TNR Appendix B: Cost Estimating Model

Appendix B of the Transportation Needs Report (TNR) is a cost estimating model. The model is used to estimate the total project costs for major road improvements including engineering, right-of-way acquisition and construction.

Estimated 2010 Average Construction Costs on Major Road Projects

	Costs Per Linear Mile	[1]Costs Per New Lane Mile	Cost Per Total Lane Mile	Costs Per Linear Mile on Flat Terrain	Costs Per Signal	Costs Per Linear Adjoining Foot of Wetland
Lane Costs	$900,000	$547,000	$0	$0	$0	$0
Drainage and Detention Costs	$1,153,000	$0	$0	$0	$0	$0
Control, Markings, and Illumination	$583,000	$0	$0	$0	$0	$0
Signal Costs	$0	$0	$0	$0	$213,000	$0
Walls and Guardrails	$920,000	$0	$0	-$636,000	$0	$0
Environmental	$0	$144,000	$0	$0	$0	$350
Curb, Gutter, Sidewalk, Planter Strip	$340,000	$0	$0	$0	$0	$0
Total: Rounded	$3,900,000	$690,000	$0	-$640,000	$210,000	$400

For calculations, the categories of costs can be collapsed into formula as follows:

*Total Estimated Construction Cost = $3,900,000*length (miles) - $640,000*length if flat terrain + $690,000*new lane miles + $210,000*number of signals + $400*average wetland length (feet)*

Notes: These costs are for urban widenings. There are adjustments made for rural projects and new alignments. The variable, total lane miles, was not found to have a statistically significant relationship with costs (see Regression Analysis on Page 8).

[1] A lane mile is an area with width equal to one lane (12 ft) and length equal to one mile (5,280 ft)

Estimated Average 2010 Right-of-Way Costs

The unit costs for right-of-way reflect market conditions for different land-use classes in different sub areas of the county. The costs shown are per square foot.

Land-Use Class	SW UGA	Other UGA	Outside UGA
Urban Low Density Residential, developed	$12	$10	
Urban Low Density Residential, undeveloped	$8	$7	
Urban Medium Density Residential, developed	$13	$10	
Urban Medium Density Residential, undeveloped	$9	$8	
Urban High Density Residential, developed	$16	$13	
Urban High Density Residential, undeveloped	$12	$10	
Industrial, developed	$10	$8	$7
Industrial, undeveloped	$5	$3	$2
Commercial, developed	$20	$16	$13
Commercial, undeveloped	$13	$10	$7
Urban Center, developed	$20	$20	
Urban Center, undeveloped	$13	$13	
Rural Residential, developed			$5
Rural Residential, undeveloped			$2
Commercial Farmland			$1

Right-of-Way Acquisition

The costs associated with acquiring right-of-way are estimated at $7,500 per parcel. In addition, 20% of the property costs are added to the right-of-way acquisition costs to estimate condemnation and relocation costs.

Inflation Factors

Cost estimates used in the TNR are in nominal dollars, meaning they are estimates of what the different aspects of the projects will cost when they are incurred. In other words, the cost model assumes inflation will occur and adjusts costs upward to reflect it. Inflation factors are estimated based on long-term trends in costs (average rate of inflation over ten or more years). The *Engineering News-Record's* national Construction Cost Index is used to estimate inflation factors for construction costs. For engineering and right-of-way acquisition costs, inflation factors are based on the urban wage earner consumer price index for the Seattle metropolitan area. Inflation factors for right-of-way (property costs) are based on data obtained from Washington State University's Washington Center for Real Estate Research. The base inflation factors are shown below:

Cost Item	**Revised 11/08**	**Revised 11/10**	**Change**
Engineering and Right-of-Way Acquisition	1.029	1.026	-0.29%
Construction	1.032	1.035	0.29%
Rural Property	1.081	N/A	N/A
Other UGA Property	1.062	N/A	N/A
SW UGA Property	1.088	N/A	N/A
Right-of-Way Property	N/A	1.051	N/A

In the 2008 and previous models, the county was split into three subareas − SW UGA, Other UGA, and Rural – and each subarea had a different base inflation factor for property costs. In the 2010 model, one countywide factor was used rather than three different factors.

