



Bored Tunnel Alternative Facility Operations and Maintenance Cost Estimate

Submitted to:

Washington State Department of Transportation
Urban Corridors Office
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The Alaskan Way Viaduct & Seawall Replacement Program

Bored Tunnel Alternative Facility Operations and Maintenance Cost Estimate

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Task CL.14

The Alaskan Way Viaduct & Seawall Replacement Program is a joint effort between the Federal Highway Administration (FHWA), the Washington State Department of Transportation (WSDOT), and the City of Seattle. To conduct this project, WSDOT contracted with:

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Bored Tunnel Alternative Facility Operations and Maintenance Cost Estimate

1.0 Executive Summary

This cost estimate is prepared in support of the toll feasibility study in order to estimate the annual labor, material, equipment and other costs for Operations & Maintenance (O&M) of the proposed SR 99 Bored Tunnel Project as well as to estimate the repair and replacement (R&R) costs for capital components of the 100-year life Alaskan Way Viaduct Bored Tunnel Project.

For the SR 99 Bored Tunnel Project, the scope of this work includes approximately 9,200 linear feet of a single bored tunnel with two SB lanes stacked above two NB lanes plus about 1,800 linear feet of portal roads connecting to surface streets and SR 99. The tunnel project scope includes about 8.3 Lane Miles (LAMI) of roadway comprised of about 7.0 LAMI of Bored Tunnel and about 1.3 LAMI of retained cut roadway from the South Royal Brougham Way on and off ramps at the south to the Mercer Street entrance and the Republican Way on and off ramps at the north. Additionally the tunnel includes portal maintenance and control buildings at both the south and north ends of the tunnel with about 90,000 square feet of combined floor area plus parking and loading dock areas. The Tunnel operations and maintenance functions (located in offices/shops of the new control buildings) will be centrally controlled or “commanded” from the newly proposed central traffic control center adjacent to the WSDOT NW Regional Office in Shoreline, Washington via a fiber optics network that will connect to the existing I-90 fiber optics network.

Exclusions from the O&M and R&R estimates are future toll collection related costs of any kind.

The above quantities are based on the July 10, 2009 Conceptual Design Documents for the SR 99 Bored Tunnel Alternative.

The O&M cost data is based on WSDOT tunnel costs experienced on the I-90 project, PB’s O&M estimate performed for the proposed Port of Miami Bored Tunnel and previous O&M estimates prepared for the AWV Program (see references). At grade roadways and bridges beyond the above limits are excluded from the O&M program.

The Tunnel Concept of Operations and O&M plan remain are evolving and will need to be completed and approved before a final estimate can be completed.

The annual operations and maintenance cost is estimated at \$4.5 Million to \$6 Million (use \$5,381,000 in 2009 dollars as detailed in Appendix A) depending on the ability of WSDOT to integrate the SR 99 tunnel related O&M work activities into the NW Region Maintenance schedule. O&M and R&R work activities will commence following project completion in 2015. Costs to construct and commission the highway to facilitate O&M are included in the Tunnel Construction (CN) cost. The estimated cost to build up initial inventory of equipment/vehicles and office furniture, fixtures and equipment/appurtenances is \$1.3 M and \$1.8 M respectively.

The useful life of the SR 99 tunnel is estimated at 100 years. Asset management costs involving the repair and replacement of tunnel and highway elements will expand over the lifetime of the tunnel. The project asset R&R annualized average cost (as detailed in Appendix B) for the tunnel, buildings and equipment is estimated at an additional:

\$1,900,000 over the initial 30 years of operation

\$3,100,000 over the initial 33 years of operation

This significant increase is driven by the large value of assets that have been assigned a 33 year useful life that will include repair or replacement at the end of the initial year 33 life-cycle.

The tunnel, buildings and equipment asset R&R annualized average cost over the entire 100 years of tunnel operation is estimated at an additional \$3 Million to \$4 Million (use \$3,600,000 in 2009 dollars as detailed in Appendix B) dependent on the actual vs. anticipated deterioration schedules as well as the preservation program implemented by WSDOT.

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2.0 Tunnel Operations and Maintenance (O&M) Estimate

2.1 Estimate Reference Projects

These estimates are built up from unit prices for labor, material and equipment derived from a recent study of the proposed Port of Miami Bored Tunnels as well as a review of WSDOT cost data on the I-90 tunnels. The cost estimate and historical cost data were reviewed and refined to reflect current conditions and then adapted to the Alaskan Way Viaduct and Seawall Replacement Bored Tunnel Project scope and quantities. These estimates were developed using third quarter 2009 dollars.

