Capital Cost Technical Report

State Highway 82 / Entrance to Aspen Environmental Reevaluation

January 10, 2007

Colorado Department of Transportation, Region 3 and

Federal Highway Administration, Colorado Division

Prepared by:

HDR Engineering, Inc.

Contents

1.0	INTR	ODUCTION	1				
	1.1	Highway Cost Items	1				
	1.2	Light Rail Cost Items	4				
	1.3	Direct Cost Items	5				
2.0	Cos	Γ SUMMARY	6				
	2.1	Capital Cost	6				
	2.2	Operation and Maintenance Costs	7				
3.0	3.0 AGENCY COORDINATION						
4.0	LIST	OF PREPARERS	8				
APPE	NDIX A	: DETAILED CAPITAL COST ANALYSIS	9				
		Tables					
Table	2-1. Sui	mmary of Capital Cost Estimates	7				

1.0 Introduction

This technical report summarizes the review of the cost estimates and assumptions presented in the 1997 State Highway 82 Entrance to Aspen Final Environmental Impact Statement (FEIS) for the Preferred Alternative selected in the Record of Decision (ROD) issued in August 1998. No review of the quantities was conducted; it is assumed that all pertinent cost items were included as items in the original Capital Cost Analysis Technical Memorandum estimate.

1.1 Highway Cost Items

For the most part, the dollar amounts used for unit costs are based on Colorado Department of Transportation (CDOT) 2005 unit costs for construction. In most cases, an average unit or construction cost over the last five years was assumed. When possible these unit costs were compared to costs for recent construction in the Aspen area. Volume of work was also considered in developing the unit costs, as large volumes can result in a cost reduction. Assumptions associated with each item are shown below.

Site Preparation – \$5,000 per acre

 Calculated using an average of CDOT item 201, Clearing and Grubbing, over the 6-year period from 2000 through 2005.

Excavation – \$15 per cubic yard

 Calculated using an average of CDOT item 203, Unclassified Excavation, over the 6-year period from 2000 through 2005.

Embankment - \$0

 Normal construction practice is to pay for the larger of either excavation or embankment. For this case, excavation was used, thus no cost was calculated for embankment.

Aggregate Base Course (ABC) - \$25 per ton

 Calculations are based on the average cost of a 12-inch- thick Class 6 ABC over the 6year period from 2000 through 2005. This unit cost was also compared to recent unit costs for the Aspen Overlay Project.

Hot Bituminous Pavement (HBP) - \$75 per ton

The 1997 FEIS cost estimate assumed the use of Grade "E" HBP. Current practice is to use 3 inches of Grade "S" HBP with 2 inches of Grade "SX" HBP on top. Quantities were determined based on a ratio of 3/5 for Grade S and 2/5 for Grade SX. Costs for both were based on 2005 cost data from CDOT, Denver International Airport (DIA), the Aspen Overlay Project, and the Snowmass Canyon Project. Costs were inflated by 10% to account for the recent increase in the cost of oil.

Guardrail Type 3 – \$16 per linear foot

o Calculations are based on the average cost over the 4year period from 2002 through 2005.

Retaining Wall – \$75 per square foot

O This unit cost was calculated based on costs of recent projects in the Roaring Fork Valley such as Aspen Overlay, Maroon Creek Bridge, and Snowmass Canyon. Because the City of Aspen is likely to require high-end architectural treatments, a cost of \$75 per square foot was assumed.

Structure Excavation – \$25 per cubic yard

O This unit cost was calculated based on the average CDOT structure excavation cost over the past 4 years and compared to recent cost data from Forest Service projects. This cost was also compared against the bid tabs from the recent Maroon Creek Bridge project and other CDOT projects in the Roaring Fork Valley.

