	0.12500	$1,360,000.00	0.12500	$1,360,000.00	0.12500	$1,360,000.00	0.12500	$1,360,000.00	1.000	$10,880,000
			Tunnel Contingency				*30%*	*$668,303,634*		0.089307189	$59,684,319.07	0.04734674	$31,642,001.08	0.121069284	$80,911,109.04	0.22983394	$153,598,859.51	0.16377056	$109,448,462.70	0.122875507	$82,118,148.03	0.13302164	$88,898,843.35	0.09277503	$62,001,891.60	1.000	$668,303,634
			Emerency Tunnel Continency (15% of tunnels)				*20%*	*$434,397,362*		0.089307189	$38,794,807.40	0.04734674	$20,567,200.70	0.121069284	$52,592,220.88	0.22983394	$99,839,258.68	0.16377056	$71,141,500.75	0.122875507	$53,376,796.22	0.13302164	$57,784,248.18	0.09277503	$40,301,229.54	1.000	$434,397,362
			Total					*$4,871,491,696*																			$0
						$0																					
	180		Stations (Omit El Rancho Sta)					$ 140,000,000	1.3%																		
	181		Civil Structures																								
			Station - Major	EA	$25,000,000	2		$ 50,000,000		1	$25,000,000	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	1	$25,000,000	2	50,000,000
			Station - Minor	EA	$15,000,000	6		$ 90,000,000				1	$15,000,000	1	$15,000,000	1	$15,000,000	1	$15,000,000	1	$15,000,000	1	$15,000,000	0	$0	6	90,000,000
			Subtotal					*$ 140,000,000*																			
			Contingency			*0%*		*$ -*																			
			Total					*$ 140,000,000*																			
	190		Operations and Maintenance Facilities					$ 15,320,000	0.1%																		
	193		Maintenance Vehicles				0%	$ -																			
		1831	Road Vehicles	LS	$300,000	4	0%	$ 1,200,000				1	$300,000	0	$0	1	$300,000	0	$0	1	$300,000	0	$0	1	$300,000	4	1,200,000
	187.1	AMT	AMT O&M Major	EA	$ 10,000,000	1		$ 10,000,000		0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	1	$10,000,000	1	10,000,000
	187.2	AMT	AMT O&M Minor	EA	$ 2,000,000	1		$ 4,000,000		1	$2,000,000	1	$2,000,000	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	1	4,000,000
			Subtotal					*$ 15,200,000*																			
			Contingency				*10%*	*$ 120,000*		0.207419568	$ 24,890.35	0.05743443	$ 6,892.13	0.17574756	$ 21,089.71	0.05028395	$ 6,034.07	0.0801411	$ 9,616.93	0.242800314	$ 29,136.04	0.099459	$ 11,935.08	0.08671408	$ 10,405.69	1.000	$120,000
			Total					*$ 15,320,000*																			
	195		Construction Support																								
	191		Beam Fabrication Plant					$ 50,000,000	0.5%	0.207419568	$ 10,370,978.42	0.05743443	$ 2,871,721.49	0.17574756	$ 8,787,378.01	0.05028395	$ 2,514,197.26	0.0801411	$ 4,007,055.05	0.242800314	$ 12,140,015.71	0.099459	$ 4,972,950.06	0.08671408	$ 4,335,704.00	1.000	$50,000,000
			Subtotal					*$ 50,000,000*																			
			Contingency					*$ -*																			
			Total					*$ 50,000,000*																			
	195		Right of Way and Corridor																								
	195		Right of Way					$ 395,390,000	3.6%																		
		195.1	Public Land	SF	$1	10,767,903		$10,767,903		2233473.84	$2,233,474	618448.382	$618,448	1892432.721	$1,892,433	541452.657	$541,453	862951.62	$862,952	2614450.289	$2,614,450	1070964.9	$1,070,965	933728.823	$933,729	10767903.232	$10,767,903
		195.2	Private Land	SF	$22	12,778,565		$281,128,433		2876068.04	$63,273,497	753192.72	$16,570,240	2350213.32	$51,704,693	299693.8	$6,593,264	864392.16	$19,016,628	3331644.16	$73,296,172	1206853.2	$26,550,770	1096507.72	$24,123,170	12778565.120	$281,128,433
			Private Land - Below Ground	SF	$5	1,909,568		$9,547,838		170538.12	$852,691	90411.811	$452,059	231190.1792	$1,155,951	438883.465	$2,194,417	312730.971	$1,563,655	234639.0945	$1,173,195	254013.816	$1,270,069	177160.202	$885,801	1909567.658	$9,547,838
			Subtotal					*$329,494,912*		0.207419568	$ 68,343,692.35	0.05743443	$ 18,924,352.38	0.17574756	$ 57,907,926.83	0.05028395	$ 16,568,304.11	0.0801411	$ 26,406,084.97	0.242800314	$ 80,001,468.12	0.099459	$ 32,771,234.82	0.08671408	$ 28,571,848.17	1.000	$329,494,912
			Contingency			*20%*		*$ 65,898,982*		0.207419568	$ 13,668,738.47	0.05743443	$ 3,784,870.48	0.17574756	$ 11,581,585.37	0.05028395	$ 3,313,660.82	0.0801411	$ 5,281,216.99	0.242800314	$ 16,000,293.62	0.099459	$ 6,554,246.96	0.08671408	$ 5,714,369.63	1.000	$65,898,982
								$ 395,393,894																			
Subtotal			*Total*					$ 6,081,800,000	55.9%																		
			Cost per KM			*194.0*		*$ 31,353,526*																			
			Cost per Mile			*120.5*		*$ 50,457,229*																			
200			**Project Support Costs**																								
	210		Professional Services			1		$ 1,581,270,000	14.5%	0.207419568	$ 327,986,340.77	0.05743443	$ 90,819,340.82	0.17574756	$ 277,904,344.47	0.05028395	$ 79,512,494.12	0.0801411	$ 126,724,718.63	0.242800314	$ 383,932,852.94	0.099459	$ 157,271,534.82	0.08671408	$ 137,118,373.43	1.000	$1,581,270,000
	211		Design Engineering	%	10%			$ 608,180,000																			
	212		Insurance and Bonding	%	2%			$ 121,636,000																			
	213		Program Management	%	4%			$ 243,272,000																			
	214		Construction Management & Inspection	%	6%			$ 364,908,000																			
	215		Engineering Services During Construction	%	2%			$ 121,636,000																			
	216		Integrated Testing and Commissioning	%	2%			$ 121,636,000																			

Route: Hybrid - 120 mph Maglev

WBS Code		Description	Unit	Unit Cost	Quantity	Adjustment Increase %	Total Cost	Percent of Total
		Subtotal					$ 1,581,268,000	
220		Utility Relocation			1		$ 547,360,000	5.0%
	221	Through Urban areas	%	6%			$ 364,908,000	
	222	outside of Urban Areas	%	3%			$ 182,454,000	
		Subtotal					$ 547,362,000	
230		Environmental Mitigation			1		$ 152,050,000	1.4%
	231	Noise Mitigation	%	1%			$ 60,818,000	
	232	Hazardous Waste	%	1%			$ 60,818,000	
	233	Erosion Control	%	0.5%			$ 30,409,000	
		Subtotal					$ 152,045,000	
Subtotal							$ 2,280,680,000	21.0%
300		**Design and Construction Contingency (30% of Previous Total)**	%	*30%*			$ 2,508,740,000	23.1%
Subtotal Planning and Engineering Costs							$ 6,081,800,000	
Subtotal Project Support Costs							$ 2,280,680,000	
Design and Construction Contingency							$ 2,508,740,000	
Grand Total							**$ 10,871,220,000**	**100.0%**
		Cost per KM			*194.0*		*$ 56,044,440*	
		Cost per Mile			*120.5*		*$ 90,192,316*	

Hybrid - 120 mph Maglev

WBS Code	Segment 1		Segment 2		Segment 3		Segment 4		Segment 5		Segment 6		Segment 7		Segment 8		TOTAL	
	Eagle	Avon	Avon	Vail	Vail	Copper	Copper	Breck	Breck	Keystone	Keystone	Idaho Springs	Idaho Springs	El Rancho	El Rancho	Golden		
220	0.207419568	$ 113,533,174.91	0.05743443	$ 31,437,309.50	0.17574756	$ 96,197,184.54	0.05028395	$ 27,523,420.28	0.0801411	$ 43,866,032.99	0.242800314	$ 132,899,180.02	0.099459	$ 54,439,878.89	0.08671408	$ 47,463,818.88	1.000	$547,360,000
230	0.207419568	$ 31,538,145.36	0.05743443	$ 8,732,905.05	0.17574756	$ 26,722,416.52	0.05028395	$ 7,645,673.88	0.0801411	$ 12,185,454.39	0.242800314	$ 36,917,787.78	0.099459	$ 15,122,741.13	0.08671408	$ 13,184,875.88	1.000	$152,050,000
300	0.146278663	$ 366,975,132.95	0.06379013	$ 160,032,863.10	0.14788605	$ 371,007,648.26	0.13202423	$ 331,214,458.68	0.11590056	$ 290,764,371.17	0.18756968	$ 470,563,558.38	0.10915746	$ 273,847,684.96	0.0973939	$ 244,335,960.29	1.000	$ 2,508,740,000.00

