

Portland Aerial Tram

Value Engineering and Cost Reduction Measures

Over the course of the design process, each estimating milestone brought a redesign value engineering effort as an attempt to reduce civil construction costs. Because the design and estimation process was focused primarily on the civil construction portion of the project, most of the design revisions and cost reduction measures were undertaken by the architectural design team. Cost reduction measures and opportunities are outlined below, along with the actions taken by the team to address or incorporate these measures into the project.

Civil Construction

Cost reduction alternatives were sought at each estimating stage of the design process, beginning with the conceptual cost model that was generated at approximately the 50% Schematic Design milestone in November 2003. Specific cost reduction measures are described in greater detail below and, where possible, the estimated dollar savings are provided based on Davis Langdon Adamson cost estimate information.

Conceptual Cost Model – 11/7/03 – Original Civil Estimate \$18,673,000
Cost Reduction Measures:

Upper Station

Modify Upper Station Structural Legs – Wood to Steel \$(2,374,000)

Conceptual Cost Phase - Total Cost Reduction **\$(2,374,000)**

Conceptual Cost Phase – Revised Project Estimate \$16,299,000

100% Schematic Design Cost Model – 2/6/04 - Original Civil Estimate \$18,627,000
Cost Reduction Measures:

Upper Station

Delete Elevator/Elevator Shaft* \$(1,482,000)

100% Schematic Design Cost Phase - Total Cost Reduction **\$(1,482,000)**

*The PATI Board did not delete the elevator and directed the design team to incorporate the elevator in the Design Development phase.

Conceptual Cost Phase – Revised Project Estimate (no change) \$18,627,000

Portland Aerial Tram

100% Design Development Cost Model – 6/22/04 – Original Civil Estimate \$20,301,000

Cost Reduction Measures:

Upper Station

Revise cladding to extruded aluminum	\$(505,927)
Delete Roof Waterproofing over platform area	\$(128,628)
Substitute underfloor heating	\$(4,906)
Upper Station Subtotal	\$(639,461)

Lower Station

Modify bike parking canopy/streetcar shelter	\$(318,168)
Delete Service Ramp/Add basement hatch	\$(585,666)
Modify Stormwater Basin	\$(133,638)
Simplify/Reduce canopy design	\$(82,493)
Delete Roof Waterproofing on canopy	\$(75,814)
Revise Cladding to extruded aluminum	\$(309,772)
Delete Infrared heaters	\$(10,153)
Lower Station Subtotal	\$(1,515,705)

100% Schematic Design Cost Phase - Total Cost Reduction **\$(2,155,166)**

Conceptual Cost Phase – Revised Project Estimate \$18,145,834

50% Construction Documents Cost Model – 10/15/04 – Original Civil Estimate \$20,697,000

Cost Reduction Measures (costs included in updated VE estimate, 11/11/04):

Upper Station

Modify Stair/Elevator Core – steel to concrete
Delete/Phase elevator mechanical equipment
Delete CCTV system
Intermediate Tower
Modify structure – steel plate to concrete reinforced steel

Lower Station

Simplify/Reduce canopy design
Reduce basement size/relocate bollards
Delete CCTV system

50% Construction Documents – Total Cost Reduction **\$(3,272,000)**

50% Construction Documents – Revised Civil Project Estimate \$17,425,000

Constructability/Technical Review Cost Savings

In addition to the cost reductions identified above, the design team has also worked to refine project designs to increase efficiency, decrease construction costs through the implementation of constructability concepts, and accommodate technical requirements related to the tramway. This work was not necessarily seen in the cost reduction numbers seen above, as it was part of the design process during each design phase. However, some examples of the design evolution, and the cost impacts, are shown below:

Portland Aerial Tram

Schematic Design Phase

- Revise Lower Station Canopy – eliminate concrete/grass cover, substitute light structural canopy over lower station, open up tram “forecourt” as a stormwater basin – *Cost Savings: \$687,000*

Design Development Phase

- Intermediate Tower – revise “chopsticks” design (6 rolled steel tube legs) to single plate steel pylon – *Cost Savings: \$430,000* (Ultimate cost savings, incorporating later revisions and conversion to concrete: \$1,299,000)

Constructability

- Upper Station – Revise 2” thick rolled steel tube legs (single source) to fabricated steel plate legs
- Upper Station – Eliminate pre-cambering of structural legs to reduce constructability issues and costs (e.g., contractor engineering costs)
- Steel component packaging – maximize off-site fabrication for custom plate steel components
- Material Palette – Simplification of number of materials/trades required for construction

Summary: Cost Savings Resulting from Value Engineering

The following chart is intended to provide a snapshot of the major cost reduction measures that were sought throughout the civil design process. It should be stated that cost control was a strong, if not primary, ethic of the project team, and that it would be impossible to quantify all of the actions that resulted in cost savings.

<u>Cost Savings Resulting from Design Value Engineering</u>	<u>Savings</u>
Conceptual Cost Model 11/03	\$(2,374,000)
Schematic Design Cost Model 2/04	\$0
Design Development Cost Model 6/04	\$(2,155,000)
Construction Documents Cost Model 10/04	\$(3,272,000)
Lower Station – Revise Canopy Height	\$(687,000)
Tower – Revise Design	\$(429,000)
Total	\$(8,917,000)

In aggregate, the six items listed on this chart have resulted in savings of approximately \$8,917,000 on the civil side of the project. Accounting for the fact that the PATI Board chose to keep the Upper Station elevator in the project scope at the end of Schematic Design, the total cost savings could have been increased by \$1,482,000 to \$10,399,000.

<u>Construction Phase Cost Reduction Measures (In Process - As of 1/7/06)</u>	
Lower Station Construction Shoring (Zidell easement and tiebacks)	\$(230,000)
Removal of Lower Station Canopy	\$(475,389)
Total	\$(705,389)
Total Estimated Cost Savings	\$(9,622,389)