Structure Backfill - \$30 per cubic yard

This unit cost was calculated based on the average CDOT structure backfill cost over the past 4
years and compared against the bid tabs from the recent Maroon Creek Bridge project

Tunnel Structure - \$10,000 per linear foot

The 1997 FEIS cost estimate assumed \$70 per square foot. Because this is not an industry standard for estimating cut and cover tunnel costs, this estimate was calculated using linear foot costs for a given width. A cut and cover tunnel structure estimated at 400 feet long and 68.5 feet wide was estimated to cost about \$145 per square foot.. It is recommended that this cost be further evaluated based on material costs for a cut and cover tunnel.

Drainage – \$80 per linear foot

No assumptions were included as to the derivation of the 1996 value for the FEIS. This updated estimate assumes an 18-inch reinforced concrete pipe, complete in place (includes all backfill, etc.). The unit cost was calculated using the average CDOT drainage cost for recent and underconstruction projects in the Roaring Fork Valley.

Bridges

Maroon Creek Bridge – \$305 per square foot (2005 selected bid for bridge infrastructure only)

o This structure is currently under construction and is scheduled for completion by spring of 2008. The 1997 estimated cost to construct the Maroon Creek Bridge was based on a design area of 35,360 square feet priced at \$155 per square foot or \$5,500,000. The 2005 selected construction bid was based on a design area of 45,260 square feet priced at \$305 per square foot or \$13,800,000, for bridge infrastructure only. Total constructed cost, including ancillary work such as tie-ins and utility relocations, is currently estimated at

\$17,900,000. This total constructed cost estimate is the figure used in the updated cost estimate (see Table 2-1 and Appendix A).

Castle Creek Bridge - \$250 per square foot

The estimated unit cost for construction of the Castle Creek Bridge, based on the 2005 selected bid for Maroon Creek Bridge minus the costs for demolition of the existing pedestrian bridge, was \$294 per square foot. This estimate was further reduced based on the assumptions that the Castle Creek Bridge is smaller in square footage and would not require supporting piers and would likely require much less aesthetic detailing.

Seeding and Landscaping - \$3000 per acre

The average cost for landscaping of the Maroon Creek Bridge project was estimated to be \$2700 per acre. This did not include any trees. To provide for a few trees the value was increased to \$3000 per acre.

Signing and Striping - \$20 per linear foot

 Two recent CDOT projects (2006 State Highway 13 and 2005 Maroon Creek Bridge) were reviewed to calculate this average cost for signing and striping per linear foot.

Curb and Gutter - \$20 per linear foot

This unit cost was based on the average CDOT curb and gutter cost from 2001 to 2005, and 2005 data from DIA.

Trail Relocations – Lump Sum of \$70,000

o No information was available regarding the assumptions about the cost of trail relocations in the 1997 FEIS. The 1996 cost estimate was \$35,000 for a trail width of 10 feet. Assuming this value was accurate for 1996, an average yearly increase of 3% over 10 years was used.

Retrofit existing Maroon Creek Bridge for Light Rail Transit (LRT) – Lump Sum of \$2,000,000

The existing bridge, constructed in 1927 and widened in 1979, is a 20-span riveted plate girder bridge, 651 feet long and 30 feet wide (19,530 square feet). This structure was designed to carry freight rail traffic, thus the structure should be capable of carrying LRT loads. Because the original bridge was constructed in 1927, retrofitting the structure may require a secondary support system. With no structure conditional data available, the cost to retrofit can be compared to the cost for a new 650-foot, long, 30-foot wide bridge at \$100 per square foot (or \$100 x 19,530 = \$1,953,000.)

New Signals with LRT Pre-empt - \$290,000 Each

New signals with LRT Pre-empt would be required at the relocated Owl Creek Road/State Highway 82 intersection, 7th Street, 5th Street, 3rd Street, and Garmisch Street. The configuration of each intersection was compared to those from the 2005 Central Phoenix/East Valley Light Rail (CP/EV LRT) system. The Owl Creek Road intersection was estimated at \$613,000 based on the

intricacies of its geometry. 7th Street is less complex but requires taking into account a skewed track alignment that crosses the major through-way, thus it is estimated at \$352,000. 5th Street, 3rd Street, and Garmisch Street will be simpler as the geometry of the intersections has the LRT running down the center of the main through-ways. Total for each of these three intersections is estimated at \$160,000. Thus the average cost for each is \$290,000. All this assumes low-end communication control such as visual and radio, not the high-end supervisory control and data acquisition (SCADA) system.