By: F. Sherkow 6/7/2013
Chk: J. Callicott 6/7/2013

Route: HS Maglev

WBS Code				Description	Unit	Unit Cost	Quantity	Adjustment Increase %	Total Cost	Percent of Total
100				**System Delivery**						
	110			**Vehicles**					$ 260,990,000	1.0%
		111.1		TRI Car Body Passenger	each sectio	$6,930,000	30	0%	$ 207,900,000	
		117.1		TRI Maintenance Equipment	each sectio	$600,000	30	0	$ 18,000,000	
		118.1		TRI Documentation/Training	LS	$9,800,000	1	0	$ 9,800,000	
		119.1		TRI Spare Parts	each sectio	$150,000	30	0	$ 4,500,000	
				Subtotal					*$ 240,200,000*	
				Contingency and Currency Fluctuation		vehicles		*10%*	*$ 20,790,000*	
				Total					*$ 260,990,000*	
	120			**Propulsion System**					$ 823,130,000	3.3%
		121.1	TRI	Substation Civil Structures	LS	$14,500,000	1	0%	$ 14,500,000	
		122.1	TRI	Substation Propulsion Block	LS	$472,000,000	1	0%	$ 472,000,000	
		123.1	TRI	Wayside Equipment	LS	$224,200,000	1	0%	$ 224,200,000	
		124.1	TRI	Maintenance Equipment	LS	$6,200,000	1	0%	$ 6,200,000	
		125.1	TRI	Documentation/Training	LS	$7,700,000	1	0%	$ 7,700,000	
		126.1	TRI	Spare Parts	LS	$7,400,000	1	0%	$ 7,400,000	
		127.1	TRI	Program Management	LS	$16,300,000	1	0%	$ 16,300,000	
				Subtotal					*$ 748,300,000*	
				Contingency				*10%*	*$ 74,830,000*	
				Total					*$ 823,130,000*	
	130			**Energy Supply**					$ 258,500,000	1.0%
		131.1	TRI	ES Substations	LS	$187,600,000	1	0%	$ 187,600,000	
		132.1	TRI	ES Operating Facilities	LS	$16,300,000	1	0%	$ 16,300,000	
		133.1	TRI	ES Wayside Equipment	LS	$8,300,000	1	0%	$ 8,300,000	
		134.1	TRI	ES Passenger Station	LS	$7,000,000	1	0%	$ 7,000,000	
		135.1	TRI	Maintenance Equipment	LS	$3,900,000	1	0%	$ 3,900,000	
		136.1	TRI	Documentation/Training	LS	$4,900,000	1	0%	$ 4,900,000	
		137.1	TRI	Spare Parts	LS	$200,000	1	0%	$ 200,000	
		138.1	TRI	Program Management	LS	$6,800,000	1	0%	$ 6,800,000	
				Subtotal					*$ 235,000,000*	
				Contingency				*10%*	*$ 23,500,000*	
				Total					*$ 258,500,000*	
	140			**Operation Control Technology**					$ 126,170,000	0.5%
		141.1	TRI	Operation Controls & Safety Technology	LS	$50,000,000	1	0%	$ 50,000,000	
		142.1	TRI	Stationary Data Transmission				0%	$ -	
		142.1.1	TRI	Single Guideway Length	FT	$23	125,538	0%	$ 2,869,796	
		142.1.2	TRI	Double Guideway Length	FT	$30	500,000	0%	$ 15,240,000	
		143.1	TRI	Radio Data Transmission				0%	$ -	
		143.1.1	TRI	Single Guideway Length	FT	$53	125,538	0%	$ 6,600,531	
		143.1.2	TRI	Double Guideway Length	FT	$70	500,000	0%	$ 35,051,999	
		144.1	TRI	Vehicle Location (Guideway Mounted)	*Included in WBS 128*			0%	$ -	
		145.1	TRI	Maintenance Equipment	% of the sum of 141-143		1.5%	0%	$ 1,646,435	
		146.1	TRI	Documentation/Training	% of the sum of 141-143		1.0%	0%	$ 1,097,623	
		147.1	TRI	Spare Parts	% of the sum of 141-143		2.0%	0%	$ 2,195,247	
				Subtotal					*$ 114,701,631*	
				Contingency				*10%*	*$ 11,470,163*	
				Total					*$ 126,171,794*	
	150			**Communication/Control Technology**					$ 8,420,000	0.0%
		151.1	TRI	Energy Supply Control Equipment	EA	$80,000	12	0%	$ 960,000	
		152.1	TRI	Building Control Equipment	EA	$70,000	12	0%	$ 840,000	
		153.1	TRI	Operations Communications	EA	$180,000	12	0%	$ 2,160,000	
		154.1	TRI	Passenger Communications	EA	$500,000	3	0%	$ 1,500,000	
		155.1	TRI	Passenger Support System	EA	$500,000	3	0%	$ 1,500,000	
		156.1	TRI	Maintenance Equipment	% of the sum of 151-153		1.0%	0%	$ 54,600	
		157.1	TRI	Documentation/Training	LS	$250,000	2	0%	$ 500,000	
		158.1	TRI	Spare Parts	% of the sum of 151-153		2.0%	0%	$ 139,200	
				Subtotal					*$ 7,653,800*	
				Contingency				*10%*	*$ 765,380*	
				Total					*$ 8,419,180*	
	160			**Guideway Infrastructure**					$ 12,169,450,000	48.1%
		162.1.1	TRI	TRI Standard Maglev Type I Guideway - Double Track - At Grade	FT	$560		0%	$ 19,830,063	
		162.1.2	TRI	TRI Standard Maglev Type III Guideway - Double Track - At Grade	FT	$560		0%	$ 118,695,455	
									$ -	
		163.1.1	TRI	TRI Standard Maglev Type I Guideway - Single Track - Elevated up to 60'	FT	$2,842.41		0%	$ -	
		164.1.1	TRI	TRI Standard Maglev Type I Guideway - Double Track - Elevated up to 60'	FT	$2,887.40		0%	$ 245,752,830	
		164.1.2.	TRI	TRI Standard Maglev Type III Guideway - Double Track - Elevated up to 60'	FT	$4,475.47		0%	$ 1,311,575,644	
									$ -	
		165.1	TRI	TRI Shims for Type III Beams	EA	$850		0%	$ 15,740,300	
		168		**Misc.**						
		168.3		Maglev Guideway Switches						
		168.3.2	TRI	High Speed	EA	$6,400,000	14.000	0%	$ 89,600,000	
	170			**Special Civil Structures**						
		171		**Bridges & Viaducts**						
		176.1	TRI/AMT	- Type B1: Maglev Double track bridge. Less than 60 m pier height and typical span of 50 m (continuous span). S	FT	$3,185		0%		
		176.2	TRI/AMT	- Type B2: Maglev Double track bridge. Less than 60 m pier height and typical span of 50 m (continuous span). D	FT	$3,185		0%		
		177.1	TRI/AMT	- Type F1: Maglev Single track bridge. Less than 60 m pier height and typical span of 50 m (continuous span). Sh	FT	$3,128		0%		
		177.2	TRI/AMT	- Type F2: Maglev Single track bridge. Less than 60 m pier height and typical span of 50 m (continuous span). De	FT	$3,128		0%		
		177.3	TRI/AMT	- Type G1: Maglev Single track bridge. Maximum height less than 100 m and span length of 90 m (continuous sp	FT	$4,351		0%		
		177.4	TRI/AMT	- Type G2: Maglev Single track bridge. Maximum height less than 100 m and span length of 90 m (continuous sp	FT	$4,351		0%		
		172		Tunnels						
				- T-4a: Single tube tunnel (length>8km). 13.9 m Excavation width. Soil/Poor quality rock. Price per tube. SEM (Se	FT	$31,890		0%		
				- T-5a: Single tube tunnel (length>8km). 13.9 m Excavation width. Average quality rock. Price per tube. SEM	FT	$30,116		0%		
				- T-7: Single tube tunnel (length<1km). Excavation width 14 m. Soil/Poor quality rock.	FT	$43,099		0%		
				- T-8: Single tube tunnel (length<1km). Excavation width 14 m. Average quality rock.	FT	$40,841		0%		
				- T-9: Single tube tunnel (length<1km). Excavation width 14 m. Good quality rock.	FT	$34,719		0%		
		173		Tunnel Subtotal					$ -	
				Escape Side Passage (if required)	15% of tunnel cost			20%	$ 1,294,093,359	
		175		Stator Packs including machining	FT	$259		10%	$ -	
				Subtotal					*$8,683,531,941*	
				Std. Contingency (10% of all expect switches)				*10%*	*$182,992,347*	
				Switch Contingency (20% of switches)				*20%*	*$17,920,000*	
				Tunnel Contingency				*30%*	*$1,990,912,860*	