2.2 Estimate Methodology

The workforce determination as detailed in Appendix 1 is based on a review of current staffing levels that WSDOT has for the I-90 Mt. Baker and Mercer Island Tunnels and adjusted to meet the requirements of the AWV Tunnel Project. We have talked to WSDOT staff and managers for these tunnels and obtained their staffing levels and discussed with them projected needs for the AWV tunnels based on their experience. An integrated approach was used to develop the staffing requirements in which all facilities would be monitored by the same personnel. This approach streamlines the procedures and minimizes staffing redundancy. It is also assumed that the existing I-90 Tunnels have the potential to share resources with the AWV Tunnel to further reduce O&M costs. The Full Time Equivalent (FTE) employees' breakdown is as follows:

- Administration – made up of 2.3 FTE's including Tunnel O&M oversight shared management, one Tunnel Facility Manager and one administrator to direct office support/clerical staff. Their primary function is to insure continuous, safe operation of the tunnel and maintenance of the various tunnel systems for bored tunnel and portal buildings.
- Incident Response Workers – are field personnel who respond to roadway emergencies and are critical to the incident response emergency management plan and fire/life safety plan for tunnel and project-wide safety. The estimate includes incident response vehicles at both ends of the tunnels. The Tunnel estimate includes 3 FTE's. This translates to 2 people on duty during peak periods (on duty 8 hours a day on weekday and weekends). The primary function is to monitor the condition of the AWV corridor and implement responses to incidents in accordance with a defined procedure. Private wreckers and towing services are on-call to clear the tunnel in the event of accidents involving disabled vehicles and are not part of the O&M costs consistent with the current WSDOT program. Costs for State highway or City of Seattle emergency responders are also excluded.
- Maintenance – The maintenance crew is divided by job function and deployed project-wide. The maintenance staff consists of 20 FTE's including one overall program supervisor, 4 journeyman level skilled

supervisors, 10 tradesmen and 4 general laborers/office support/caretakers and an IT computer technician. Maintenance trades include plumbers, millwrights, electricians, and general laborers/roadway workers. Their primary responsibility is maintenance of the various systems associated with the operation of the tunnel and the roadway prism. Additionally, the general laborers assist in the setup and removal of temporary traffic control required in the case of incidents or planned tunnel maintenance.

- Operations – Staff consists of 6 FTE's including one tunnel operator continuously on duty 24/7 and a supervisor during the week day shifts only. The control center is to be located in the proposed WSDOT central command center in Shoreline, WA that will monitor all regional WSDOT projects including the I-90 and AWV Tunnels. Local controls will allow the on-site maintenance personnel to monitor the tunnel systems status from both portal buildings. Operation's primary responsibility is to monitor the various systems related to the operation of the tunnels and roadway prism, to acknowledge alarms or incidents detected or reported and to implement appropriate responses.

2.2.1 Staff Labor Rates and Full Time Equivalent (FTE)

Labor hours and rates used in Appendix 1 are salaried or craft hourly wage rates based on fully burdened wages including benefits that were provided by WSDOT's Maintenance Group as well as a review of the previous AWV Tunnel and Elevated O&M Cost Study dated August, 2007 for staffing projections and updating for the current tunnel conceptual design. A FTE breakdown is as follows: WSDOT typically uses 1,800 hr/yr after factoring for time off, holidays, etc for FTE's. Additionally we can deduct 80 hr/yr for meetings, training, etc and use 1,720 hr/yr. Since WSDOT pays employees for 2,080 hrs/year this rate was used to develop the base wage rate. For non-salaried hourly workers a 15% cost factor has been applied to cover anticipated overtime requirements.

2.2.2 Vendor Representatives and Inspection Services

The requirements for outside vendor representative services will depend on the WSDOT plan as to what specialty systems and equipment will be able to be self-maintained vs. contracted through outside vendors in order to preserve the warranty and to repair complex mechanical and electrical systems. Furthermore, WSDOT will implement a tunnel inspection program that will periodically call in professional engineers, either WSDOT employed or independently contracted, to assess the condition of the tunnel and portal building structures and architectural finishes, as well as the tunnel mechanical/electrical/plumbing (MEP) systems. At this early stage of design the cost estimate for the vendor representatives as included in Appendix 1 are considered an allowance based on the Port of Miami estimate with adjustments for the added portal buildings and escalation/location adjustments. As an operations & maintenance plan is developed and the design is better defined the vendor representative and inspection costs will be estimated in more detail reflecting

actual requirements. Tunnel structural, mechanical and electrical inspection estimates were based on WSDOT Bridge Preservation Group's estimate plus 20% added for miscellaneous un-scheduled inspections.

2.2.3 Major Support Equipment and Vehicles

The major support equipment and vehicles estimate included in Appendix 1 was developed based on the previous AWW Comparative Tunnel Maintenance and Operations TS&L Report dated February 2007 and adjusted to add four electric carts for maintenance due to the length of the tunnels. Unit costs used were based on WSDOT's transportation equipment fund (TEF) inventory capital cost and expected life schedules. Allowances were added for small equipment and incidentals. As an Operations & Maintenance Plan is developed and the design is better defined equipment and vehicle costs will be estimated in detail reflecting actual requirements.