LRT Crossing Gates - \$250,000 per set of gates

This estimate is based on recent Regional Transportation District (RTD) T-REX costs.

Install LRT Pre-empt on Existing Signals - \$100,000

This estimate is based on recent RTD T-REX and CP/EV LRT costs.

1.2 Light Rail Cost Items

For the most part, the dollar amounts used for the unit costs are based on RTD (T-REX) 2005 unit costs for construction. Where possible, these unit costs were compared to costs for other recent light rail projects throughout the United States. Assumptions associated with each item are presented below.

Ballast, Tie and Rail - \$300 per track foot

The 1997 Capital Cost Analysis technical memorandum noted that utility relocation was included in this item for a total unit cost of \$250 per track foot. This updated estimate is based on current RTD costs for ballast, tie and rail that does not include utility relocates. A lump sum cost of \$1,000,000 was added to account for utility relocates. The 1997 technical memorandum did not indicate that Rail was included in this total but based on the cost used in 1997, it is reasonable to assume that it is included.

Embedded Track - \$570 per track foot

 This estimate is based on current RTD costs for embedded track. Again, utility relocation was broken out from this item and estimated at \$1,000,000 total.

Special Track Work - \$160,000 each

This unit cost pertains to the cost of turn-outs at the switch points. The average RTD cost for turn-outs in 2005 dollars is approximately \$60,000. The total unit cost is based on the cost for each turn-out plus approximately \$100,000 to account for switches and labor.

Maintenance Facility - \$500 per square foot

 This unit cost is based on RTD T-REX costs of \$480 per square foot which includes site work, track and electrification facilities. It does not include traction power substations.

Electrification - \$1,500,000 per Track Mile

o This cost is taken directly from recent RTD T-REX data.

LRT Control Systems - \$1,200,000 per Track Mile

o This cost is taken directly from recent RTD T-REX data.

LRT Truing Lathe - \$1,300,000 each

This cost is taken directly from recent RTD T-REX data.

Ticket Vending Machines (TVM) - Lump Sum of \$1,200,000

ORTD T-REX cost per TVM is \$70,000 (includes engineering, installation and software development – does not include weather shelters for customers). Usually 2 to 3 TVMs are required per station. For five of the seven stations it was assumed that 2 TVMs will suffice, while the end stations will require 3 TVMs each, for a total of 16 TVMs. Lump sum cost is calculated for 16 TVMs at \$70,000 each, and rounded up.

Right-of-way (ROW) Acquisition – a per acre cost of \$650,000 for developable and \$32,500 for non-developable

o For the ROW associated with the highway widening, it is assumed that the majority of this land is outside of downtown and would only increase in value at approximately 30% over the ten years since the original cost estimate. For the ROW associated with the LRT, the majority of this land is in the higher cost downtown area, thus the developable land is assumed to have increased by 60% over the last ten years. For both the highway and LRT, undevelopable land was assumed to have increased by 30%. The values should be verified by recent CDOT ROW costs.

1.3 Direct Cost Items

Parking Structures – Lump Sum of \$83,300,000

The 1997 FEIS parking structures estimate assumed 3,600 spaces would be required at the airport station and 750 spaces would be required at the Buttermilk Station. Recent RTD costs are \$13,000 per space for a station location similar to Buttermilk in terms of land availability and construction impacts. Recent DIA costs are \$26,000 per space for expansions to existing parking with relatively high impacts to existing traffic. Thus \$15,000 per space was estimated for Buttermilk and \$20,000 per space for the airport.

Transit Stations - \$1,000,000 per station

One station will be required at each of the following locations: Airport Terminal, Buttermilk Ski Area, Moore Property, 7th Street, 3rd Street, Monarch Street, and Rubey Park. This cost is taken directly from recent RTD T-REX data.