HS Maglev

Item	Segment 1 Eagle	Segment 1 Avon	Segment 2 Avon	Segment 2 Vail	Segment 3 Vail	Segment 3 Cooper	Segment 4 Copper	Segment 4 Breckenridge	Segment 5 Breckenridge	Segment 5 Keystone	Segment 6 Keystone	Segment 6 Georgetown	Segment 7 Georgetown	Segment 7 Jeffco	TOTAL	TOTAL
111.1 TRI Car Body Passenger	0	$0	5	$34,650,000	5	$34,650,000	5	$34,650,000	5	$34,650,000	5	$34,650,000	5	$34,650,000	30	207,900,000
117.1 TRI Maintenance Equipment	0	$0	5	$3,000,000	5	$3,000,000	5	$3,000,000	5	$3,000,000	5	$3,000,000	5	$3,000,000	30	18,000,000
118.1 TRI Documentation/Training	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	1	$9,800,000	1	9,800,000
119.1 TRI Spare Parts	0	$0	5	$750,000	5	$750,000	5	$750,000	5	$750,000	5	$750,000	5	$750,000	30	4,500,000
110 Contingency and Currency Fluctuation	0.21	$ 4,417,030.28	0.08	$ 1,580,367.15	0.16	$ 3,414,260.98	0.06	$ 1,185,265.01	0.02	$ 447,652.86	0.20	$ 4,260,712.82	0.26	$ 5,484,710.89	1	20,790,000
120 Subtotal	0.21	$ 158,983,345.83	0.08	$ 56,882,575.34	0.16	$ 122,890,403.73	0.06	$ 42,661,558.84	0.02	$ 16,112,488.57	0.20	$ 153,356,969.74	0.26	$ 197,412,657.96	1	748,300,000
120 Contingency	0.21	$ 15,898,334.58	0.08	$ 5,688,257.53	0.16	$ 12,289,040.37	0.06	$ 4,266,155.88	0.02	$ 1,611,248.86	0.20	$ 15,335,696.97	0.26	$ 19,741,265.80	1	74,830,000
130 Subtotal	0.21	$ 49,927,951.72	0.08	$ 17,863,697.99	0.16	$ 38,593,137.61	0.06	$ 13,397,656.46	0.02	$ 5,060,049.20	0.20	$ 48,161,015.49	0.26	$ 61,996,491.54	1	235,000,000
130 Contingency	0.21	$ 4,992,795.17	0.08	$ 1,786,369.80	0.16	$ 3,859,313.76	0.06	$ 1,339,765.65	0.02	$ 506,004.92	0.20	$ 4,816,101.55	0.26	$ 6,199,649.15	1	23,500,000
141.1 Operation Controls & Safety Technology													1	$ 50,000,000	1	50,000,000
142.1.1 Single Guideway Length	0.21	$ 609,715.11	0.08	$ 218,149.68	0.16	$ 471,295.50	0.06	$ 163,610.83	0.02	$ 61,792.81	0.20	$ 588,137.46	0.26	$ 757,094.90	1	2,869,796
142.1.2 Double Guideway Length	0.21	$ 3,237,880.68	0.08	$ 1,158,479.78	0.16	$ 2,502,805.95	0.06	$ 868,852.25	0.02	$ 328,149.56	0.20	$ 3,123,292.99	0.26	$ 4,020,538.30	1	15,240,000
143.1.1 Single Guideway Length	0.21	$ 1,402,344.75	0.08	$ 501,744.26	0.16	$ 1,083,979.65	0.06	$ 376,304.91	0.02	$ 142,123.46	0.20	$ 1,352,716.16	0.26	$ 1,741,318.27	1	6,600,531
143.1.2 Double Guideway Length	0.21	$ 7,447,125.56	0.08	$ 2,664,503.50	0.16	$ 5,756,453.69	0.06	$ 1,998,360.17	0.02	$ 754,743.99	0.20	$ 7,188,573.88	0.26	$ 9,247,238.09	1	35,051,999
145.1 Maintenance Equipment													1	$ 1,646,434.89	1	1,646,435
146.1 Documentation/Training													1	$ 1,097,623.26	1	1,097,623
147.1 Spare Parts	0	$ -	0.16666667	$ 365,874.42	0.16666667	$ 365,874.42	0.166666667	$ 365,874.42	0.16666667	$ 365,874.42	0.166666667	$ 365,874.42	0.166666667	$ 365,874.42	1	2,195,247
140 Contingency	0.21	$ 2,436,943.61	0.08	$ 871,912.89	0.16	$ 1,883,700.35	0.06	$ 653,928.96	0.02	$ 246,976.98	0.20	$ 2,350,700.86	0.26	$ 3,025,999.44	1	11,470,163
150 Subtotal	0.21	$ 1,626,121.52	0.08	$ 581,809.24	0.16	$ 1,256,953.86	0.06	$ 436,353.12	0.02	$ 164,802.57	0.20	$ 1,568,573.53	0.26	$ 2,019,186.16	1	7,653,800
150 Contingency	0.21	$ 162,612.15	0.08	$ 58,180.92	0.16	$ 125,695.39	0.06	$ 43,635.31	0.02	$ 16,480.26	0.20	$ 156,857.35	0.26	$ 201,918.62	1	765,380
162.1.1 Type I Guideway - Double Track - At Grade	14487.730	8,113,129	9751.388	5,460,778	10580.709	5,925,197	0.000	-	591.000	330,960	0.000	-	0.000	-	35410.827	$ 19,830,063
162.1.2 Type III Guideway - Double Track - At Grade	15813.697	8,855,671	7618.124	4,266,149	32775.591	18,354,331	19028.871	10,656,168	2051.390	1,148,778	69011.694	38,646,549	65656.802	36,767,809	211956.169	$ 118,695,455
(blank row)																$ -
163.1.1 Type I Guideway - Single Track - Elevated up to 60'		-		-		-		-		-		-		-	0.000	$ -
164.1.1 Type I Guideway - Double Track - Elevated up to 60'	23405.980	67,582,427	0.822	2,372	114.831	331,564	6151.580	17,762,072	1443.570	4,168,164	14041.990	40,544,842	39953.380	115,361,389	85112.153	$ 245,752,830
164.1.2. Type III Guideway - Double Track - Elevated up to 60'	79193.980	354,430,282	30180.390	135,071,430	59258.530	265,209,773	10482.280	46,913,130	9383.200	41,994,230	45144.360	202,042,229	59416.010	265,914,570	293058.750	$ 1,311,575,644
(blank row)															0.000	
165.1 TRI Shims for Type III Beams	2782.000	2,364,700	1190.000	1,011,500	3919.000	3,331,150	296.000	251,600	557.000	473,450	4339.000	3,688,150	5435.000	4,619,750	18518.000	$ 15,740,300
(blank row)															0.000	$ -
168 Misc.															0.000	$ -
168.3 Maglev Guideway Switches															0.000	$ -
168.3.2 High Speed	2.000	12,800,000	2.000	12,800,000	2.000	12,800,000	2.000	12,800,000	2.000	12,800,000	2.000	12,800,000	2.000	12,800,000	14.000	$ 89,600,000
170 Special Civil Structures															0.000	$ -
171 Bridges & Viaducts															0.000	$ -
176.1 Type B1			4397.966	14,006,158						-		-		-	4397.966	$ 14,006,158
176.2 Type B2			1884.843	6,002,639					591.000	1,882,152		-		-	2475.843	$ 7,884,791
177.1 Type F1	6028.543	18,854,269	3226.706	10,091,523	7406.496	23,163,816				-					16661.745	$ 52,109,609
177.2 Type F2	2583.661	8,080,401	241.874	756,461	3174.213	9,927,350				-					5999.748	$ 18,764,212
177.3 Type G1	3970.998	17,277,811													3970.998	$ 17,277,811
177.4 Type G2	1904.528	8,286,599													1904.528	$ 8,286,599
(row below 177.4)	14487.730		9751.388		10580.709		0.000		591.000		0.000		0.000		35410.827	$ -
172 Tunnels																$ -
T-4a		-		-	1686.352	53,777,756		-	2051.390	65,418,820	1213.911	38,711,614	4068.241	129,736,220	9019.894	$ 287,644,410
T-5a					31089.239	936,295,953	19028.871	573,081,102		-	67797.784	2,041,825,174	61588.560	1,854,825,719	179504.454	$ 5,406,027,948
T-7	2345.801	101,101,657	360.892	15,554,101		-		-		-		-		-	2706.693	$ 116,655,758
T-8	11220.472	458,255,315	6174.554	252,174,973		-		-		-		-		-	17395.027	$ 710,430,288
T-9	2247.424	78,028,328	1082.677	37,589,469		-		-		-		-		-	3330.102	$ 115,617,797
173 Tunnel Subtotal	15813.697		7618.124		32775.591		19028.871		2051.390		69011.694		65656.802		211956.169	$ -
Escape Side Passage (if required)		124,290,133		59,537,116		193,064,373		111,750,815		12,756,670		405,704,674		386,989,578		$ 1,294,093,359
175 Stator Packs including machining		0		12,319,442		26,615,200		9,239,500		3,489,590		33,213,549		42,754,986	0.000	$ 127,632,268
Subtotal	132901.387	$1,144,030,588	47550.724	$507,106,995	102729.661	$1,355,732,090	35662.731	$670,703,573	13469.160	$131,706,144	128198.044	$2,411,472,107	165026.192	$2,462,780,444	625537.899	$8,683,531,941
Std. Contingency (10% of all expect switches)	0.21245937	$38,878,438.62	0.07601574	$13,910,297.98	0.16422612	$30,052,122.71	0.057011304	$10,432,632.35	0.02153212	$3,940,213.95	0.204940491	$37,502,541.56	0.263814858	$48,276,100.02		$ 182,992,347
Switch Contingency (20% of switches)	0.14286	$2,560,000.00	0.14286	$2,560,000.00	0.14286	$2,560,000.00	0.14286	$2,560,000.00	0.14286	$2,560,000.00	0.14286	$2,560,000.00	0.14286	$2,560,000.00		$ 17,920,000
Tunnel Contingency	0.07460834	$148,538,698.26	0.03594198	$71,557,345.39	0.15463381	$307,862,446.06	0.089777389	$178,738,957.67	0.00967837	$19,268,786.92	0.325594177	$648,229,634.15	0.309765939	$616,716,991.95		$ 1,990,912,860

HS Maglev Alignment
Estimate of Costs

By: F. Sherkow 6/7/2013
Chk: J. Callicott 6/7/2013

				Item	Unit	Unit Cost	Qty	%	Amount	Share
				Emerency Tunnel Continency (15% of tunnels)				20%	*$1,294,093,359*	
				Total					*$12,169,450,508*	
	180			**Stations**					**$ 140,000,000**	**0.6%**
		181		Civil Structures						
				Station - Major	EA	$25,000,000	2		$ 50,000,000	
				Station - Minor	EA	$15,000,000	0		$ 90,000,000	
				Subtotal					*$ 140,000,000*	
				Contingency				0%	*$ -*	
				Total					*$ 140,000,000*	
	190			**Operations and Maintenance Facilities**					**$ 54,180,000**	**0.2%**
		191		Operations Control Center	EA	$250,000	1	0%	$ 250,000	
		192		Maintenance Facilities				0%	$ -	
			1821	Central Facility	EA	$16,000,000	1	0%	$ 16,000,000	
				Decentralized Facility	EA	$6,000,000	1	0%	$ 6,000,000	
			1822	Washing Equipment	EA	$2,600,000	2	0%	$ 5,200,000	
		193		Maintenance Vehicles					$ -	
			1831	Road Vehicles	LS	$300,000	4	0%	$ 1,200,000	
			1832	Guideway Bound Vehicles	LS	$1,800,000	1	0%	$ 1,800,000	
		194		Guideway and Equipment	EA	$8,000,000	1	0%	$ 8,000,000	
		195		Low Speed Switch	LS	$3,400,000	1	0%	$ 3,400,000	
		196		Transfer Table	LS	$7,400,000	1	0%	$ 7,400,000	
				Subtotal					*$ 49,250,000*	
				Contingency				10%	*$ 4,925,000*	
				Total					*$ 54,175,000*	
	195			**Construction Support**						
		191		Beam Fabrication Plant					**$ 50,000,000**	**0.2%**
				Subtotal					*$ 50,000,000*	
				Contingency				0%	*$ -*	
				Total					*$ 50,000,000*	
	195			**Right of Way and Corridor**						
		195		Right of Way					**$ 268,690,000**	**1.1%**
			195.1	Public Land	SF	$1	27,623,754		$13,811,877	
			195.2	Private Land	SF	$22	170,461,846		$163,050,461	
				Private Land - Below Ground	SF	$5	22,789,527		$18,991,273	
				Subtotal					*$ 223,904,348*	
				Contingency			*20%*		*$ 44,780,870*	
				Total					*$ 268,685,218*	
Subtotal Infrastructure Costs				*Total*					***$ 14,159,530,000***	**55.9%**
				Cost per KM			*190.7*		*$ 74,264,327*	
				Cost per Mile			*118.5*		*$ 119,513,581*	
200				**Project Support Costs**						
	210			**Professional Services**			1		**$ 3,681,480,000**	**14.5%**
		211		Design Engineering	%	10%			$ 1,415,953,000	
		212		Insurance and Bonding	%	2%			$ 283,190,600	
		213		Program Management	%	4%			$ 566,381,200	
		214		Construction Management & Inspection	%	6%			$ 849,571,800	
		215		Engineering Services During Construction	%	2%			$ 283,190,600	
		216		Integrated Testing and Commissioning	%	2%			$ 283,190,600	
				Subtotal					$ 3,681,477,800	
	220			**Utility Relocation**			1		**$ 1,274,360,000**	**5.0%**
		221		Through Urban areas	%	6%			$ 849,571,800	
		222		outside of Urban Areas	%	3%			$ 424,785,900	
				Subtotal					$ 1,274,357,700	
	230			**Environmental Mitigation**			1		**$ 353,990,000**	**1.4%**
		231		Noise Mitigation	%	1%			$ 141,595,300	
		232		Hazardous Waste	%	1%			$ 141,595,300	
		233		Erosion Control	%	0.5%			$ 70,797,650	
				Subtotal					$ 353,988,250	
Subtotal									**$ 5,309,830,000**	**21.0%**
300				**Design and Construction Contingency (30% of Previous Total)**	%	*30%*			**$ 5,840,810,000**	**23.1%**
Subtotal Planning and Engineering Costs									$ 14,159,530,000	
Subtotal Project Support Costs									$ 5,309,830,000	
Design and Construction Contingency									$ 5,840,810,000	
Grand Total									**$ 25,310,170,000**	**100.0%**
				Cost per KM			*190.7*		*$ 132,747,537*	
				Cost per Mile			*118.5*		*$ 213,630,611*	

