Appendix E: Analysis Performed on the Plan Alternatives

1 In general terms, what analysis was performed on the plan alternatives?

After regional stakeholders collaborated to create the six plan alternatives, Regional Council staff performed analysis to identify the potential outcomes and impacts of those alternatives. To do so, staff applied the PSRC integrated modeling system comprised of a suite of computer-based statistical software tools. These tools and the general assumptions encoded in them are described in more detail in a separate report entitled *Transportation 2040: Data Analysis and Forecasting at the PSRC.* This appendix describes how the tools were applied specifically to the plan alternatives and the detailed assumptions and inputs that were assembled to properly characterize the alternatives for the analytic tools.

The analysis tools produced forecasts of the future distribution of jobs and population across the region and the future performance of the region's transportation system. The transportation system inputs used in the forecasts were derived directly from the investments specified for each alternative as documented in the Transportation 2040 Alternatives Specification report (Appendix A of the DEIS). The inputs therefore vary across the alternatives. The outputs of the forecast tools are presented in detail in the Policy Analysis and Evaluation Criteria Report (Appendix D of the DEIS).

The forecast tools used in this analysis—like all such tools—have certain limitations. This appendix documents both the strengths and the limitations of the actions proposed in the alternatives. In cases where the actions proposed are not captured (or not captured fully) by the quantitative tools, these actions and their potential impacts are discussed qualitatively in the DEIS.

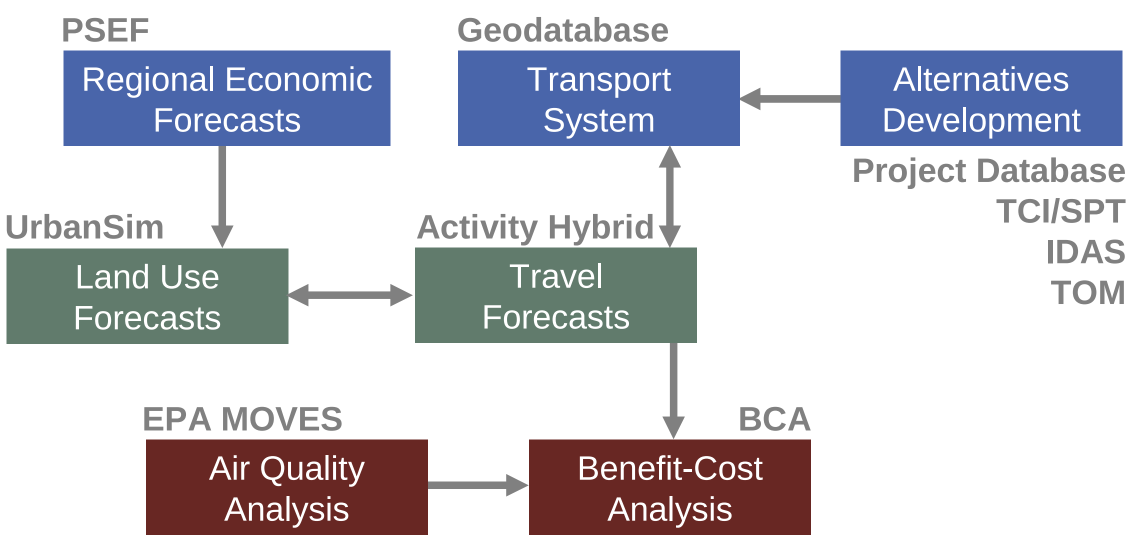
What were the key inputs to the analysis?

- Forecasts of total jobs and population for the region in future years (these do not change across the alternatives).
- Future characteristics of the transportation system as defined by the "actions" specified in each alternative (these change across alternatives).
- Toll rates and other changes to future baseline assumptions because of specific investments in an alternative (these change across alternatives).