Construction Targets and Inflation Factors for Different Project Phases

The base inflation factors above were used to create tables that estimate the impacts of inflation for the different project phases: preliminary engineering (PE), right-of-way (R/W) acquisition, and construction. For the model, all projects were assumed to take five years to complete. The projects were divided into three groups − short, medium, and long range − and the base inflation factors were used to derive inflation factors for the project phases of each time range. The costs for PE were inflated using the inflation factor for Year One of the appropriate range. R/W costs were inflated with the year-three factor and construction costs were inflated with the year-five factor of the appropriate range.

Inflation Factors for Short, Medium, and Long Range

Range (Years)	**PE** (Year One)	**R/W Property** (Year Three)	**Construction** (Year Five)
Short Range (2011-2015)	1.026	1.161	1.188
Medium Range (2016-2020)	1.166	1.489	1.411
Long Range (2021-2025)	1.326	1.909	1.675

The source of the inflation factor for construction costs is the *Engineering News Record's* Construction Cost Index. This national index tracks the cost of construction materials and labor. The ten-year average is used as opposed to annual increases because the inflation factor is used to estimate inflation for a list of projects that will be constructed over an extended period of time (2011 to 2025).

Ten-Year Construction Cost Index from Engineering News Record

Year	Index	Annual Increase	10-Yr Average
2000	6221	2.7%	2.8%
2001	6343	2.0%	2.8%
2002	6538	3.1%	2.7%
2003	6694	2.4%	2.5%
2004	7115	6.3%	2.8%
2005	7446	4.7%	3.1%
2006	7751	4.1%	3.3%
2007	7966	2.8%	3.2%
2008	8310	4.3%	3.4%
2009	8570	3.1%	3.5%
2010	8802	2.7%	3.5%

Detention Acquisition Area Estimates

	Revised (2003)
Widenings: Detention Acquisition Area (square feet per new lane mile)	36,000 sf flat terrain, 22,500 sf rolling, 24,750 sf mountainous
New Alignments: Detention Acquisition Area (square feet per new lane mile)	24,750 sf flat terrain , 15,750 sf rolling, 15,750 sf mountainous

Bridge Rehabilitation and Replacement Costs (per square foot)

$423 per square foot	Last Revised (1/07)

Stand-Alone Intersection Projects

	Estimated 2004 Costs ($1,000s)
Permanent Mast-Arm Signal	$225
Temporary Span-Wire Signal	$135
Major Realignment if Required	$500
Turn Pockets (Each) if Required	$50
Detention if Required	$100
Other Minor Physical Improvements if required	$50
Assumed PE, CE, and Mobilization as percentage of construction	60%
Assumed Right-Of-Way Costs for 3-Legged Intersection	$104
Assumed Right-Of-Way Costs for 4-Legged Intersection	$125

Wetland Mitigation Acquisition Area Estimates

	Last Revised (9/00)
Replacement Ratio	1.5 to 1
Buffers	Assumes 25’ buffers on small wetlands and 50’ buffers on wetlands larger than one acre
Wetland Area Acquisition Costs (per square foot)	For new wetland creation, assumes cost of undeveloped property with Urban Low Density Residential or Rural Residential Comprehensive Plan designation.

Other Costs

	Last Revised (7/06)
Mobilization	6.0% of construction costs
Preliminary Engineering (PE)	20% of construction costs
Construction Engineering (CE)	15% of construction costs

Objective and Uses of the Cost Model

DPW lacks the staff resources to be able to make detailed, engineering-type cost estimates for the 100-plus major road projects identified as future needs. The main objective of the cost model is to provide reasonably accurate cost estimates of a large number of future road projects with a minimum of necessary data inputs. These costs will be aggregated for their primary uses (fee cost basis and GMA planning). Thus, accuracy in aggregate is more important than individual accuracy. The estimates from the cost model are used primarily in aggregate to establish the cost basis of the Chapter 30.66B SCC impact fees and to estimate expenditures in the GMA Transportation Element. They are also used individually as inputs into the TNR improvement evaluation process.

Impact Fee Cost Basis

The aggregated cost estimates of a set of major road improvements is the basis upon which the County imposes impact fees on new developments under Chapter 30.66B. Also, when developers construct improvements that are part of the impact fee cost basis, they receive credits against their impact fees. The value of the construction, and hence the amount of the credits, is estimated using the cost model.