Item																
Emerency Tunnel Continency (15% of tunnels)	0.07460834	$96,550,153.87	0.03594198	$46,512,274.50	0.15463381	$200,110,589.94	0.089777389	$116,180,322.49	0.00967837	$12,524,711.50	0.325594177	$421,349,262.20	0.309765939	$400,866,044.77		$ 1,294,093,359
Station - Major	1	$25,000,000	0	$0	0	$0	0	$0	0	$0	0	$0	1	$25,000,000	2	50,000,000
Station - Minor	0	$0	1	$15,000,000	1	$15,000,000	1	$15,000,000	1	$15,000,000	1	$15,000,000	1	$15,000,000	6	90,000,000
Operations Control Center	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	1	$250,000	1	250,000
Central Facility	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	1	$16,000,000	1	16,000,000
Decentralized Facility	1	$6,000,000	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	1	6,000,000
Washing Equipment	1	$2,600,000	0	$0	0	$0	0	$0	0	$0	0	$0	1	$2,600,000	2	5,200,000
Road Vehicles	1	$300,000	0	$0	1	$300,000	0	$0	1	$300,000	0	$0	1	$300,000	4	1,200,000
Guideway Bound Vehicles	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	1	$1,800,000	1	1,800,000
Guideway and Equipment	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	1	$8,000,000	1	8,000,000
Low Speed Switch	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	1	$3,400,000	1	3,400,000
Transfer Table	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	1	$7,400,000	1	7,400,000
Contingency (190)	0.21	$ 1,046,362.39	0.08	$ 374,377.50	0.16	$ 808,813.63	0.06	$ 280,780.67	0.02	$ 106,045.71	0.20	$ 1,009,331.92	0.26	$ 1,299,288.17	1	4,925,000
Construction Support	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	1	$50,000,000	1	50,000,000
Contingency (195)	0.21	$ -	0.08	$ -	0.16	$ -	0.06	$ -	0.02	$ -	0.20	$ -	0.26	$ -	1	0
Public Land	2934462.63	$2,934,463	1049919.98	$1,049,920	2268270.9	$2,268,271	787433.1091	$787,433	297399.048	$297,399	2830612.822	$2,830,613	3643778.316	$3,643,778	27623753.633	$13,811,877
Private Land	2098211.4	$46,160,651	715592.192	$15,743,028	1253576.93	$27,578,693	298078.7712	$6,557,733	204606.438	$4,501,342	1060619.392	$23,333,627	1780699.469	$39,175,388	170461845.837	$163,050,461
Private Land - Below Ground	283381.457	$1,416,907	136516.78	$682,584	587338.583	$2,936,693	340997.3753	$1,704,987	36760.9046	$183,805	1236689.565	$6,183,448	1176569.889	$5,882,849	22789527.322	$18,991,273
Subtotal (195)	0.21	$ 47,570,576.58	0.08	$ 17,020,253.86	0.16	$ 36,770,941.83	0.06	$ 12,765,078.89	0.02	$ 4,821,136.25	0.20	$ 45,887,067.19	0.26	$ 59,069,293.79	1	223,904,348
Contingency (195)	0.21	$ 9,514,115.32	0.08	$ 3,404,050.77	0.16	$ 7,354,188.37	0.06	$ 2,553,015.78	0.02	$ 964,227.25	0.20	$ 9,177,413.44	0.26	$ 11,813,858.76	1	44,780,870
Professional Services	0.21245937	$ 782,164,917.82	0.07601574	$ 279,850,412.20	0.16422612	$ 604,595,167.06	0.057011304	$ 209,885,975.75	0.02153212	$ 79,270,084.74	0.204940491	$ 754,484,320.39	0.263814858	$ 971,229,122.03	1	3,681,480,000
Utility Relocation	0.21245937	$ 270,749,721.49	0.07601574	$ 96,871,413.48	0.16422612	$ 209,283,195.10	0.057011304	$ 72,652,925.47	0.02153212	$ 27,439,677.85	0.204940491	$ 261,167,964.66	0.263814858	$ 336,195,101.96	1	1,274,360,000
Environmental Mitigation	0.21245937	$ 75,208,492.04	0.07601574	$ 26,908,810.43	0.16422612	$ 58,134,403.33	0.057011304	$ 20,181,431.53	0.02153212	$ 7,622,156.66	0.204940491	$ 72,546,884.56	0.263814858	$ 93,387,821.45	1	353,990,000
Subtotal															0	0
Design and Construction Contingency (30% of Previous Total)	0.14904723	$ 870,556,577.73	0.06213343	$ 362,909,570.29	0.15724486	$ 918,437,376.56	0.072837115	$ 425,427,750.16	0.01899095	$ 110,922,509.87	0.254831528	$ 1,488,422,534.77	0.284914454	$ 1,664,131,190.53	1.0000	$ 5,840,807,509.91

Route: Hybrid - High Speed Maglev

WBS Code			Description	Unit	Unit Cost	Source/Basis	Source/Basis	Quantity	Adjustment Increase %	Total Cost	Percent of Total
100			**System Delivery**								
	110		**Vehicles**							$ 240,200,000	1.8%
	111.1		TRI Car Body Passenger	each sectio	$6,930,000	TRI		0	0%	$ 207,900,000	
	117.1		TRI Maintenance Equipment	each sectio	$600,000	TRI		30	0	$ 18,000,000	
	118.1		TRI Documentation/Training	LS	$9,800,000	TRI		1	0	$ 9,800,000	
	119.1		TRI Spare Parts	each sectio	$150,000	TRI		30	0	$ 4,500,000	
			Subtotal							*$ 240,200,000*	
			Contingency and Currency Fluctuation					*0%*		*$ -*	
			Total							*$ 240,200,000*	
	120		**Propulsion System**							$ 823,130,000	6.2%
	121.1	TRI	Substation Civil Structures	LS	$14,500,000	TRI		1	0%	$ 14,500,000	
	122.1	TRI	Substation Propulsion Block	LS	$472,000,000	TRI		1	0%	$ 472,000,000	
	123.1	TRI	Wayside Equipment	LS	$224,200,000	TRI		1	0%	$ 224,200,000	
	124.1	TRI	Maintenance Equipment	LS	$6,200,000	TRI		1	0%	$ 6,200,000	
	125.1	TRI	Documentation/Training	LS	$7,700,000	TRI		1	0%	$ 7,700,000	
	126.1	TRI	Spare Parts	LS	$7,400,000	TRI		1	0%	$ 7,400,000	
	127.1	TRI	Program Management	LS	$16,300,000	TRI		1	0%	$ 16,300,000	
			Subtotal							*$ 748,300,000*	
			Contingency					*0%*	*10%*	*$ 74,830,000*	
			Total							*$ 823,130,000*	
	130		**Energy Supply**							$ 258,500,000	1.9%
	131.1	TRI	ES Substations	LS	$187,600,000	TRI		1	0%	$ 187,600,000	
	132.1	TRI	ES Operating Facilities	LS	$16,300,000	TRI		1	0%	$ 16,300,000	
	133.1	TRI	ES Wayside Equipment	LS	$8,300,000	TRI		1	0%	$ 8,300,000	
	134.1	TRI	ES Passenger Station	LS	$7,000,000	TRI		1	0%	$ 7,000,000	
	135.1	TRI	Maintenance Equipment	LS	$3,900,000	TRI		1	0%	$ 3,900,000	
	136.1	TRI	Documentation/Training	LS	$4,900,000	TRI		1	0%	$ 4,900,000	
	137.1	TRI	Spare Parts	LS	$200,000	TRI		1	0%	$ 200,000	
	138.1	TRI	Program Management	LS	$6,800,000	TRI		1	0%	$ 6,800,000	
			Subtotal							*$ 235,000,000*	
			Contingency						*10%*	*$ 23,500,000*	
			Total							*$ 258,500,000*	
	140		**Operation Control Technology**							$ 127,110,000	1.0%
	141.1	TRI	Operation Controls & Safety Technology	LS	$50,000,000	TRI		1	0%	$ 50,000,000	
	142.1	TRI	Stationary Data Transmission			TRI			0%	$ -	
	142.1.1	TRI	Single Guideway Length	FT	$23	TRI		136,401	0%	$ 3,118,124	
	142.1.2.	TRI	Double Guideway Length	FT	$30	TRI		500,000	0%	$ 15,240,000	
	143.1	TRI	Radio Data Transmission			TRI			0%	$ -	
	143.1.1	TRI	Single Guideway Length	FT	$53	TRI		136,401	0%	$ 7,171,686	
	143.1.2	TRI	Double Guideway Length	FT	$70	TRI		500,000	0%	$ 35,051,999	
	144.1	TRI	Vehicle Location (Guideway Mounted)	Included in WBS 128		TRI			0%	$ -	
	145.1	TRI	Maintenance Equipment	% of the sum of 141-143		TRI		1.5%	0%	$ 1,658,727	
	146.1	TRI	Documentation/Training	% of the sum of 141-143		TRI		1.0%	0%	$ 1,105,818	
	147.1	TRI	Spare Parts	% of the sum of 141-143		TRI		2.0%	0%	$ 2,211,636	
			Subtotal							*$ 115,557,991*	
			Contingency						*10%*	*$ 11,555,799*	
			Total							*$ 127,113,790*	
	150		**Communication/Control Technology**							$ 8,420,000	0.1%
	151.1	TRI	Energy Supply Control Equipment	EA	$80,000	TRI		12	0%	$ 960,000	
	152.1	TRI	Building Control Equipment	EA	$70,000	TRI		12	0%	$ 840,000	
	153.1	TRI	Operations Communications	EA	$180,000	TRI		12	0%	$ 2,160,000	
	154.1	TRI	Passenger Communications	EA	$500,000	TRI		3	0%	$ 1,500,000	
	155.1	TRI	Passenger Support System	EA	$500,000	TRI		3	0%	$ 1,500,000	
	156.1	TRI	Maintenance Equipment	% of the sum of 151-153		TRI		1.0%	0%	$ 54,600	
	157.1	TRI	Documentation/Training	LS	$250,000	TRI		2	0%	$ 500,000	
	158.1	TRI	Spare Parts	% of the sum of 151-153		TRI		2.0%	0%	$ 139,200	
			Subtotal							*$ 7,653,800*	
			Contingency						*10%*	*$ 765,380*	
			Total							*$ 8,419,180*	
	160		**Guideway Infrastructure**							$ 5,364,880,000	40.2%
	166.1.1	TRI/AMT	High column areas with standard Maglev guideway – single tr	FT					0%		
	166.1.2	TRI/AMT	High column areas with standard Maglev guideway – double t	FT	$9,144				0%	$133,502,400	
	162.3	AMT	TRI Standard Maglev Type I Guideway - Double Track - At Grac	FT	$560	Lawrence Construction				$99,211,784	
	164.3	AMT	TRI Standard Maglev Type I Guideway - Double Track - Elevate	FT	$2,887.40	Lawrence Construction				$1,326,000,914	
	168		**Misc.**								
	168.2		Safety Fencing and K-Rail - Type 7 Rail (special) including pave	FT	$95	Lawrence Construction	Just for Straddle Bent length			$2,683,757	
	168.3		Maglev Guideway Switches								
	168.3.1	TRI/AMT	Low Speed	EA	$3,400,000	TRI/AMT	Anaheim-L	16.000	0%	$54,400,000	
	170		**Special Civil Structures**								
	171		**Bridges & Viaducts**								
	171.2	TRI/AMT	Straddle Bent Crossings over I-70 (or other facilities) - Dc	FT	$3,271				0%		
	172.2	TRI/AMT	- B-2: Double track bridge. Standard column height. Colur	FT	$4,267				0%		
	172.3	TRI/AMT	- B-3: Double track bridge. Standard column height. Colur	FT	$3,879				0%		
	172.7	TRI/AMT	- B-7a: Double track bridge. Viaduct (higher columns, long	FT	$5,554				0%		
	172		Tunnels								
			- T-4a: Single tube tunnel (length>8km). 13.9 m Excavatio	FT	$31,890	Ken Fiorentino (Jacobs)	+ 20% per Ken		0%		
			- T-5a: Single tube tunnel (length>8km). 13.9 m Excavatio	FT	$30,116	Ken Fiorentino (Jacobs)	+ 20% per Ken		0%		
			- T-7: Single tube tunnel (length<1km). Excavation width	FT	$43,099	Ken Fiorentino (Jacobs)	T-7		0%		
			- T-8: Single tube tunnel (length<1km). Excavation width	FT	$40,841	Ken Fiorentino (Jacobs)	T-8		0%		
			- T-9: Single tube tunnel (length<1km). Excavation width	FT	$34,719				0%		
			- T-10: Cut & cover section for both tracks. Standard cove	FT	$14,630				0%		
	173		Tunnel Subtotal							$ -	
			Escape Side Passage (if required)	15% of tunnel cost					20%	$434,397,362	
	173.1	Talgo	**Cuts & Embankments** (even though is minimum)								
	175		Stator Packs including machining	FT	$259				0%	$ -	
			Subtotal							*$4,217,078,206*	
			Std Contingency (10% of all expect switches)						*10%*	*$34,222,422*	
			Switch Contingency (20% of switches)						*20%*	*$10,880,000*	
			Tunnel Contingency						*30%*	*$668,303,634*	
			Emerency Tunnel Continency (15% of tunnels)						*20%*	*$434,397,362*	
			Total							*$5,364,881,625*	
	180		**Stations** (Omit El Rancho Sta)							$ 140,000,000	1.0%
	181		Civil Structures								