2 How did the forecast tools work together overall to produce the analysis results?

The integrated modeling system is comprised of seven sets of models, as shown in Exhibit 1. To analyze the alternatives, staff ran the regional economic model, which forecast that the Central Puget Sound region would have 2.2 million households and 5.0 million people and 2.8 million jobs in 2040. Each alternative was thereafter constrained to these "control totals" at the regional level.

Exhibit 1. PSRC Integrated Modeling System



Staff then used the results of the Alternatives Development process to craft specific transportation system inputs (for example, how many lanes would be present on which roads and how much transit service to include) for each alternative. These inputs were used to apply the integrated modeling system in a series of iterative model runs. The "first pass" through the integrated travel demand forecast/land use forecast model systems iterated between the land use model (which always runs first in the iterative loop) and the travel model as shown in Exhibit 2.

Exhibit 2. Land Use/Travel Model Integration for Fully Integrated Runs

Model Inputs and Integration	Analysis Year				
	2006 (base)	2015	2025	2035	2040
Travel Model Networks and other Inputs created for these Years:	2006	2020	2020	2040	2040
Land Use Model Runs, using accessibilities from: *	a previous trave model run for land use model run 2006	2006 travel model for land use model runs 2007 through 2015	2015 travel model for land use model runs 2016 through 2025	2025 travel model for land use model runs 2026 through 2035	2035 for land use model runs 2036 through 2040
Travel Model Runs, using population and employment from:	2006 land use model run	2015 land use model run	2025 land use model run	2035 land use model run	2040 land use model run

The "first pass" runs produced forecasts of future system responses to actions that affected the system's physical capacity in the context of the forecasted overall population and employment growth. These results were used to complete the analysis process, which included setting appropriate toll rates, setting appropriate inputs for the effects of system management and similar investments, and fine-tuning the supply of transit service. Staff used these additional inputs to run a "second pass" of each alternative through the travel model only for years 2025 and 2040. More information on the tolling, transit, and system management approaches is provided in subsequent sections of this appendix.

After reviewing the "second pass" travel-model-only runs, staff ran the alternatives through the full integrated model application in a "final pass" to develop inputs for the Benefit-

Cost Analysis (BCA) tool and to produce other metrics presented in the Evaluation Report (Appendix D).

3 What land use policy assumptions were used in the analysis?

The Regional Council's new land use model, UrbanSim (www.urbansim.org), uses future year land use plans as an implicit input. Given the adoption of Vision 2040 in 2008, modeling inputs for Transportation 2040 were developed to correspond with the goals and objectives of the Regional Growth Strategy component of Vision 2040. Staff developed a representation of the region's collective future year land use plans as a starting point, and then modified existing comprehensive plan constraints in areas designated in Vision 2040 as locations likely to see more intensive growth. These changes allowed the integrated models to accommodate the full amount of growth from the regional economic model while providing enough development capacity for land use patterns to be affected by variations in the transportation alternatives. All alternatives—including the Baseline—were modeled using the same future year land use policies and constraints.

4 How were tolling actions analyzed?

Each action alternative has a different proposed tolling strategy, from variations on High Occupancy/Toll (HOT) approaches in Alternatives 1 and 2 through variations on tolling freeways in Alternatives 3 and 4 to tolling all arterials and freeways in Alternative 5. Various managed lane strategies (HOT lanes themselves are one example; restricting the types of vehicles allowed in certain lanes such as HOV lanes is another) were applied to the various alternatives (see section 5 below for additional information). The main policy objective of the tolling strategies for Alternatives 1, 2, 4, and 5 was to maximize benefits to system users (in other words: to maximize the overall efficiency of the roadway portion of the regional transportation system). The policy objective of Alternative 3 was to generate sufficient revenue to fund investments on the tolled freeways while still varying tolls across time of day to create some congestion management benefits. Staff, with the assistance of the consulting firm EcoNorthwest, used objective analytic methods to create toll rates that would achieve these goals.