Transit Vehicles - \$ 3,200,000 per vehicle

As stated in the 1997 FEIS, the LRT system will require nine light rail vehicles (LRV), and would consist of four trains of two vehicles used in the following manner: 2 trains in operation, 1 spare and 1 in maintenance. The ninth vehicle serves as additional backup. The train type should be similar to those used in neighboring locations to help in getting parts when needed. This cost estimate is taken directly from recent RTD T-REX data.

2.0 Cost Summary

2.1 Capital Cost

The capital cost comparison presented in Table 2-1 below shows that the overall project cost has increased 84.4% since publication of the 1997 FEIS. The total capital cost of the 1997 ROD Preferred Alternative was \$155.5 million. Since that time, the total cost has risen to \$286.8 million. For a more detailed breakdown of costs, see Appendix A of this report.

Table 2-1
Summary of Capital Cost Estimates

Cost Item	FEIS Capital Cost Estimate (\$ Million)	Reevaluation Capital Cost Estimate (\$ Million)	Cost Differential (%)
			1997 to Current
Design and Construction Costs – SH82 and LRT System			
-Highway -LRT	\$ 24.8 \$ 40.5	\$ 74.4 \$88.3	200.0 % 118.0 %
Subtotal	\$ 65.3	\$162.7	149.1 %
LRT Stations	\$ 2.2	\$ 7.0	218.2 %
Right-of-Way			
-Highway/LRT	\$ 2.6	\$ 3.3	26.9 %
-LRT Stations	\$ 3.0	\$ 4.9	63.3 %
Subtotal	\$ 5.6	\$ 8.2	46.4 %
Multimodal Facilities			
-Airport -Buttermilk	\$ 60.0 \$ 8.5	\$ 72.0 \$ 11.3	20.0 % 32.9 %
Subtotal	\$ 68.5	\$ 83.3	21.6 %
LRT Vehicles	\$ 13.9	\$ 25.6	84.2 %
TOTAL	\$ 155.5	\$ 286.8	84.4 %
Projects Completed or In Construction			
-Realigned Owl Ck. Road	\$3.3	\$7.6	130.3%
-Maroon Creek Bridge	\$5.5	\$17.9	
-Maroon Ck. Roundabout		\$6.3	225.4%
TOTAL		\$31.8	
COST REMAINING		\$255.0	

The total estimated cost for completing the interim bus-lane phase of the ROD Preferred Alternative is \$30.9 million (2005 dollars), including highway design, construction and right-of-way, but not including any required parking additions in the study area. (See Appendix A for highway design, construction and right-of-way cost details. The total amount is approximately \$77.7 million, less the \$31.8 million already spent or funded, as shown in Table 2-1 above).

2.2 Operation and Maintenance Costs

The operations and maintenance cost estimate for the 1997 FEIS and this Reevaluation are compared in Table 2-2. The Reevaluation estimate is based on the most recent (2006) cost data available from Houston METRORail (Slaughter, personal communication 2006).

The Reevaluation cost estimate is based on the transit (headway) scenarios used in the 1997 FEIS: (1)15-minute service during peak (high volume) periods, and 30-minute base service, and (2) 10-minute service during peak periods and 20-minute base service.

Table 2-2
Comparison of Annual Operation and Maintenance Costs for the Preferred Alternative (\$Million)

	1997	FEIS	2006 Reevaluation		
O&M Cost Item	15-minute Peak/ 30-minute Base	10-minute Peak/ 20-minute Base	15-minute Peak/ 30-minute Base	10-minute Peak/ 20-minute Base	
Total	\$ 1.65	\$ 2.27	\$ 4.17	\$ 4.59	

3.0 Agency Coordination

Highway cost items were reviewed by CDOT, Region 3 and revised based on costs of recent projects in the Roaring Fork Valley such as the Aspen Overlay Project, Maroon Creek Bridge Project, and the Snowmass Canyon Project.

4.0 List of Preparers

Jane Donovan, P.E., Bridge Engineer, HDR Engineering, Inc.