Hybrid - High Speed Maglev

WBS / Description	Segment 1 Eagle	Segment 1 Avon	Segment 2 Avon	Segment 2 Vail	Segment 3 Vail	Segment 3 Copper	Segment 4 Copper	Segment 4 Breck	Segment 5 Breck	Segment 5 Keystone	Segment 6 Keystone	Segment 6 Idaho Springs	Segment 7 Idaho Springs	Segment 7 El Rancho	Segment 8 El Rancho	Segment 8 Golden	TOTAL	TOTAL
111.1 TRI Car Body Passenger	0	$0	5	$34,650,000	0	$0	5	$34,650,000	5	$34,650,000	5	$34,650,000	5	$34,650,000	5	$34,650,000	30.000	$207,900,000
117.1 TRI Maintenance Equipment	0	$0	5	$3,000,000	5	$3,000,000	5	$3,000,000	5	$3,000,000	5	$3,000,000	0	$0	5	$3,000,000	30.000	$18,000,000
118.1 TRI Documentation/Training	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	1	$9,800,000	1.000	$9,800,000
119.1 TRI Spare Parts	0	$0	5	$750,000	5	$750,000	5	$750,000	5	$750,000	5	$750,000	0	$0	5	$750,000	30.000	$4,500,000
120 Subtotal	0.20741957	$ 155,212,062.96	0.05743443	$ 42,978,183.82	0.17574756	$ 131,511,899.28	0.050283945	$ 37,627,476.24	0.080141	$ 59,969,585.81	0.24280031	$ 181,687,475.16	0.099459001	$ 74,425,170.59	0.08671408	$ 64,888,146.13	1.000	$748,300,000
120 Contingency	0.20741957	$ 15,521,206.30	0.05743443	$ 4,297,818.38	0.17574756	$ 13,151,189.93	0.050283945	$ 3,762,747.62	0.080141	$ 5,996,958.58	0.24280031	$ 18,168,747.52	0.099459001	$ 7,442,517.06	0.08671408	$ 6,488,814.61	1.000	$74,830,000
130 Subtotal	0.20741957	$ 48,743,598.55	0.05743443	$ 13,497,091.00	0.17574756	$ 41,300,676.64	0.050283945	$ 11,816,727.14	0.080141	$ 18,833,158.71	0.24280031	$ 57,058,073.85	0.099459001	$ 23,372,865.28	0.08671408	$ 20,377,808.82	1.000	$235,000,000
130 Contingency	0.20741957	$ 4,874,359.86	0.05743443	$ 1,349,709.10	0.17574756	$ 4,130,067.66	0.050283945	$ 1,181,672.71	0.080141	$ 1,883,315.87	0.24280031	$ 5,705,807.39	0.099459001	$ 2,337,286.53	0.08671408	$ 2,037,780.88	1.000	$23,500,000
141.1 Operation Controls & Safety Technology	0.20741957	$ 10,370,978.42	0.05743443	$ 2,871,721.49	0.17574756	$ 8,787,378.01	0.050283945	$ 2,514,197.26	0.080141	$ 4,007,055.05	0.24280031	$ 12,140,015.71	0.099459001	$ 4,972,950.06	0.08671408	$ 4,335,704.00	1.000	$50,000,000
142.1 Stationary Data Transmission																	0.000	$0
142.1.1 Single Guideway Length	0.20741957	$ 646,760.03	0.05743443	$ 179,087.70	0.17574756	$ 548,002.77	0.050283945	$ 156,791.60	0.080141	$ 249,889.93	0.24280031	$ 757,081.60	0.099459001	$ 310,125.55	0.08671408	$ 270,385.30	1.000	$3,118,124
142.1.2. Double Guideway Length	0.20741957	$ 3,161,074.12	0.05743443	$ 875,300.68	0.17574756	$ 2,678,392.73	0.050283945	$ 766,327.30	0.080141	$ 1,221,350.34	0.24280031	$ 3,700,276.67	0.099459001	$ 1,515,755.13	0.08671408	$ 1,321,522.54	1.000	$15,240,000
143.1 Radio Data Transmission																	0.000	$0
143.1.1 Single Guideway Length	0.20741957	$ 1,487,548.08	0.05743443	$ 411,901.71	0.17574756	$ 1,260,406.37	0.050283945	$ 360,620.68	0.080141	$ 574,746.84	0.24280031	$ 1,741,287.69	0.099459001	$ 713,288.76	0.08671408	$ 621,886.18	1.000	$7,171,686
143.1.2 Double Guideway Length	0.20741957	$ 7,270,470.48	0.05743443	$ 2,013,191.57	0.17574756	$ 6,160,303.28	0.050283945	$ 1,762,552.79	0.080141	$ 2,809,105.78	0.24280031	$ 8,510,636.34	0.099459001	$ 3,486,236.80	0.08671408	$ 3,039,501.84	1.000	$35,051,999
144.1 Vehicle Location (Guideway Mounted)																	0.000	$0
145.1 Maintenance Equipment													1	$ 1,658,727.14	0	$ -	1.000	$1,658,727
146.1 Documentation/Training													1	$ 1,105,818.09	0	$ -	1.000	$1,105,818
147.1 Spare Parts	0.20741957	$ 458,736.62	0.05743443	$ 127,024.06	0.17574756	$ 388,689.66	0.050283945	$ 111,209.79	0.080141	$ 177,242.96	0.24280031	$ 536,985.96	0.099459001	$ 219,967.13	0.08671408	$ 191,780.00	1.000	$2,211,636
140 Contingency	0.20741957	$ 2,396,898.85	0.05743443	$ 663,700.73	0.17574756	$ 2,030,903.49	0.050283945	$ 581,071.17	0.080141	$ 926,094.46	0.24280031	$ 2,805,751.64	0.099459001	$ 1,149,328.23	0.08671408	$ 1,002,050.49	1.000	$11,555,799
150 Subtotal	0.20741957	$ 1,587,547.89	0.05743443	$ 439,591.64	0.17574756	$ 1,345,136.68	0.050283945	$ 384,863.26	0.080141	$ 613,383.96	0.24280031	$ 1,858,345.05	0.099459001	$ 761,239.30	0.08671408	$ 663,692.23	1.000	$7,653,800
150 Contingency	0.20741957	$ 158,754.79	0.05743443	$ 43,959.16	0.17574756	$ 134,513.67	0.050283945	$ 38,486.33	0.080141	$ 61,338.40	0.24280031	$ 185,834.50	0.099459001	$ 76,123.93	0.08671408	$ 66,369.22	1.000	$765,380
160 Guideway Infrastructure																	Total (FT)	
166.1.1		-		-		-		-		-		-		-		-		$0
166.1.2	0.000	-	3300.000	30,175,200	2800.000	25,603,200		-		-	6000.000	54,864,000	1250.000	11,430,000	1250.000	11,430,000	14600.000	$133,502,400
162.3	27347.000	15,314,320	10317.323	5,777,701	27070.906	15,159,707	19017.748	10,649,939	13551.869	7,589,047	29502.339	16,521,310	26268.798	14,710,527	24087.919	13,489,234	177163.900	$99,211,784
164.3	104655.000	302,180,847	26234.000	75,748,052	84775.000	244,779,335	12983.000	37,487,114	37450.000	108,133,130	125016.000	360,971,198	37027.000	106,911,760	31097.000	89,789,478	459237.000	$1,326,000,914
168 Misc.																		$0
168.2	3000.000	286,410	1549.000	147,883	5600.000	534,632	0.000	-	0.000	-	6311.000	602,511	4993.000	476,682	6658.000	635,639	28111.000	$2,683,757
168.3																		$0
168.3.1	2.000	6,800,000	2.000	6,800,000	2.000	6,800,000	2.000	6,800,000	2.000	6,800,000	2.000	6,800,000	2.000	6,800,000	2.000	6,800,000	16.000	$54,400,000
171.2	3000.000	9,813,000	1549.000	5,066,779	5600.000	18,317,600		-		-	6311.000	20,643,281	4993.000	16,332,103	6658.000	21,778,318	28111.000	$91,951,081
172.2	1500.000	6,400,800	0.000	-	269.000	1,147,877		-		-		-	773.000	3,298,546			2542.000	$10,847,222
172.3	3000.000	11,637,818	0.000	-	973.000	3,774,532		-		-	712.000	2,762,042	1509.000	5,853,823	358.000	1,388,780	6552.000	$25,416,995
172.7	9456.000	52,519,469		-	1810.000	10,052,902		-		-		-	1743.000	9,680,778	1486.000	8,253,377	14495.000	$80,506,525
(blank row)																		$0
172 Tunnels																		$0
T-4a		-			1627.297	51,894,488	19015.748	606,412,205		-	803.806	25,633,366		-		-	21446.850	$683,940,059
T-5a					4878.609	146,926,138			13549.869	408,073,268	7237.533	217,968,433					25666.010	$772,967,839
T-7		-	587.270	25,310,764		-		-		-		-	872.703	37,612,644	209.974	9,049,659	1669.948	$71,973,068
T-8		-	3330.052	136,002,674		-		-		-		-	2181.759	89,105,200	1190.945	48,639,380	6702.756	$273,747,254
T-9		-		-		-		-		-		-	1312.336	45,562,992		-	1312.336	$45,562,992
T-10	7389.000	108,101,070		-	3511.000	51,365,930		-		-	2125.000	31,088,750	6639.000	97,128,570	6275.000	91,803,250	25939.000	$379,487,570
Escape Side Passage (if required)		21,079,709		31,456,120		48,786,378		118,250,380		79,574,287		53,564,657		52,534,834		29,150,996		$434,397,362
173.1 Cuts & Embankments																		$0
175 Stator Packs including machining		34,199,078		9,469,717		28,977,037		8,290,754		13,213,564		40,032,611		16,398,675		14,297,309		$164,878,745
Subtotal	132002.000	$547,252,813	36551.323	$294,498,769	111845.906	$605,333,378	32000.748	$669,640,012	51001.869	$543,809,008	154518.339	$777,887,503	63295.798	$461,302,299	55184.919	$317,354,423	636400.900	$4,217,078,206
Std Contingency (10% of all expect switches)	0.12977061	$4,441,064.65	0.06980479	$2,389,915.67	0.14354331	$4,912,399.91	0.15879341	$5,434,260.94	0.128954	$4,413,117.49	0.18446125	$6,312,710.70	0.109389079	$3,743,559.26	0.07525457	$2,575,393.82	1.000	$34,222,422
Switch Contingency (20% of switches)	0.12500	$1,360,000.00	0.12500	$1,360,000.00	0.12500	$1,360,000.00	0.12500	$1,360,000.00	0.12500	$1,360,000.00	0.12500	$1,360,000.00	0.12500	$1,360,000.00	0.12500	$1,360,000.00	1.000	$10,880,000
Tunnel Contingency	0.08930719	$59,684,319.07	0.047346744	$31,642,001.08	0.12106938	$80,911,109.04	0.229833943	$153,598,859.51	0.163771	$109,448,462.70	0.12287551	$82,118,148.03	0.133021637	$88,898,843.35	0.09277503	$62,001,891.60	1.000	$668,303,634
Emerency Tunnel Continency (15% of tunnels)	0.08930719	$38,794,807.40	0.047346744	$20,567,300.70	0.12106938	$52,592,220.88	0.229833943	$99,839,258.68	0.163771	$71,141,500.75	0.12287551	$53,376,796.22	0.133021637	$57,784,248.18	0.09277503	$40,301,229.54	1.000	$434,397,362
Total																		$0