2.2.4 Other costs: Utilities, Lamps, Maintenance, Consumables, Supplies

The remainder of the other costs included in Appendix 1 were developed parametrically at this early stage of design. Utility charges for electrical power, communications, water and sewer were reviewed for the I-90 tunnels and the electrical power estimate was increased by a factor of 2 for anticipated increased tunnel ventilation and lighting demands for the longer continuous tunnels as well as for the portal building areas. Loads are currently under development by the design team. Re-lamping of lighting fixtures in the tunnel and portal buildings is estimated based on replacing one lamp per light fixture every two years (on average). Maintenance agreements for items such as buildings janitorial services, yard landscaping, computer equipment and other miscellaneous tasks are included as a monthly allowance. Consumable materials, supplies and small tools including personnel protection equipment (PPE) used as part of maintenance are estimated based on \$6/maintenance labor hour. Office supplies and furniture, fixtures and equipment (FFE) required for operations are estimated based on \$15/operations labor hour. As the AWW Project's Operations & Maintenance Plan is developed and the design is better defined material and equipment costs will be estimated in detail reflecting actual requirements.

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3.0 Tunnel Preservation (R&R) Cost Estimate

3.1 Tunnel Asset Preservation (P3) Repair and Replacement Cost

The AWV Tunnel Program's Operations & Maintenance Plan as described above excludes the costs associated with performing periodic rehabilitation or replacement of tunnel and building asset components during the 100-year expected life of the AWV Tunnel as part of WSDOT's preservation (P3) program. Preliminary asset preservation repair and replacement (R&R) average annualized cost estimates and schedules for the initial 30 year operations period, the initial 33 year operations period as well as the entire 100 year tunnel design useful life are included in Appendix 2.

The assets are broken down into major categories of tunnel systems including mechanical, electrical and traffic control systems, tunnel structures and portal buildings. As advised by WSDOT the equipment and vehicle replacement costs have been included in the annual O&M estimate and are therefore excluded from the tunnel asset R&R preservation (P3) costs. Cost of assets by major system that are anticipated to have a useful life less than 100 years (all items except for tunnel and building structural components and HVAC ductwork) have been estimated in current dollars and assigned a useful life. A percentage of the system removal and replacement cost to be incurred based on an assessment of components that can be re-used in place or salvaged (such as structural components, piping and conduit) vs. items that are to be removed and replaced (such as movable parts, electronic hardware and software) are estimated at the cycle intervals listed in the asset R&R schedule.

The cost of replacement over the life of the tunnel is estimated without forecasting escalation, financing or capitalization discount costs and divided by 30, 33 or 100 years to arrive at a present day (August, 2009) non-escalated average annual replacement cost. The cost of financing and escalation will be applied by the tolling study team. As detailed design evolves and sub-system capital costs are estimated in more detail a more accurate depreciation schedule will be prepared to refine component replacement schedule cycles and unit costs.

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4.0 Design Allowance

A Design Allowance or contingency is not included to allow for changes between the current conceptual design and final design of the AWV Bored Tunnel Alternative project.

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5.0 Statement of Probable Cost

As the design evolves from the current conceptual design the O&M requirements will be further defined and support a more detailed estimate. This opinion of probable cost is made on the basis of experience, qualifications, and best judgment of cost consultants familiar with the construction industry. A staff of professional cost consultants has prepared this estimate in accordance with generally accepted principals and practices.

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6.0 Reference Documents

1. AWVRP SR 99 Bored Tunnel Alternate SDEIS-2 Plan Set, July 10, 2009
2. AWVRP SR 99 Bored Tunnel Alternative - Tunnel Systems Design Criteria, June 2009
3. AWVRP SR 99 Bored Tunnel Alternative - Architectural Themes and Concepts, June 2009
4. AWVRP SR 99 Comparative Tunnel Maintenance and Operations TS&L Report, February 2007
5. AWVRP SR 99 Cost Estimate Tunnel and Elevated Structure Operating and Maintenance Cost Study, August 2006
6. Port of Miami Tunnel Annual Operations and Maintenance Costs, April 21, 2005
7. WSDOT I-90 Tunnel M&O, Tunnel Operations, Inspection, and Preservation Costs and 2007 to 2009 biennium I-90 Tunnel M2 actual cost register per Tareq Alzeer 7/23/09 email
8. WSDOT SR 99 Tunnel Staffing Cost Exercise Draft 8/13/09 and WSDOT TEF Equipment Schedule for 201001 per Mia Waters 8/13/09 email

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Appendix A

AWV Tunnel Operations and Maintenance (O&M) Estimate, Notes, Qualifications and Assumptions