5.0 References

Slaughter, Kimberly, 2006. Kimberly Slaughter, Transportation Engineer, HDR Engineering, Inc. Personal communication, operational and maintenance capital costs discussion with Jane Donovan, December 28, 2006.

Appendix A: Detailed Capital Cost Analysis

STATE HIGHWAY 82 ENTRANCE TO ASPEN CONCEPTUAL COST ESTIMATE							
ITEM DESCRIPTION	APPROX QUANT	UNIT	UNIT COST (1996)	UNIT COST (2005)	TOTAL COST (1996)	TOTAL COST (2005)	
Highway Cost Items							
Site Preparation (Clearing and Grubbing)	22	ACRE	\$900.00	\$5,000.00	\$20,000	\$110,000	
Excavation	86095	CY	\$7.00	\$15.00	\$603,000	\$1,291,000	
Embankment Material (Information Only)	45380	CY					
Aggregate Base Course (Class 6)	51756	TON	\$10.00	\$25.00	\$518,000	\$1,294,000	
Hot Bituminous Pavement	21560	TON	\$39.00	\$75.00	\$841,000	\$1,617,000	
Guard Rail (Type 3)	5570	LF	\$16.00	\$16.00	\$90,000	\$90,000	
Guard Rail (Type 4)		LF					
Retaining Wall	4000	SF	\$40.00	\$75.00	\$160,000	\$300,000	
Structural Excavation	43860	CY	\$7.00	\$25.00	\$307,000	\$1,097,000	
Structural Backfill (Class 1)	25400	CY	\$18.00	\$30.00	\$457,000	\$762,000	
Tunnel Structure	27400	SF	\$70.00	\$145.00	\$1,918,000	\$3,973,000	
Drainage	11200	LF	\$30.00	\$80.00	\$336,000	\$896,000	
Maroon Creek Bridge	35360	SF	\$155.00	*	\$5,481,000	\$17,900,000	
Castle Creek Bridge	33125	SF	\$135.00	\$250.00	\$4,472,000	\$8,281,000	
Seeding (landscaping)	11	ACRE	\$1,000.00	\$3,000.00	\$11,000	\$33,000	
Signing & Striping	16000	LF	\$10.00	\$20.00	\$160,000	\$320,000	
Curb and Gutter Type 2 II-B and I-B	43250	LF	\$9.00	\$20.00	\$390,000	\$870,000	
Trail Relocations	1	LS	\$35,000.00	\$70,000.00	\$35,000	\$70,000	
OVERALL HIGHWAY SUBTOTAL					\$15,800,000	\$38,904,000	
TRAFFIC CONTROL (FOR CONSTRUCTION) 4% MOBILIZATION 8% SUBTOTAL					\$632,000 \$790,000 \$17,222,000	\$1,556,000 \$3,112,000 \$43,572,000	
LEVEL OF DESIGN CONTINGINCIES 20% (1996), 30 CONSTRUCTION SUBTOTAL	% (2005)				\$3,444,000 \$20,666,000	\$13,072,000 \$56,644,000	
DESIGN ENGINEERING 10% CONSTRUCTION MGMNT 21.3%				_	\$2,067,000 \$2,067,000	\$5,664,000 \$12,065,000	
HIGHWAY DESIGN & CONSTRUCTION TOTAL				•	\$24,800,000	\$74,373,000	

^{*}Total constructed cost, based on 2005-6 estimate (see text).