Route: Hybrid - High Speed Maglev

WBS Code			Description	Unit	Unit Cost	Source/Basis	Source/Basis	Quantity	Adjustment Increase %	Total Cost	Percent of Total
			Station - Major	EA	$25,000,000	Aztec		2		$ 50,000,000	
			Station - Mior	EA	$15,000,000			6		$ 90,000,000	
			Subtotal							*$ 140,000,000*	
			Contingency					*0%*		*$ -*	
			Total							*$ 140,000,000*	
190			**Operations and Maintenance Facilities**							**$ 53,900,000**	**0.4%**
	192		Maintenance Facilities						0%	$ -	
		1821	Central Facility	EA	$16,000,000	Anaheim-LV Proj.	TRI	1	0%	$ 16,000,000	
			Decentralized Facility	EA	$6,000,000	Aztec	TRI	1	0%	$ 6,000,000	
		1822	Washing Equipment	EA	$2,600,000	Anaheim-LV Proj.	TRI	2	0%	$ 5,200,000	
	193		Maintenance Vehicles			Anaheim-LV Proj.	TRI			$ -	
		1831	Road Vehicles	LS	$300,000			4	0%	$ 1,200,000	
		1832	Guideway Bound Vehicles	LS	$1,800,000			1	0%	$ 1,800,000	
	194		Guideway and Equipment	EA	$8,000,000	Anaheim-LV Proj.	TRI	1	0%	$ 8,000,000	
	195		Low Speed Switch	LS	$3,400,000	Anaheim-LV Proj.		1	0%	$ 3,400,000	
	196		Transfer Table	LS	$7,400,000	TRI		1	0%	$ 7,400,000	
			Beam Maint. And Testing Vehicle						0%	$ -	
			Subtotal							*$ 49,000,000*	
			Contingency						*10%*	*$ 4,900,000*	
			Total							*$ 53,900,000*	
195			**Construction Support**								
	191		Beam Fabrication Plant							**$ 50,000,000**	**0.4%**
			Subtotal							*$ 50,000,000*	
			Contingency							*$ -*	
			Total							*$ 50,000,000*	
195			**Right of Way and Corridor**								
	195		Right of Way							**$ 395,390,000**	**3.0%**
		195.1	Public Land	SF	$1			10,767,903		$10,767,903	
		195.2	Private Land	SF	$22			12,778,565		$281,128,433	
			Private Land - Below Ground	SF	$5			1,909,568		$9,547,838	
			Subtotal							*$ 329,494,912*	
			Contingency					*20%*		*$ 65,898,982*	
										$ 395,393,894	
Subtotal			*Total*							**$ 7,461,530,000**	**55.9%**
			Cost per KM					*194.0*		*$ 38,466,453*	
			Cost per Mile					*120.5*		*$ 61,904,063*	
200			**Project Support Costs**								
210			**Professional Services**					1		**$ 1,940,000,000**	**14.5%**
	211		Design Engineering	%	10%					$ 746,153,000	
	212		Insurance and Bonding	%	2%					$ 149,230,600	
	213		Program Management	%	4%					$ 298,461,200	
	214		Construction Management & Inspection	%	6%					$ 447,691,800	
	215		Engineering Services During Construction	%	2%					$ 149,230,600	
	216		Integrated Testing and Commissioning	%	2%					$ 149,230,600	
			Subtotal							$ 1,939,997,800	
220			**Utility Relocation**					1		**$ 671,540,000**	**5.0%**
	221		Through Urban areas	%	6%					$ 447,691,800	
	222		outside of Urban Areas	%	3%					$ 223,845,900	
			Subtotal							$ 671,537,700	
230			**Environmental Mitigation**					1		**$ 186,540,000**	**1.4%**
	231		Noise Mitigation	%	1%					$ 74,615,300	
	232		Hazardous Waste	%	1%					$ 74,615,300	
	233		Erosion Control	%	0.5%					$ 37,307,650	
			Subtotal							$ 186,538,250	
Subtotal										**$ 2,798,080,000**	**21.0%**
300			**Design and Construction Contingency (30% of Previous Total)**	%	*30%*					**$ 3,077,880,000**	**23.1%**
Subtotal Planning and Engineering Costs										$ 7,461,530,000	
Subtotal Project Support Costs										$ 2,798,080,000	
Design and Construction Contingency										$ 3,077,880,000	
Grand Total										**$ 13,337,490,000**	**100.0%**
			Cost per KM					*194.0*		*$ 68,751,311*	
			Cost per Mile					*120.5*		*$ 110,653,565*	

Hybrid - High Speed Maglev

Description	Segment 1 Eagle	Segment 1 Avon	Segment 2 Avon	Segment 2 Vail	Segment 3 Vail	Segment 3 Copper	Segment 4 Copper	Segment 4 Breck	Segment 5 Breck	Segment 5 Keystone	Segment 6 Keystone	Segment 6 Idaho Springs	Segment 7 Idaho Springs	Segment 7 El Rancho	Segment 8 El Rancho	Segment 8 Golden	TOTAL	
Station - Major	1	$25,000,000	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	1	$25,000,000	2	50,000,000
Station - Mior	0	$0	1	$15,000,000	1	$15,000,000	1	$15,000,000	1	$15,000,000	1	$15,000,000	1	$15,000,000	0	$0	6	90,000,000
Central Facility	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	1	$16,000,000	1	16,000,000
Decentralized Facility	1	$6,000,000	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	1	6,000,000
Washing Equipment	1	$2,600,000	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	1	$2,600,000	2	5,200,000
Road Vehicles	1	$300,000	0	$0	1	$300,000	0	$0	1	$300,000	0	$0	0	$0	1	$300,000	4	1,200,000
Guideway Bound Vehicles	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	1	$1,800,000	1	1,800,000
Guideway and Equipment	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	1	$8,000,000	1	8,000,000
Low Speed Switch	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	1	$3,400,000	1	3,400,000
Transfer Table	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	0	$0	1	$7,400,000	1	7,400,000
Contingency (190)	0.20741957	$ 1,016,355.88	0.05743443	$ 281,428.71	0.17574756	$ 861,163.04	0.050283945	$ 246,391.33	0.080141	$ 392,691.39	0.24280031	$ 1,189,721.54	0.099459001	$ 487,349.11	0.08671408	$ 424,898.99	1.000	$4,900,000
Beam Fabrication Plant	0.20741957	$ 10,370,978.42	0.05743443	$ 2,871,721.49	0.17574756	$ 8,787,378.01	0.050283945	$ 2,514,197.26	0.080141	$ 4,007,055.05	0.24280031	$ 12,140,015.71	0.099459001	$ 4,972,950.06	0.08671408	$ 4,335,704.00	1.000	$50,000,000
Right of Way	0.20741957	$ 82,011,623.11	0.05743443	$ 22,708,999.20	0.17574756	$ 69,488,827.82	0.050283945	$ 19,881,769.12	0.080141	$ 31,686,989.89	0.24280031	$ 96,000,816.26	0.099459001	$ 39,325,094.48	0.08671408	$ 34,285,880.13	1.000	$395,390,000
Public Land	2233473.84	$2,233,474	618448.3824	$618,448	1892432.72	$1,892,433	541452.6567	$541,453	862951.6	$862,952	2614450.29	$2,614,450	1070964.9	$1,070,965	933728.823	$933,729	10767903.232	$10,767,903
Private Land	2876068.04	$63,273,497	753192.72	$16,570,240	2350213.32	$51,704,693	299693.8	$6,593,264	864392.2	$19,016,628	3331644.16	$73,296,172	1206853.2	$26,550,770	1096507.72	$24,123,170	12778565.120	$281,128,433
Private Land - Below Ground	170538.12	$852,691	90411.81102	$452,059	231190.179	$1,155,951	438883.4646	$2,194,417	312731	$1,563,655	234639.094	$1,173,195	254013.8155	$1,270,069	177160.202	$885,801	1909567.658	$9,547,838
Professional Services	0.20741957	$ 402,393,963	0.05743443	$ 111,422,794	0.17574756	$ 340,950,267	0.050283945	$ 97,550,854	0.080141	$ 155,473,736	0.24280031	$ 471,032,610	0.099459001	$ 192,950,462	0.08671408	$ 168,225,315	1.000	$1,940,000,000
Utility Relocation	0.20741957	$ 139,290,537	0.05743443	$ 38,569,517	0.17574756	$ 118,021,517	0.050283945	$ 33,767,681	0.080141	$ 53,817,955	0.24280031	$ 163,050,123	0.099459001	$ 66,790,698	0.08671408	$ 58,231,973	1.000	$671,540,000
Environmental Mitigation	0.20741957	$ 38,692,046	0.05743443	$ 10,713,819	0.17574756	$ 32,783,950	0.050283945	$ 9,379,967	0.080141	$ 14,949,521	0.24280031	$ 45,291,971	0.099459001	$ 18,553,082	0.08671408	$ 16,175,645	1.000	$186,540,000
Design and Construction Contingency (30% of Previous Total)	0.15703311	$ 483,329,080	0.064346944	$ 198,052,171	0.15092969	$ 464,543,478	0.117711881	$ 362,303,045	0.11264	$ 342,456,645	0.20059405	$ 617,404,418	0.10812945	$ 332,809,471	0.08999151	$ 276,983,069	1.000	$ 3,077,880,000