EcoNorthwest applied its Toll Optimization Model (TOM) to set toll rates for the HOT systems in Alternatives 1 and 2. The TOM model took the "first pass" model outputs from those alternatives (the "first pass" outputs show system response to capacity changes and growth but without tolls) and optimized toll rates individually on each model link. The optimization process set tolls that maximized the use of any capacity not utilized by HOV vehicles in the HOT lanes while still maintaining adequate performance in those HOT lanes. The TOM-derived HOT lane toll rates were then coded into travel model input files for the "second pass" of model runs using only the travel model.

For the freeway and full tolling strategies in Alternatives 3, 4, and 5 EcoNorthwest mathematically modified the volume-delay functions in the travel model to include a term that calculated the optimal toll on each arterial and freeway model link as a function of volume and capacity as the models ran. This "toll term" essentially calculated the marginal (incremental) congestion cost imposed by a vehicle choosing to enter the roadway system on all other users of the system. As a result, the model inherently balanced toll rates across all tolled roadways to maximize benefits (minimize costs) to the roadway system users. For Alternative 5 staff coded the "toll term" data as toll inputs, reset the travel model to use the normal volume-delay functions, and ran a "second pass" using only the travel models to produce the final travel model outputs for the Evaluation Report and the inputs used to produce BCA results.

For Alternatives 3 and 4 in which the arterials were not designated by design to be tolled, staff performed additional optimization of the "toll term" rates to apply only to the designated tolled freeways. They did so by borrowing findings from the "Tolling Concepts" analysis performed in the summer

Why two passes through the modeling for each alternative?

For the processes of setting toll rates and finalizing bus service levels staff needed preliminary model results that showed the transportation system response to major changes caused by actions in the alternatives that altered major physical and performance system characteristics.

For example, it is more appropriate to ask what toll rate to use for a roadway that will have two extra lanes in the future by examining how that facility will be used with the lanes but without tolls rather than by examining how that facility will be used without any extra lanes.

of year 2008 to give the Pricing Task Force (PTF) a preliminary examination of potential tolling strategies. The Tolling Concepts analysis examined a freeway-only tolling scenario and employed EcoNorthwest to set optimal toll rates. For the freeway-only tolling scenario EcoNorthwest used a mathematical process known as "Ramsey pricing" to calculate freeway-only tolls. This process took as inputs a model run applying the "modified volume-delay toll term" rates to freeways only, a run applying half the "toll term" rates to freeways only, and a run applying no tolls whatsoever. The Ramsey process then mathematically calculated the relative elasticities of the tolled links (freeways) to the non-tolled links (arterials) to maximize user benefit while minimizing diversion. Staff used the Tolling Concepts elasticities to adjust the Alternative 3 and 4 "toll term" rates to more optimal levels ("Ramsey rates") for freeway-only tolling. Staff coded the Ramsey rates as the tolls for "second pass" travel-model-only runs to produce final results for Alternative 4.

Finally, staff examined the revenues produced from the Ramsey toll rates in Alternative 3 compared to the revenues necessary to fund investments in that alternative on the freeways designated as tolled. To align revenues with proposed expenditures staff scaled the Ramsey rates to 80% of their original values on all tolled freeways to produce the final toll rates. These were then encoded for a "second pass" of travel-model-only runs to produce final results for Alternative 3.

It is important to note that the analytic process outlined above captured the land use response (through the land use forecast model iteration with the travel model) in slightly different ways. For alternatives 1 and 2, the land use responded to all the physical capacity changes but not to tolling, since the HOT system essentially sorts users in or out of a small portion of total roadway capacity (the non-HOV capacity for sale in the HOT lanes). For alternatives 3, 4, and 5 the land use response captured both physical system changes and the application of tolls since tolling the entire cross sections of significant

What was the "Tolling Concepts" analysis?

Under the direction of the Transportation Policy Board subcommittees known as the Transportation 2040 Working Group (WG) and the Pricing Task Force (PTF), staff did preliminary analysis of a variety of tolling strategies in the summer of 2008. This effort tested the analytic methods applied in setting toll rates and examined the potential benefits and impacts of different tolling strategies by themselves (absent other changes to the transportation system). Four strategies were tested on a year 2020 "baseline" network:

- full system tolling (tolling all arterials and freeways),
- freeway system tolling,
- one-lane HOT system using the existing HOV lanes, and
- parking cost surcharges applied to high-activity areas in the region.

amounts of roadway affects a large proportion of total roadway capacity.