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Alaskan Way Viaduct Tunnel
Annual Operating and Maintenance Costs

Prepared by: Parsons Brinckerhoff - Joe Klink, Kareem Grace, Rich Matrisian
Reviewed by: Parsons Brinckerhoff - Gary Kile and Mike Rigsby
Date: 8/17/2009

		O&M %
Electrical Service Power and Utility Charges	\$875,000	16%
<i>Includes: Annual cost of electrical power, communications, water, sewer and other miscellaneous utility charges and fees</i>		
Staffing for Operations and Maintenance	\$2,545,000	47%
<i>Includes: 11 person Operations full-time staff including 3 IRT persons; 20 person Maintenance full-time staff plus 0.3 person Mngt Oversight</i>		
Outside Services: Vendor Reps and Inspection Engineers	\$798,000	15%
<i>Vendor Representatives and Engineers to perform inspections and certification of equipment, specialty systems, structures and building systems</i>		
Support Equipment and Vehicles	\$233,000	4%
<i>Fleet cars/vans/pickup trucks, traffic control trucks, aerial truck, scissors lift, tunnel washer, forklifts, carts, dollies, load banks, lane closure signs and equipment</i>		
Other: Maintenance Agreements, Consumables, Lamps, Supplies	\$930,000	17%
<i>Annual cost allowance for maintenance service agreements such as janitorial, landscaping; consumable materials; lamps and filters; office and maintenance supplies and incidental costs</i>		
Total	\$5,381,000	100%

AWV Tunnel O&M Estimate Notes, Qualifications and Assumptions:

- 1 This estimate is in USD for the year 2009 and does not allow for escalation on annual Operations and Maintenance (O&M) costs or Repair and Replacement (R&R) costs for the 100 year AWV tunnel and buildings useful life window of January 2016 through December 2115.
- 2 This estimate covers annual operation and maintenance costs for the 9,200 lf 55' o.d. single bored 2 lane stacked tunnel, approx 2,000 lf additional cut and cover and open cut portal exit ramps and two 45,000 sf floor area multi-story portal buildings only. Approach roads, surface streets and SR 99 limits beyond the S. Royal Brougham and Republican and Mercer St on/off-ramps to and from SR 99 are not included in this scope of study.
- 3 The tunnel will be maintained locally and monitored from a remote control center in Shoreline, WA via a fiber optics line and a shared facility staffed for this tunnel as well as other WSDOT projects. Estimated staffing levels and rates are to be reviewed by WSDOT. Shared resources from existing staff are not considered at this time and could result in a reduction of estimated project O&M costs.
- 4 O&M costs included in this estimate include WSDOT M2 and Q2 program costs yet exclude initial construction cost or WSDOT P3 preservation program allowances for tunnel, building traffic, M&E systems or equipment/vehicle asset replacement costs at the end of each asset's useful life interval. A table depicting anticipated asset repair and replacement schedule cycles and estimated costs has been developed based on the planning level tunnel, portal buildings and systems estimate.
- 5 O&M costs for in-house staffing are based on WSDOT provided total employee costs (including salary and benefits) based on the WSDOT Salary Benefit Calculator for the estimated managerial and hourly O&M positions. A 15% cost premium has been added to non-managerial positions to cover anticipated overtime requirements. No other employee cost adjustments have been included in the staffing cost estimate.
- 6 O&M costs of tunnel support equipment and vehicles are based on purchased or leased assets in new condition based on current WSDOT Transportation Equipment Fund (TEF) inventory costs and expected life where available. The purchase of a new tunnel equipment washer has been included. Wrecking and Towing equipment have not been included consistent with WSDOT's current practice.
- 7 O&M costs for outside professional services including vendor reps and independent or WSDOT engineers to perform specialized maintenance, testing and/or inspections are rough estimate allowances pending development of the O&M plan and design of the tunnel and building systems.
- 8 Other O&M costs include general service agreements; maintenance consumables, tools and supplies; light fixture re-lamping; and operations office supplies as well as furniture, fixtures and equipment and are rough estimate allowances pending development of the O&M plan and design of the tunnel and building systems.
- 9 Utility rates are not based on equipment load calculations or published SCL rates and are rough estimates only not accounting for any discounts or negotiated agreements. Load calculations are under development.
- 10 O&M costs include the initial \$1.3 Mil for the procurement of major support equipment and vehicles as well as approximately \$1.7 Mil for the procurement of office furniture, fixtures and equipment.
- 11 The design basis used for estimating asset repair and replacement schedules is as follows:
 - 100-year design life for the tunnel and portal building structures including internal bridge decks/walls
 - 50-year design life for tunnel and building architectural finishes: tiling, windows, doors and roofing
 - 15 to 33-year design life for tunnel paving, traffic and M&E systems
 - 10 to 20-year design life for equipment and vehicles
- 12 Tunnel design is based on SR 99 Bored Tunnel alternative EIS plan set dated July 10, 2009; Tunnel systems design criteria and Architectural themes and concepts both dated June 2009
- 13 Future tolling equipment, facilities and staffing Capital and O&M costs are not part of this estimate.