Route: HS Rail

WBS Code			Description	Unit	Unit Cost	Quantity	Adjustment Increase %	Total Cost	Percent of Total	Segment 1 Eagle	Segment 1 Vail	Segment 2 Vail	Segment 2 Lake Hill	Segment 3 Lake Hill	Segment 3 Georgetown	Segment 3b (Spur) Lake Hill	Segment 3b (Spur) Breckenridge	Segment 4 Georgetown	Segment 4 Jeffco	TOTAL	TOTAL
100			System Delivery																		
110			Vehicles					$ 180,000,000	0.6%												
	#REF!		Talgo Consist	EA	$30,000,000	6		$ 180,000,000		1	$30,000,000	1	$30,000,000	1	$30,000,000	1	$30,000,000	2	$60,000,000	6	180,000,000
			Subtotal					$ 180,000,000													
			Contingency and Currency Fluctuation				0%	$ -		0.266357266	$ -	0.175709146	$ -	0.22191837	$ -	0.06731714	$ -	0.268698077	$ -	1	0
			Total					$ 180,000,000													
120			Propulsion System					$ -	0.0%	0.266357266	$ -	0.175709146	$ -	0.22191837	$ -	0.06731714	$ -	0.268698077	$ -	1	0
130			Energy Supply					$ 308,510,000	1.0%												
	131.2	Talgo	Overhead contact system for HSR - Includes: Energy system for HSR (double track) including: Overhead contact line with all its elements (fo	FT	$488		0%	$280,463,479		153181.365	74,703,486	101049.869	49,279,998	127624.672	62,239,998	38713.911	18,879,999	154527.559	75,359,998	575097.375	$280,463,479
			Subtotal					$ 280,463,479													
			Contingency				10%	$ 28,046,348		0.266357266	$ 7,470,348.56	0.175709146	$ 4,927,999.84	0.22191837	$ 6,223,999.80	0.06731714	$ 1,887,999.94	0.268698077	$ 7,535,999.76	1	28,046,348
			Total					$ 308,509,827													
140			Operation Control Technology					$ 241,020,000	0.7%												
	141.2	Talgo	Signaling system for HSR. Includes: signaling system for HSR (double track), including electronic interlockings (SIL 4) with all its elements, t	FT	$381	575097.375	0%	$219,112,093		153181.365	58,362,098	101049.869	38,499,999	127624.672	48,624,998	38713.911	14,750,000	154527.559	58,874,998	575097.375	$219,112,093
			Subtotal					$ 219,112,093													
			Contingency				10%	$ 21,911,209		0.266357266	$ 5,836,209.81	0.175709146	$ 3,849,999.88	0.22191837	$ 4,862,499.84	0.06731714	$ 1,474,999.95	0.268698077	$ 5,887,499.81	1	21,911,209
			Total					$ 241,023,302													
150			Communication/Control Technology					$ 61,350,000	0.2%												
	151.2	Talgo	Telecommunication system for HSR, including both data / voice networks, GSM-R network, (BTS'S, MSC'S, BSC'S, etc), communication no	FT	$107	575,097		$ 61,351,386		153181.365	16,341,387	101049.869	10,780,000	127624.672	13,615,000	38713.911	4,130,000	154527.559	16,484,999	575097.375	$61,351,386
			Subtotal					$ 61,351,386													
			Contingency				0%	$ -		0.266357266	$ -	0.175709146	$ -	0.22191837	$ -	0.06731714	$ -	0.268698077	$ -	1	0
			Total					$ 61,351,386													
160			Guideway Infrastructure					$ 16,795,170,000	51.8%												
	161.2.1	Talgo	HSR Single Track - Includes the slab track of 0,45 m depth for a 8 m wide platform, the special concrete ties for the slab track solution and t	FT	$899		0%			269978.215	242,753,612	163254.593	146,792,000	255249.344	229,510,000	77427.822	69,620,000	298884.514	268,745,000	1064794.488	$957,420,612
	162.2.1	Talgo	HSR Double Track - Includes the slab track of 0,45 m depth for a 14 m wide platform, the special concrete ties for the slab track solution and	FT	$1,753		0%			18192.257	31,883,750	19422.572	34,040,000	0.000	-	0.000	-	5085.302	8,912,500	42700.131	$74,836,250
	168		Misc.																		
	168.4		HSR Guideway Switches																		
	168.4.1	Talgo	Low Speed	EA	$950,000	10.000		$9,500,000		2.000	1,900,000	2.000	1,900,000	2.000	1,900,000	2.000	1,900,000	2.000	1,900,000	10.000	$9,500,000
	168.4.2	Talgo	High Speed	EA	$2,250,000	10.000		$22,500,000		2.000	4,500,000	2.000	4,500,000	2.000	4,500,000	2.000	4,500,000	2.000	4,500,000	10.000	$22,500,000
	169		Guideway Equip.																		
170			Special Civil Structures																		
	171		Bridges & Viaducts																		
	174.1	Talgo	- Type A1: Double track bridge. Maximum height less than 20 m, typical span of 30 m (simple spans). Shallow Foundation	FT	$8,463		0%									9060.039	76,679,009	459.318	3,887,402	9519.357	$80,566,411
	174.2	Talgo	- Type A2: Double track bridge. Maximum height less than 20 m, typical span of 30 m (simple spans). Deep Foundation	FT	$8,463		0%									3882.874	32,862,432	196.850	1,666,030	4079.724	$34,528,462
	174.3	Talgo	- Type B1: Double track bridge. Less than 60 m pier height and typical span of 50 m (continuous span). Shallow Foundation	FT	$7,765		0%			3134.843	24,343,337	4179.790	32,457,783							7314.633	$56,801,121
	174.4	Talgo	- Type B2: Double track bridge. Less than 60 m pier height and typical span of 50 m (continuous span). Deep Foundation	FT	$7,765		0%			1343.504	10,432,859	1791.339	13,910,479							3134.843	$24,343,337
	175.1	Talgo	- Type E1: Single track bridge. Maximum height less than 20 m, typical span of 30 m (simple spans). Shallow Foundation	FT	$5,658		0%					459.318	2,598,842					2526.247	14,293,630	2985.564	$16,892,472
	175.2	Talgo	- Type E2: Single track bridge. Maximum height less than 20 m, typical span of 30 m (simple spans). Deep Foundation	FT	$5,658		0%					196.850	1,113,789					1082.677	6,125,842	1279.528	$7,239,631
	175.3	Talgo	- Type F1: Single track bridge. Less than 60 m pier height and typical span of 50 m (continuous span). Shallow Foundation	FT	$4,698		0%			12642.717	59,397,252			3731.955	17,533,249			3754.921	17,641,146	20129.593	$94,571,647
	175.4	Talgo	- Type F2: Single track bridge. Less than 60 m pier height and typical span of 50 m (continuous span). Deep Foundation	FT	$4,698		0%			5418.307	25,455,965			1599.409	7,514,250			1609.252	7,560,491	8626.969	$40,530,706
	175.5	Talgo	- Type G1: Single track bridge. Maximum height less than 100 m and span length of 90 m (continuous span). Shallow Foundation	FT	$11,996		0%											895.669	10,744,207	895.669	$10,744,207
	175.6	Talgo	- Type G2: Single track bridge. Maximum height less than 100 m and span length of 90 m (continuous span). Deep Foundation	FT	$11,996		0%											383.858	4,604,660	383.858	$4,604,660
	175.7	Talgo	- Type H1: Single track bridge. Higher than 100 pier and typical span of 120 m (continuous span). Shallow Foundation	FT	$25,937		0%							7601.706	197,167,806					7601.706	$197,167,806
	175.8	Talgo	- Type H2: Single track bridge. Higher than 100 pier and typical span of 120 m (continuous span). Deep Foundation	FT	$25,937		0%							3257.874	84,500,488					3257.874	$84,500,488
	172		Tunnels																		
			- T-2: Twin tube tunnel (length>1km). 10 m Excavation Diameter. Average quality rock. Price per 2 tubes. TBM	FT	$20,042		0%			23622.047	473,433,071	55118.110	1,104,677,165	0.000	-			27066.929	542,475,394	105807.087	$2,120,585,630
			- T-3: Twin tube tunnel (length>1km). 10 m Excavation Diameter. Good quality rock. Price per 2 tubes.TBM	FT	$19,240		0%			29855.643	574,432,126	0.000	-	103182.415	1,985,262,677				-	133038.058	$2,559,694,803
			- T-4: Twin tube tunnel (length>1km). 12 m Excavation width. Soil/Poor quality rock. Price per 2 tubes. SEM (Sequential Excavation M	FT	$53,150		0%			4133.858	219,714,567	0.000	-	0.000	-	935.039	49,697,343	5442.913	289,290,846	10511.811	$558,702,756
			- T-5: Twin tube tunnel (length>1km). 12 m Excavation width. Average quality rock. Price per 2 tubes. SEM	FT	$50,194		0%			17667.323	886,793,602	0.000	-	0.000	-	5610.236	281,600,197	24691.601	1,239,370,223	47969.160	$2,407,764,022
			- T-6: Twin tube tunnel (length>1km). 12 m Excavation width. Good quality rock. Price per 2 tubes. SEM	FT	$49,979		0%			5265.748	263,176,821	0.000	-	0.000	-	2805.118	140,196,998	24294.619	1,214,220,784	32365.486	$1,617,594,603
			- T-7: Single tube tunnel (length<1km). Excavation width 14 m. Soil/Poor quality rock.	FT	$43,099		0%			623.360	26,866,175	472.441	20,361,732	0.000	-		-	370.735	15,978,304	1466.535	$63,206,211
			- T-8: Single tube tunnel (length<1km). Excavation width 14 m. Average quality rock.	FT	$40,841		0%			2181.759	89,105,200	2834.646	115,769,764	0.000	-		-	1482.940	60,564,738	6499.344	$265,439,701
			- T-9: Single tube tunnel (length<1km). Excavation width 14 m. Good quality rock.	FT	$34,713		0%			311.680	10,821,211	1417.323	49,208,031	0.000	-		-	1853.675	64,357,726	3582.677	$124,386,969
			- T-10: Cut & cover section for both tracks. Standard cover.	FT	$14,630		0%				-	0.000	-	0.000	-	1804.462	26,399,278		-	1804.462	$26,399,278
	173		Tunnel Subtotal					$ -													
			Escape Side Passage (if required)	15% of tunnel cost			20%	$1,900,035,925			496,146,841		251,553,255		387,126,222		97,089,294		668,120,313	0.000	$1,900,035,925
	173.1	Talgo	Cuts & Embankments (even though is minimum)																		
			CE-1: Cut less than 10 m deep. Slopes 1:1. 50% conventional, 50% drill&blast.	CY	$34		0%			313908.149	10,800,000	332219.457	11,430,000	11771.556	405,000	11444.568	393,750	444703.211	15,300,000	1114046.940	$38,328,750
			CE-2: Cut less than 20 m deep. Slopes 1:1. 25% conventional. 75% drill&blast. (cuts>20 m are considered tunnels)	CY	$54		0%			393630.136	21,070,000	408080.593	21,840,000	15695.407	840,000	12948.711	693,000	588577.779	31,500,000	1418895.627	$75,943,000
			CE-3: Embankment less than 10 m height. Armored for slab track.	CY	$23		0%			2058714.275	47,220,000	2282373.831	52,350,000	59511.753	1,365,000	53625.975	1,230,000	3905213.562	89,572,500	8359439.396	$191,737,500
	173.2		Drainage																		
			Subtotal					$11,766,531,034		153181.365	$3,024,099,548	101049.869	$1,612,949,586	127624.672	$2,530,498,470	38713.911	$685,772,007	154527.559	$3,913,211,423	575097.375	$11,766,531,034
			Std. Contingency (10% of all expect switches)				10%	$199,075,706		0.2664	$53,025,260.88	0.1757	$34,979,422.33	0.2219	$44,178,556.12	0.0673	$13,401,207.26	0.2687	$53,491,259.47	1.000	$199,075,706
			Switch Contingency (20% of switches)				20%	$6,400,000		0.20000	$1,280,000.00	0.20000	$1,280,000.00	0.20000	$1,280,000.00	0.20000	$1,280,000.00	0.20000	$1,280,000.00	1.000	$6,400,000
			Tunnel Contingency				30%	$2,923,132,192		0.243879112	$712,890,884.60	0.174445295	$509,926,656.28	0.300784239	$879,232,091.01	0.03251721	$95,052,117.95	0.248374139	$726,030,442.08	1.000	$2,923,132,192
			Emerency Tunnel Continency (15% of tunnels)				20%	$1,900,035,925		0.243879112	$463,379,074.99	0.174445295	$331,452,326.58	0.300784239	$571,500,859.16	0.03251721	$61,783,876.67	0.248374139	$471,919,787.36	1.000	$1,900,035,925
			Total					$16,795,174,856													
180			Stations					$ 110,000,000	0.3%											1	
	181		Civil Structures																		
			Station - Major	EA	$25,000,000	2		$ 50,000,000		1	$25,000,000	0	$0	0	$0	0	$0	1	$25,000,000	2	50,000,000
			Station - Mior	EA	$15,000,000	4		$ 60,000,000		0	$0	1	$15,000,000	1	$15,000,000	1	$15,000,000	1	$15,000,000	4	60,000,000
			Subtotal					$ 110,000,000													0
			Contingency				0%	$ -		0.266357266	$ -	0.175709146	$ -	0.22191837	$ -	0.06731714	$ -	0.268698077	$ -	1	0
			Total					$ 110,000,000													
190			Operations and Maintenance Facilities					$ 54,180,000	0.2%												
	191		Operations Control Center	EA	$250,000	1	0%	$ 250,000		0	$0	0	$0	0	$0	0	$0	1	$250,000	1	250,000
	192		Maintenance Facilities				0%	$ -													
		1821	Central Facility	EA	$16,000,000	1	0%	$ 16,000,000		0	$0	0	$0	0	$0	0	$0	1	$16,000,000	1	16,000,000
			Decentralized Facility	EA	$6,000,000	1	0%	$ 6,000,000		1	$6,000,000	0	$0	0	$0	0	$0	0	$0	1	6,000,000
		1822	Washing Equipment	EA	$2,600,000	2	0%	$ 5,200,000		1	$2,600,000	0	$0	0	$0	0	$0	1	$2,600,000	2	5,200,000
	193		Maintenance Vehicles				0%	$ -													
		1831	Road Vehicles	LS	$300,000	4	0%	$ 1,200,000		1	$300,000	0	$0	1	$300,000	1	$300,000	1	$300,000	4	1,200,000