5 How were roadway actions analyzed?

PSRC staff created a travel model link and node representation of the roadway and transit systems comprising each alternative for years 2006 (which was the same across all alternatives, including the Baseline), 2020, and 2040. The information in the Alternatives Specification (Appendix A) was used to create these networks. Roadway investments could add roads (add new links), widen roads (add lanes to existing roads), or change other physical or geometric characteristics of roads (upgrade so that attainable speed or capacity increased). Details of the location and nature of such changes may be found in Appendix A Addendum B. In addition, staff coded the networks to represent key policy guidance from the alternatives such as the presence of and constraints upon managed lanes. See Appendix A Addendum A for managed lanes policy specifications.

To ensure that longer-range location choices in the land use forecast model responded to user knowledge of future tolling applications and capital investments, the 2020 network was applied to the 2015 and 2025 travel model runs while the 2040 network was applied to the 2035 and 2040 model runs (see section 2 above for the general modeling flow).

6 How were transit actions analyzed?

The nature of the PSRC model suite dictates an iterative approach to implementing transit service differences across alternatives. Staff followed the process outlined below to create and analyze the model representation of the transit service “design philosophies” expressed in each of the plan alternatives:

1. Applied the transit “design” specified in Section 2 of the Alternatives Specification (Appendix A). Staff coded global changes to existing bus service levels in the Baseline with the values shown in Exhibit 3 as the starting point.

Exhibit 3. Baseline Base Year (2006) Transit Service Allocation

Service Type	2006 Base Year			
	AM Hours	AM %	MD Hours	MD %
Core	45,621	55.8%	39,315	73.9%
Connector	15,035	18.4%	12,863	24.2%
Specialized	21,073	25.8%	1,031	1.9%
Bus Rapid Transit	0	0.0%	0	0.0%
Total	81,729	100.0%	53,209	100.0%

2. Staff coded specific Bus Rapid Transit (BRT), Light Rail Transit (LRT), and Commuter Rail (CR) capital and service investments listed in Addendum C of Appendix A. Future Park and Ride capacities as specified in Appendix F

3. Staff adjusted bus service hours on routes for each service type per the guidance from Appendix A Section 2 of as summarized here:

Service Type	Service Hours Target Percent Increase (Annual)						
	Baseline	Core (to 2020)	Alt 1 (2020 to 2040)	Alt 2 (2020 to 2040)	Alt 3 (2020 to 2040)	Alt 4 (2020 to 2040)	Alt 5 (2020 to 2040)
Core	Per Appendix A Section 2	1%	1.25%	0.5%	0.3%	1%	2.5%
Connector		1%	1.25%	0.3%	0%	0%	2.5%
Specialized		1%	1.25%	0.4%	1%	1%	3%

Staff incorporated sketch planning (Transit Competitive Index/Sketch Planning Tool) results by coding transit service by corridor (BRT, signal prioritization, BAT lanes, service changes or additions) as expressed in Addendum F of Appendix A. Addendum F actions are based on input from transit agencies informed by ridership and market analyses done using the sketch planning tools (reports on those analyses are available separately).

- With the transit inputs from items (1) and (2) above staff ran the “first pass” of the integrated model framework as described in section 2 of this Appendix and equilibrated service supply and demand by comparing route ridership to route capacity and adjusting headways to match capacity to demand.
- Staff ran the “second pass” of Travel Demand Modeling described in Section 2 of this Appendix. These second pass runs provided the final configuration of transit service supply for each Alternative as tabulated in Exhibit 4. This service was used to estimate operating costs to add to the total cost of each alternative.