Annual Staffing Requirements

Operations Staff

	people	shift hours	days/week	yearly	salary	salary/hrly	Non-Managerial 15% OT adds	total
tunnel O&M oversight management	0.3	8 hr	5	624 hr	\$ 124,963.33	\$ 60.08	\$ -	\$ 37,489.00
tunnel facility manager	1	8 hr	5	2,080 hr	\$ 92,440.00	\$ 44.44	\$ -	\$ 92,440.00
operations supervisor	1	8 hr	5	2,080 hr	\$ 68,559.00	\$ 32.96	\$ 10,283.85	\$ 78,842.85
administrator	1	8 hr	5	2,080 hr	\$ 68,559.00	\$ 32.96	\$ 10,283.85	\$ 78,842.85
tunnel operators (1 person continuous coverage)	1	24 hr	7	8,736 hr	\$ 60,577.00	\$ 29.12	\$ 9,086.55	\$ 292,586.91
tunnel operator (extra person to assure 1 person continuous coverage)				1,664 hr	\$ 60,577.00	\$ 29.12	\$ 9,086.55	\$ 55,730.84
emergency responders (2 persons during rush hour and w/e events)	2	8 hr	7	5,824 hr	\$ 58,221.00	\$ 27.99	\$ 8,733.15	\$ 187,471.62
emergency responders (extra person to assure coverage above)				416 hr	\$ 58,221.00	\$ 27.99	\$ 8,733.15	\$ 13,390.83
	6.3			23,504 hr		11.3 FTE		\$836,795

Maintenance Staff

maintenance supervisor	1	8 hr	5	2,080 hr	\$ 92,440.00	\$ 44.44	\$ -	\$ 92,440.00
maintenance foreman (skilled-trades)	4	8 hr	5	8,320 hr	\$ 71,504.00	\$ 34.38	\$ 10,725.60	\$ 328,918.40
maintenance - electrical/technicians	6	8 hr	5	12,480 hr	\$ 90,454.00	\$ 43.49	\$ 13,568.10	\$ 624,132.60
maintenance - mechanical/plumbing	4	8 hr	5	8,320 hr	\$ 70,039.00	\$ 33.67	\$ 10,505.85	\$ 322,179.40
maintenance - general/laborers	2	8 hr	5	4,160 hr	\$ 50,841.00	\$ 24.44	\$ 7,626.15	\$ 116,934.30
IT computer technician	1	8 hr	5	2,080 hr	\$ 77,790.00	\$ 37.40	\$ 11,668.50	\$ 89,458.50
general staff - office support/caretakers	2	8 hr	5	4,160 hr	\$ 58,221.00	\$ 27.99	\$ 8,733.15	\$ 133,908.30
	20			41,600 hr		20.0 FTE		\$1,707,972

Total WSDOT O&M Staff (Full Time Equivalent FTE based on 2,080 Hrs/year)

Total WSDOT O&M Staff (Full Time Equivalent FTE based on 1,720 Hrs/year)

31.3 FTE

25.9 FTE

WSDOT O&M Staffing Total \$2,544,766

Outside Professional Services (Vendor Reps and Inspection)

Outside Contractors (Vendor reps for special systems maintenance)	Use Port of Miami x 140% for escalation and regional cost of living plus 2 added portal buildings	\$700,000
Independent or WSDOT Engineers (Structural and Systems Inspections)	WSDOT I-90 Program Estimate x 120%	\$98,400