HS Rail Alignment
Estimate of Costs

By: F. Sherkow 6/7/2013
Chk: J. Callicott 6/7/2013

Route: HS Rail

WBS Code				Description	Unit	Unit Cost	Quantity	Adjustment Increase %	Total Cost	Percent of Total
			1832	Guideway Bound Vehicles	LS	$1,800,000	1	0%	$ 1,800,000	
		194		Guideway and Equipment	EA	$8,000,000	1	0%	$ 8,000,000	
		195		Low Speed Switch	LS	$3,400,000	1	0%	$ 3,400,000	
		196		Transfer Table	LS	$7,400,000	1	0%	$ 7,400,000	
				Subtotal					*$ 49,250,000*	
				Contingency				*10%*	*$ 4,925,000*	
				Total					*$ 54,175,000*	
	195			**Construction Support**						
		191		Beam Fabrication Plant					**$ 50,000,000**	**0.2%**
				Subtotal					*$ 50,000,000*	
				Contingency				*0%*	*$ -*	
				Total					*$ 50,000,000*	
	195			**Right of Way and Corridor**						
		195		Right of Way					**$ 321,610,000**	**1.0%**
			195.1	Public Land	SF	$1	24,968,638		$24,968,638	
			195.2	Private Land	SF	$22	160,687,993		$160,687,993	
				Private Land - Below Ground	SF	$5	54,298,327		$54,298,327	
				Subtotal					*$ 268,005,695*	
				Contingency			*20%*		*$ 53,601,139*	
Subtotal Infrastructure Costs				*Total*					*$ 321,606,834*	
									$ 18,121,840,000	**55.9%**
				Cost per KM	***575097.375***		*175.3*		*$ 103,382,241*	
				Cost per Mile			*108.9*		*$ 166,373,041*	
200				Project Support Costs						
	210			**Professional Services**			1		**$ 4,711,680,000**	**14.5%**
		211		Design Engineering	%	10%			$ 1,812,184,000	
		212		Insurance and Bonding	%	2%			$ 362,436,800	
		213		Program Management	%	4%			$ 724,873,600	
		214		Construction Management & Inspection	%	6%			$ 1,087,310,400	
		215		Engineering Services During Construction	%	2%			$ 362,436,800	
		216		Integrated Testing and Commissioning	%	2%			$ 362,436,800	
				Subtotal					$ 4,711,678,400	
	220			**Utility Relocation**			1		**$ 1,630,970,000**	**5.0%**
		221		Through Urban areas	%	6%			$ 1,087,310,400	
		222		outside of Urban Areas	%	3%			$ 543,655,200	
				Subtotal					$ 1,630,965,600	
	230			**Environmental Mitigation**			1		**$ 453,050,000**	**1.4%**
		231		Noise Mtigation	%	1%			$ 181,218,400	
		232		Hazardous Waste	%	1%			$ 181,218,400	
		233		Erosion Control	%	0.5%			$ 90,609,200	
				Subtotal					$ 453,046,000	
Subtotal									**$ 6,795,700,000**	**21.0%**
300				Design and Construction Contingency (30% of Previous Total)	%	*30%*			**$ 7,475,260,000**	**23.1%**
Subtotal Planning and Engineering Costs									$ 18,121,840,000	
Subtotal Project Support Costs									$ 6,795,700,000	
Design and Construction Contingency									$ 7,475,260,000	
Grand Total									**$ 32,392,800,000**	**100.0%**
				Cost per KM			*175.3*		*$ 184,795,819*	
				Cost per Mile			*108.9*		*$ 297,391,912*	

	High Speed Rail											
	Segment 1		Segment 2		Segment 3		Segment 3b (Spur)		Segment 4		TOTAL	
Description	Eagle	Vail	Vail	Lake Hill	Lake Hill	Georgetown	Lake Hill	Breckenridge	Georgetown	Jeffco		
Guideway Bound Vehicles	0	$0	0	$0	0	$0	0	$0	1	$1,800,000	1	1,800,000
Guideway and Equipment	0	$0	0	$0	0	$0	0	$0	1	$8,000,000	1	8,000,000
Low Speed Switch	0	$0	0	$0	0	$0	0	$0	1	$3,400,000	1	3,400,000
Transfer Table	0	$0	0	$0	0	$0	0	$0	1	$7,400,000	1	7,400,000
Contingency (10%)	0.266357266	$ 1,311,809.54	0.175709146	$ 865,367.54	0.22191837	$ 1,092,947.97	0.06731714	$ 331,536.92	0.268698077	$ 1,323,338.03	1	4,925,000
Beam Fabrication Plant	0.266357266	$ 13,317,863.32	0.175709146	$ 8,785,457.31	0.22191837	$ 11,095,918.48	0.06731714	$ 3,365,857.02	0.268698077	$ 13,434,903.87	1	50,000,000
Public Land	6628923.563	$6,628,924	4372933.071	$4,372,933	5522957.677	$5,522,958	1756643.7	$1,756,644	6687180.118	$6,687,180	24968638.130	$24,968,638
Private Land	2205520.335	$48,521,447	1307303.15	$28,760,669	775430.6102	$17,059,473	816437.008	$17,961,614	2199308.563	$48,384,788	7303999.665	$160,687,993
Private Land - Below Ground	2654158.465	$13,270,792	1898503.937	$9,492,520	3273462.106	$16,367,311	330462.598	$1,652,313	2703078.248	$13,515,391	10859665.354	$54,298,327
Subtotal (Right of Way)	0.266357266	$ 71,385,264.34	0.175709146	$ 47,091,051.85	0.22191837	$ 59,475,386.91	0.06731714	$ 18,041,377.01	0.268698077	$ 72,012,615.00	1	268,005,695
Contingency (20%)	0.266357266	$ 14,277,052.87	0.175709146	$ 9,418,210.37	0.22191837	$ 11,895,077.38	0.06731714	$ 3,608,275.40	0.268698077	$ 14,402,523.00	1	53,601,139
Professional Services	0.266357266	$ 1,254,990,205.14	0.175709146	$ 827,885,269.69	0.22191837	$ 1,045,608,343.86	0.06731714	$ 317,176,824.10	0.268698077	$ 1,266,019,357.21	1	$ 4,711,680,000.15
Utility Relocation	0.266357266	$ 434,420,710.85	0.175709146	$ 286,576,346.08	0.22191837	$ 361,942,203.33	0.06731714	$ 109,792,236.49	0.268698077	$ 438,238,503.26	1	$ 1,630,970,000.05
Environmental Mitigation	0.266357266	$ 120,673,159.56	0.175709146	$ 79,605,028.66	0.22191837	$ 100,540,117.36	0.06731714	$ 30,498,030.46	0.268698077	$ 121,733,663.96	1	$ 453,050,000.01
Design and Construction Contingency (30% of Previous Total)	0.256512643	$ 1,917,498,703.35	0.156642772	$ 1,170,945,445.82	0.232735904	$ 1,739,761,390.46	0.05724988	$ 427,957,768.29	0.296858797	$ 2,219,096,692.07	1	$ 7,475,260,000.00