Exhibit 4. Final Bus Service Configuration, AM and Mid-day Transit Service Hours

Service type	2006 Service Hours**	Transportation System (2040)										
		Baseline Service Hours**	*Baseline % Change from 2006*	Alt. 1 Service Hours**	*Alt. 1 % Change from 2006*	Alt. 2 Service Hours**	*Alt. 2 % Change from 2006*	Alt. 3 Service Hours**	*Alt. 3 % Change from 2006*	Alt. 4 Service Hours**	*Alt. 4 % Change from 2006*	Alt. 5 Service Hours**
AM core bus service*	46,000 (56%)	53,000 (48%)	*17%*	55,000 (45%)	*21%*	54,000 (49%)	*18%*	55,000 (46%)	*22%*	57,000 (46%)	*25%*	55,000 (42%)
AM connector bus service*	15,000 (18%)	19,000 (17%)	*24%*	21,000 (17%)	*39%*	19,000 (17%)	*25%*	19,000 (16%)	*28%*	20,000 (16%)	*33%*	21,000 (16%)
AM specialized bus service*	21,000 (26%)	35,000 (31%)	*2%*	40,000 (32%)	*91%*	33,000 (30%)	*59%*	39,000 (32%)	*85%*	37,000 (29%)	*73%*	41,000 (31%)
AM bus rapid transit (BRT) service*	0	4,000 (4%)	-	7,000 (6%)	-	5,000 (4%)	-	8,000 (7%)	-	12,000 (9%)	-	16,000 (12%)
AM Bus Total	**82,000**	**111,000**	***36%***	**124,000**	***51%***	**111,000**	***36%***	**122,000**	***49%***	**125,000**	***53%***	**133,000**
Mid-day core bus service*	39,000 (74%)	45,000 (71%)	*15%*	45,000 (68%)	*14%*	44,000 (70%)	*13%*	45,000 (67%)	*67%*	45,000 (63%)	*15%*	44,000 (60%)
Mid-day connector bus service*	13,000 (24%)	15,000 (23%)	*13%*	15,000 (22%)	*13%*	14,000 (22%)	*10%*	14,000 (21%)	*21%*	15,000 (21%)	*17%*	15,000 (20%)
Mid-day specialized bus service*	1,000 (2%)	1,000 (2%)	*0%*	1,000 (1%)	*0%*	1,000 (2%)	*0%*	1,000 (2%)	*0%*	1,000 (1%)	*0%*	1,000 (1%)
Mid-day BRT service*	0	3,000 (4%)	-	6,000 (9%)	-	4,000 (6%)	-	7,000 (10%)	-	10,000 (14%)	-	13,000
Mid-day Bus Total	**53,000**	**64,000**	***20%***	**66,000**	***24%***	**63,000**	***19%***	**67,000**	***25%***	**72,000**	***34%***	**73,000**
AM light rail service*	112	2,900	*2,500%*	3,700	*3,200%*	4,800	*4,200%*	3,700	*3,200%*	4,800	*4,200%*	6,600
AM commuter rail service*	109	400	*235%*	400	*235%*	400	*235%*	400	*235%*	400	*235%*	800
Mid-day light rail service*	106	2,200	*2,000%*	3,000	*2,700%*	3,800	*3,500%*	3,000	*2,700%*	3,800	*3,500%*	5,600
Mid-day commuter rail service*	0	0	-	0	-	0	-	0	-	0	-	400
Total rail service*	**327**	**5,500**	***1,600%***	**7,100**	***2,100%***	**9,000**	***2,600%***	**7,100**	***2,100***	**9,000**	***2,600%***	**13,400**

* Hours of service during the morning peak and mid-day periods, not entire day. Numbers rounded to the nearest hundred or thousand, except for rail service in 2006, and may not sum precisely.

** Numbers in parentheses indicate the proportion of that service type out of the total bus service hours in that time of day (AM or Mid-day).