Total Outside Professional Services

Outside Professional Services Total \$798,400

Major Support Equipment and Vehicles

	Number required	Capital Cost per each	Capital Cost	Operate	TEF / Rental	useful life	Source	
Tunnel-Washer	1	467,500	467,500	\$23,375.00	\$38,958.33	12 yrs	P of M Est	
Crew Truck First Responder (w/TMA) (2 ea)	2	128,000	256,000	\$12,800.00	\$21,333.33	12 yrs	WSDOT	
Traffic control 3/4 Ton Pickup Trucks (2ea)	2	21,063	42,126	\$2,106.30	\$4,212.60	10 yrs	WSDOT	
Maintenance w/ Lift 40'	1	80,778	80,778	\$4,038.90	\$6,731.50	12 yrs	WSDOT	
Manlift Platform Scissor Lift	1	26,358	26,358	\$1,317.90	\$1,317.90	20 yrs	WSDOT	
Load Bank Generators (2 ea)	2	28,200	56,400	\$2,820.00	\$2,820.00	20 yrs	WSDOT	
Signage	1	33,000	33,000	\$1,650.00	\$3,300.00	10 yrs	P of M Est	
Passenger Van	1	17,353	17,353	\$867.65	\$1,446.08	12 yrs	WSDOT	
Fork Lift (2ea)	2	19,554	39,108	\$1,955.40	\$1,955.40	20 yrs	WSDOT	
1/2 Ton Pickup Trucks (2ea)	2	19,307	38,614	\$1,930.70	\$3,861.40	10 yrs	WSDOT	
Service Vans (4 ea)	4	22,000	88,000	\$4,400.00	\$7,333.33	12 yrs	P of M Est	
Lane Closure Equipment	1	55,000	55,000	\$2,750.00	\$5,500.00	10 yrs	P of M Est	
Sedans or 1/4 Ton Pickups (3ea)	3	14,206	42,618	\$2,130.90	\$3,551.50	12 yrs	WSDOT	
Electric Utility Golf Carts (4ea)	4	7,063	28,252	\$1,412.60	\$1,883.47	15 yrs	WSDOT	
Carts/Dollies (6ea)	6	5,500	33,000	\$1,650.00	\$3,300.00	10 yrs	Est	
Totals			\$1,304,107.00	\$65,205.35	\$107,504.85			Equipment Total \$172,710

Notes:

Capital Cost is based on WSDOT TEF Inventory cost where available or Estimated Capital cost
 Operating is estimated service, fuel and other consumables costs at 5% of Capital Cost per Year
 TEF / Rental rate is WSDOT TEF Inventory cost/useful life where available or Estimated Capital cost/useful life
 Labor Costs to operate equipment are included within Staffing Above
 Wrecking and Towing Services are excluded and are not charged to WSDOT in current practice

Total Support Equipment	above	\$172,710
Small equipment (Radios, Remote controls, etc)	20%	\$34,542
Incidentals	15%	\$25,907

Total Equipment O&M \$233,159

Total Support Equipment and Vehicles

Support Equipment and Vehicles Total \$233,000

Other O&M Costs: Agreements, Consumables, Lamps, Supplies

General Service agreements (landscaping, janitorial, other)	12	\$20,000.00	\$ per month	\$240,000
Consumables and Supplies including PPE, Maintenance hrs	41,600 hr	\$6.00	\$ per maintenance hr	\$249,600
Light Fixture Lamps (50% replacement x 1 lamp per fixture per year)	3,500	\$25.00	1 failed lamp per fixture allowed	\$87,500
Supplies, office FFE, miscellaneous, Operations hrs	23,504 hr	\$15.00	\$ per operations hr	\$352,560

Total Other O&M Costs

Other O&M Costs Total \$929,660

<p>Electrical Service (Seattle City Light)</p> <p>Primary Service \$0.00 Demand \$1.03 per kW Usage 4.67000 cents/kW-hr</p>

Demand Load Information

Demand load is currently under development and power utility charge estimate will be updated later

1-90 annual Power costs	\$	425,000.00	
x factor of 2 per K. Grace	\$	850,000.00	Electricity, Power demand to be determined, allowance
1-90 annual Comm. costs	\$	15,000.00	
	\$	15,000.00	Communications, Phone
1-90 annual Water/misc. cost	\$	10,000.00	
	\$	10,000.00	Water, Sewer, Misc
	\$	875,000.00	Total Utilities preliminary estimate