GMA Transportation Element

As part of the GMA planning process, future road improvements needed to support development are identified in the Transportation Element. The costs of these projects is estimated using the cost estimating model. The costs of these projects is aggregated into the expenditure forecasts used for the County capital facilities plan (CFP). The CFP also includes the annual "Statement of Assessment" which uses the same aggregates of estimated project costs.

Improvement Evaluation Process

Every two years the identified major road improvements are evaluated against a set of criteria to establish high, medium or low priority ratings. Estimated project cost is one of the inputs into this process in criteria for cost effectiveness and accident reduction benefit.

Evolution of the Cost Model

The Department of Public Works published the first version of the cost model in the 1990 Road Needs Report based on unit costs and following an approach that was fairly consistent with typical engineering cost estimates. The model was updated in 1995 using the same framework and updating the unit costs. Further minor updates were made in 1998 and 1999.

2000, 2002, 2003, 2004, 2006, 2008, and 2010 Updates

The main uses of the cost model (i.e., aggregates of costs) "opens the door" to the use of a statistical / average type model. In September of 2000 a major revision was made based on averages from bid tabs. This approach was used to update the model in 2002, 2003, 2004, 2006, 2008, and 2010.

Statistical/Averaging Approach Based on Bid Tabs

Engineering Services compiles the bids received from contractors for major road projects. Based on 17 major road projects dating back to 1998, categories have been developed and each unit item in the bid lists is assigned to one of the following categories:

Categories of Construction Costs in Cost Model

1 lane costs
   - prep, grading, paving, rock, materials
   - utilities and other

2 curb, gutter, sidewalk and planter strip costs

3 signal costs

4 traffic control costs
   - construction traffic control
   - temporary and permanent markings
   - illumination

5 drainage and detention costs
   - drainage
   - detention
   - fences around ponds

6 environmental costs
   - landscaping, wetland const, erosion control, clean up

7 walls and guardrails
   - retaining walls
   - guardrails, handrails

Recently Finished Projects Used in Cost Model

Year	**Project Name**
1998	164 ST SE/SW Phase One
1999	Paine Field Blvd
2001	35 AV SE Phase One
2001	228 ST SE
2001	Airport Rd
2003	112 ST SW
2003	132 ST SE / Cathcart Way
2003	Marine Drive NE/NW
2004	35 AV SE Phase Two
2004	148th ST SW
2004	164th ST SW Phase Two
2004	Lundeen Park Way Extension
2005	Sno Wood Road
2006	Bev Park / 112th Corridor
2008	20 ST SE Phase One
2008	Bev Park / 52nd Av W Corridor
2009	Granite Falls Alternate Route

The costs for these items are taken from the lowest bidder and aggregated into the different categories for each of the projects. A set of input variables is compiled for the projects including such data as length of project, new lane miles, total lane miles, wetland length, terrain, etc. This is the basis for linear regression analysis to determine which input variables have statistically significant relationships with the costs. These outputs are used to create a cost model which provides reasonably accurate estimates of the low bid amounts for the projects.

Construction Index Used for Inflation Factors

The set of projects is spread out over time, the first going to bid in 1997. To account for inflation, the bid costs are increased across categories based upon the most current construction cost index.

Regression Analysis

The regression analysis shows strong correlations with variables such as project length, new lane miles, and wetland length.

The six input variables were:

1) Project Length
2) New lane miles
3) Total lane miles
4) Terrain (flat or not flat)
5) Number of Signals
6) Average Wetland Length

Average wetland length is estimated using GIS data. The length of the road that adjoins wetlands is estimated for both sides of the road and averaged to get "average wetland length."

For the 2010 update, one of the input variables, total lane miles, was not found to have a statistically significant relationship with costs. Consequently, this variable was not included as a type of cost in the 2010 update of the cost model.

The five types of costs are:

1) Costs per linear mile
2) Costs per new lane mile
3) Costs per linear mile on flat terrain
4) Costs per signal
5) Costs per foot of adjoining wetlands.

Inflation Factors

Inflation factors are updated based on recent data (see Page 3).

Conclusion

The model would seem to meet its objectives of providing reasonable cost estimates with minimal inputs. While the limited number of inputs leads to inaccuracies on the individual level, these will tend to balance when aggregated.