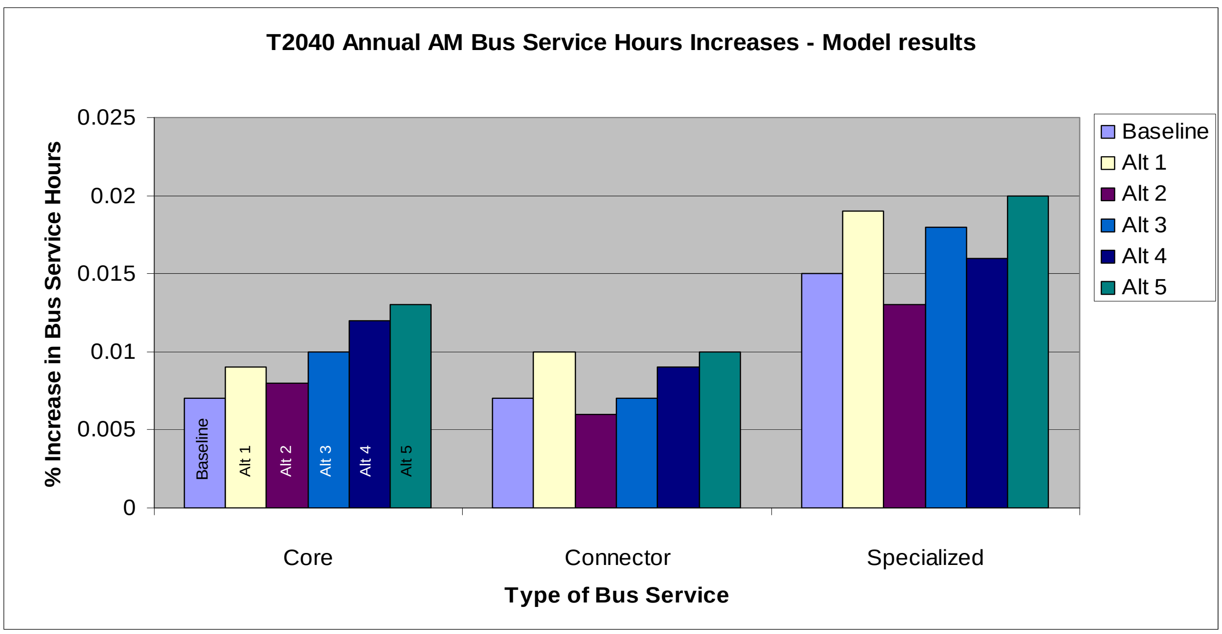
Exhibit 4. Final Bus Service Configuration (continued)

Final Bus Service Configurations Shown as Average Annual Growth by Alternative (Table)

Service	Baseline		Alt 1		Alt 2		Alt 3		Alt 4		Alt 5	
Type	AM	MD	AM	MD	AM	MD	AM	MD	AM	MD	AM	MD
Core	0.7%	0.6%	0.9%	0.7%	0.8%	0.6%	1.0%	0.8%	1.2%	1.0%	1.3%	1.1%
Connector	0.7%	0.4%	1.0%	0.4%	0.6%	0.3%	0.7%	0.3%	0.9%	0.5%	1.0%	0.4%
Specialized	1.5%	0.3%	1.9%	-0.1%	1.3%	0.4%	1.8%	0.2%	1.6%	0.1%	2.0%	0.0%
Total	0.9%	0.5%	1.2%	0.6%	0.9%	0.5%	1.2%	0.7%	1.3%	0.9%	1.4%	1.0%

Service hours increase for one hour of AM peak service or one hour of mid-day service
Core Service includes BRT service
Service hour increases take into account transit volumes on commuter and light rail systems that would otherwise have been on bus transit.

Final Bus Service Configurations Shown as Average Annual Growth by Alternative (Bar Chart)



7 How were "efficiency" or system management actions analyzed?

The regional travel model adds time to vehicle trips using arterial roadways to account for the delay imposed by intersection traffic controls such as signals and stop signs. This "intersection delay" appears as a term in the volume-delay functions for arterials; the term adds to the time required for a vehicle to traverse the link and leave it for the next link in its travel path. The model imputes intersection delay for all pertinent links as a function of each link's intersection geometry (number of competing inbound roadways and competing inbound lanes) and the volume of traffic on the link in each time period. In this way, intersection delay changes across the alternatives as a function of geometric roadway changes and travel volumes.