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Appendix B

AWV Tunnel Asset Preservation Repair and Replacement (R&R) Cost Estimate

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TUNNEL ASSET PRESERVATION - REPAIR and REPLACEMENT COST (30 yr and 100 yr Analysis Periods)													
30													
33													
100													
Annual Cost = Replacement Cost / 100 yr analysis period													
0% Escalation for Replacement Cost													
Annual Cost = Replacement Cost / 30 yr analysis period													
0% Escalation for Replacement Cost													
Annual Cost = Replacement Cost / 33 yr analysis period													
0% Escalation for Replacement Cost													
Annual Cost = Replacement Cost / 100 yr analysis period													
Description	System Initial Capital Cost \$2009	Useful Life	Components Replacement Cost \$2009	Remarks	Number of System Replacement Cycles	Escalated Replacement Cost	Annual Cost	Number of System Replacement Cycles	Escalated Replacement Cost	Annual Cost	Number of System Replacement Cycles	Escalated Replacement Cost	Annual Cost
Tunnel Systems													
Portal Axial Fans	\$ 10,800,000	33	\$ 6,480,000	Removal of existing & installation of 50% components	0	\$ -	\$ -	1	\$ 6,480,000	\$ 196,364	2	\$ 12,960,000	\$ 129,600
Ventilation Jet Fans	\$ 1,200,000	33	\$ 720,000	Removal of existing & installation of 50% components	0	\$ -	\$ -	1	\$ 720,000	\$ 21,818	2	\$ 1,440,000	\$ 14,400
Fire Dampers, motor-operated	\$ 29,700,000	33	\$ 17,820,000	Removal of existing & installation of 50% components	0	\$ -	\$ -	1	\$ 17,820,000	\$ 540,000	2	\$ 35,640,000	\$ 356,400
Other HVAC - ductwork	\$ 5,700,000	100	\$ -	Inspection and Cleaning only - part of Annual O&M	0	\$ -	\$ -	0	\$ -	\$ -	0	\$ -	\$ -
Drainage Pumps, Valves, Piping, Inlets	\$ 7,000,000	33	\$ 2,100,000	Removal of existing & installation of 25% components	0	\$ -	\$ -	1	\$ 2,100,000	\$ 63,636	2	\$ 4,200,000	\$ 42,000
Deluge Fire Protection System	\$ 18,300,000	33	\$ 5,490,000	Removal of existing & installation of 25% components	0	\$ -	\$ -	1	\$ 5,490,000	\$ 166,364	2	\$ 10,980,000	\$ 109,800
CO/HC Detection Systems	\$ 500,000	15	\$ 300,000	Fixture, conduit, cable etc. 50% for replacement	2	\$ 600,000	\$ 20,000	2	\$ 600,000	\$ 18,182	6	\$ 1,800,000	\$ 18,000
Electrical Power Substations, Trans, MCCs	\$ 32,000,000	50	\$ 38,400,000	Removal of existing & installation of 100% components	0	\$ -	\$ -	0	\$ -	\$ -	1	\$ 38,400,000	\$ 384,000
Tunnel Construction Power	\$ 6,100,000	50	\$ -	temporary or turn-over to COS/CSL	0	\$ -	\$ -	0	\$ -	\$ -	1	\$ -	\$ -
Emergency Generators	\$ 2,400,000	50	\$ 2,880,000	Removal of existing & installation of 100% components	0	\$ -	\$ -	0	\$ -	\$ -	1	\$ 2,880,000	\$ 28,800
UPS, Power Monitoring and Control, LV	\$ 3,400,000	20	\$ 4,080,000	Removal of existing & installation of 100% components	1	\$ 4,080,000	\$ 136,000	1	\$ 4,080,000	\$ 123,636	4	\$ 16,320,000	\$ 163,200
Lighting and wiring	\$ 16,500,000	20	\$ 9,900,000	Fixture, conduit, cable etc. 50% for replacement	1	\$ 9,900,000	\$ 330,000	1	\$ 9,900,000	\$ 300,000	4	\$ 39,600,000	\$ 396,000
Fire Detection	\$ 7,300,000	20	\$ 4,380,000	Fixture, conduit, cable etc. 50% for replacement	1	\$ 4,380,000	\$ 146,000	1	\$ 4,380,000	\$ 132,727	4	\$ 17,520,000	\$ 175,200
SCADA system	\$ 3,800,000	20	\$ 4,560,000	Removal of existing & installation of 100% components	1	\$ 4,560,000	\$ 152,000	1	\$ 4,560,000	\$ 138,182	4	\$ 18,240,000	\$ 182,400
ITS Conduit and Cabling	\$ 8,500,000	20	\$ 5,100,000	Fixture, conduit, cable etc. 50% for replacement	1	\$ 5,100,000	\$ 170,000	1	\$ 5,100,000	\$ 154,545	4	\$ 20,400,000	\$ 204,000
Dayton Expansion (AWV Portion)	\$ 30,000,000	20	\$ 9,000,000	Removal of existing & installation of 25% components	1	\$ 9,000,000	\$ 300,000	1	\$ 9,000,000	\$ 272,727	4	\$ 36,000,000	\$ 360,000