STATE HIGHWAY 82 ENTRANCE TO ASPEN CONCEPTUAL COST ESTIMATE							
ITEM DESCRIPTION	APPROX QUANT	UNIT	UNIT COST (1996)	UNIT COST (2005)	TOTAL COST (1996)	TOTAL COST (2005)	
LRT Cost Items							
Light Rail - Tie, Ballast and Rail	28850	TF	\$250.00	\$300.00	\$7,213,000	\$8,655,000	
Utility Relocation	1	LS	\$0.00	\$1,000,000.00	\$0	\$1,000,000	
Light Rail - Embedded Track	7850	TF	\$550.00	\$570.00	\$4,318,000	\$4,474,500	
Utility Relocation	1	LS	\$0.00	\$1,000,000.00	\$0	\$1,000,000	
Special Track Work (switches)	9	EA	\$120,000.00	\$160,000.00	\$1,080,000	\$1,440,000	
Maintenance Facility	25000	SF	\$146.00	\$500.00	\$3,650,000	\$12,500,000	
Electrification	6.95	TM	\$834,244.00	\$1,500,000.00	\$5,798,000	\$10,425,000	
LRT Control Systems	6.95	TM	\$292,266.00	\$1,200,000.00	\$2,031,000	\$8,340,000	
LRT Wheel Truning Lathe	1	EA	\$980,714.00	\$1,300,000.00	\$981,000	\$1,300,000	
Retrofit Maroon Creek for LRT	1	LS	\$1,500,000.00	\$2,000,000.00	\$1,500,000	\$2,000,000	
Traffic Control - New Signals w/ LRT Pre-empts	5	EA	\$125,000.00	\$290,000.00		\$1,450,000	
Traffic Control - LRT Crossing Gates	8	EA	\$200,000.00	\$250,000.00		\$2,000,000	
Traffic Control - Install LRT Pre-empt for ex. Signals	3	EA	\$25,000.00	\$100,000.00		\$300,000	
Miscellaneous LRT Items	1	EA	\$148,000.00	\$192,400.00		\$192,400	
Ticket Vending Machines	1	LS	\$501,000.00	\$1,200,000.00	\$501,000	\$1,200,000	
•			φουτ,σοσ.σο	ψ1,200,000.00			
OVERALL LRT SUBTOTAL					\$29,520,000	\$56,277,000	
TRAFFIC CONTROL (FOR CONSTRUCTION) 4% MOBILIZATION 5%					\$1,181,000 \$1,476,000	\$2,251,000 \$2,814,000	
SUBTOTAL					\$32,177,000	\$61,342,000	
ALLOWANCE FOR UNLISTED ITEMS 5%					\$1,608,850	N/A	
LEVEL OF DECICAL CONTINCINCIES 6224					NI/A	#10.000.000	
LEVEL OF DESIGN CONTINGINCIES 20% CONSTRUCTION SUBTOTAL					N/A \$33,785,850	\$12,268,000 \$73,610,000	
DESIGN ENGINEERING 10% CONSTRUCTION MGMNT 10%					\$3,379,000 \$3,379,000	\$7,361,000 \$7,361,000	
LRT DESIGN & CONSTRUCTION TOTAL					\$40,544,000	\$88,332,000	

	APPROX		UNIT COST	UNIT COST	TOTAL COST	TOTAL COST
ITEM DESCRIPTION	QUANT	UNIT	(1996)	(2005)	(1996)	(2005)
Direct Cost Items						
Highway ROW Acquisition - Developable	4.7	ACRE	\$500,000.00	\$650,000.00	\$2,350,000	\$3,055,000
Highway ROW Acquisition - Non-Developable	8.4	ACRE	\$25,000.00	\$32,500.00	\$210,000	\$273,000
LRT Station ROW Acquisition - Developable	6	ACRE	\$500,000.00	\$800,000.00	\$3,000,000	\$4,800,000
LRT Station ROW Acquisition - Non-Developable	1.7	ACRE	\$25,000.00	\$32,500.00	\$43,000	\$55,000
Transit Stations	1	LS	\$2,200,000.00	\$7,000,000.00	\$2,200,000	\$7,000,000
Parking	1	LS	\$68,500,000.00	\$83,250,000.00	\$68,500,000	\$83,250,000
Transit Vehicles	8	EA	\$1,735,500.00	\$3,200,000.00	\$13,884,000	\$25,600,000
DIRECT COST TOTAL					\$90,187,000	\$124,033,000
HIGHWAY TOTAL					\$24,800,000	\$74,373,000
LRT TOTAL					\$40,544,000	\$88,332,000
GRAND TOTAL FOR PROJECT						