Emergency Telephones	\$ 120,000	15	\$ 72,000	Fixture, conduit, cable etc. 50% for replacement	2	\$ 144,000	\$ 4,800	2	\$ 144,000	\$ 4,364	6	\$ 432,000	\$ 4,320
AM/FM and 2 Way Radios	\$ 1,200,000	15	\$ 720,000	Fixture, conduit, cable etc. 50% for replacement	2	\$ 1,440,000	\$ 48,000	2	\$ 1,440,000	\$ 43,636	6	\$ 4,320,000	\$ 43,200
CCTV/Security	\$ 600,000	15	\$ 360,000	Fixture, conduit, cable etc. 50% for replacement	2	\$ 720,000	\$ 24,000	2	\$ 720,000	\$ 21,818	6	\$ 2,160,000	\$ 21,600
Access Control/Intrusion Detection	\$ 300,000	15	\$ 180,000	Fixture, conduit, cable etc. 50% for replacement	2	\$ 360,000	\$ 12,000	2	\$ 360,000	\$ 10,909	6	\$ 1,080,000	\$ 10,800
Incident Detection	\$ 2,400,000	15	\$ 1,440,000	Fixture, conduit, cable etc. 50% for replacement	2	\$ 2,880,000	\$ 96,000	2	\$ 2,880,000	\$ 87,273	6	\$ 8,640,000	\$ 86,400
Overhead Vehicle Detection	\$ 240,000	15	\$ 144,000	Fixture, conduit, cable etc. 50% for replacement	2	\$ 288,000	\$ 9,600	2	\$ 288,000	\$ 8,727	6	\$ 864,000	\$ 8,640
Traffic Signals	\$ 60,000	33	\$ 72,000	Removal of existing & replacement.	0	\$ -	\$ -	1	\$ 72,000	\$ 2,182	2	\$ 144,000	\$ 1,440
Dynamic Message Signage	\$ 1,500,000	33	\$ 1,500,000	Assume removal = salvage	0	\$ -	\$ -	1	\$ 1,500,000	\$ 45,455	2	\$ 3,000,000	\$ 30,000
Fixed Message Signage	\$ 2,000,000	33	\$ 2,000,000	Assume removal = salvage	0	\$ -	\$ -	1	\$ 2,000,000	\$ 60,606	2	\$ 4,000,000	\$ 40,000
Traffic Gates	\$ 120,000	33	\$ 36,000	Incls. Removal & installation of arms and motors	0	\$ -	\$ -	1	\$ 36,000	\$ 1,091	2	\$ 72,000	\$ 720
Subtotal Tunnel Systems	\$ 191,740,000												
Tunnel Structures													
Permanent Structural Elements (excluded)	\$ -	100	\$ -	Inspection and Cleaning only - part of Annual O&M	0	\$ -	\$ -	0	\$ -	\$ -	0	\$ -	\$ -
PCC Paving, Barriers, Joints and Striping	\$ 28,000,000	15	\$ 5,600,000	Grind Pavement or Mill/Fill, Barriers/EJ/striping, 20%	2	\$ 11,200,000	\$ 373,333	2	\$ 11,200,000	\$ 339,394	6	\$ 33,600,000	\$ 336,000
Tunnel Liner Joints - Sealing	\$ 10,000,000	15	\$ 1,000,000	Repair 10% Joints on average each 15 year cycle	2	\$ 2,000,000	\$ 66,667	2	\$ 2,000,000	\$ 60,606	6	\$ 6,000,000	\$ 60,000
Retaining Walls - Pigment Sealer	\$ 500,000	15	\$ 500,000	Cleaning and resealing	2	\$ 1,000,000	\$ 33,333	2	\$ 1,000,000	\$ 30,303	6	\$ 3,000,000	\$ 30,000
Wall Panels-Tiles	\$ 10,000,000	50	\$ 12,000,000	Removal of Tiles, disposal & replacement	0	\$ -	\$ -	0	\$ -	\$ -	1	\$ 12,000,000	\$ 120,000
Stairwell Doors	\$ 600,000	50	\$ 720,000	Removal of doors/hardware, disposal & replacement	0	\$ -	\$ -	0	\$ -	\$ -	1	\$ 720,000	\$ 7,200
Subtotal Tunnel Structures	\$ 49,100,000												
Portal Buildings													
Structural Elements (excluded)	\$ -	100	\$ -	Inspection and Cleaning only - part of Annual O&M	0	\$ -	\$ -	0	\$ -	\$ -	0	\$ -	\$ -
Yard Improvements	\$ 2,000,000	50	\$ 1,250,000	Overlay Pavement & re-striping, lighting, allow 50%	0	\$ -	\$ -	0	\$ -	\$ -	2	\$ 2,500,000	\$ 25,000
Windows, Roofing and Finishes	\$ 6,000,000	50	\$ 7,500,000	Removal of components, disposal & replacement	0	\$ -	\$ -	0	\$ -	\$ -	1	\$ 7,500,000	\$ 75,000
Elevators, Hoists, Lifts	\$ 3,000,000	33	\$ 3,000,000	Removal of 80% system, disposal & replacement	0	\$ -	\$ -	1	\$ 3,000,000	\$ 90,909	2	\$ 6,000,000	\$ 60,000
MEP Services	\$ 9,000,000	33	\$ 5,625,000	Removal of 50% system, disposal & replacement	0	\$ -	\$ -	1	\$ 5,625,000	\$ 170,455	2	\$ 11,250,000	\$ 112,500
Subtotal Portal Buildings	\$ 20,000,000												
Equipment and Vehicles (None - Part of O&M)													
Subtotal Equipment and Vehicles	\$ -												
TOTAL ASSET VALUE	\$ 260,840,000												
				TOTAL ANNUAL R & R COST			\$ 1,921,733			\$ 3,105,909			\$ 3,636,620
						Rounded	\$ 1,900,000		Rounded	\$ 3,100,000		Rounded	\$ 3,600,000