Staff worked with system management stakeholders and consultants to devise a means of modeling the effects of levels of Intelligent Transportation Systems (ITS) investments (signal timing, signal coordination, etc.) on arterials across the plan alternatives. They concluded that a general factoring of the intersection delay term across all urban arterial links would in aggregate represent the effects of these arterial system management investments. The factors used by alternative are presented in Exhibit 5.

Model terminology: what is a Volume-Delay Function (VDF)?

- Travel demand models use a mathematical formula to forecast how long a vehicle will take to travel along a given stretch of roadway. The stretch of roadway is represented in the model as a "link."
- VDF inputs include the amount of traffic trying to use the roadway (volume), the time it would take a vehicle to travel the roadway if there was no congestion, and the capacity of the roadway to carry vehicles in the form of the number of travel lanes.
- VDF output is the time it would take to travel along the roadway given all the traffic trying to use it at the moment.

Exhibit 5. ITS Investment Assumptions

Alternative:	Baseline	1	2	3	4	5
Intersection delay reduced by:	0%	11.25%	3.75%	7.5%	7.5%	11.25%
Intersection delay reduction represents:	No additional ITS investments	"High" ITS investment	"Low" ITS investment	"Medium" ITS investment	"Medium" ITS investment	"High" ITS investment

8 How were "demand management" actions analyzed?

Transportation Demand Management (TDM) actions included two efforts that were coded explicitly into the model inputs: vanpool program expansion and a suite of parking management strategies in Alternatives 1, 3, and 4. See Addendum E of Appendix A for details of these programs.

Vanpool Analysis

The regional travel model takes vanpool origin-destination trip tables as an input and uses a "previous mode choice" model to forecast the mode from which users switched after making the choice to travel by vanpool. The model then deducts the number of vanpool travelers in each "previous mode" from that mode's total of users to be assigned.

Staff allocated the increase in vanpool users (see Appendix A Addendum E for a tabulation thereof) in each action Alternative to existing vanpool origin-destination pairs in proportion to the Baseline allocation of vanpool trips among those same O-D pairs.

Parking Policy Analysis

While the regional travel model does not explicitly represent parking availability for trips made to destination zones by passenger vehicles (both SOV and HOV) it does apply parking charges to such trips. Daily charges are applied to work trips and hourly charges are applied to non-work trips for all passenger vehicle trips destined to each traffic analysis zone (TAZ) in which charges apply.

The Baseline base year (2006) configuration of parking charges across the region is based on observed data from the semi-annual PSRC Parking Survey. The historical trend shown by the Parking Survey indicates that parking rates tend to increase at 1.5% per year above the inflation rate. Parking charges in future years in the Baseline are factored up from the base year using this rate of increase and applied to the zones in

Model terminology: what are "Transportation Analysis Zones" (TAZ's)?

- A TAZ is an area of the region defined by a precise boundary for planning purposes. Each TAZ is both a potential destination and origin for trips as those trips are represented in the travel demand model. TAZ's are the smallest units within which the model represents activities (jobs by sector) and population (people living there who may choose to travel on a given day).

which parking charges existed in the base year. Alternatives 2 and 5 use the same parking charges as the Baseline.

Alternatives 1, 3, and 4 specify a variety of actions designed to reduce demand for SOV travel by managing parking supply, including among other policies a surcharge on parking rates in future years (see Section 2 of Appendix A for descriptions of these policies). These Alternatives also specify extending parking management strategies to areas of the region beyond those which already have parking charges. The Transportation 2040 modeling represented the cumulative effect of these policies by an increase in parking charges in selected TAZ's (see Addendum E of Appendix A for the surcharge definitions and a complete list of charges applied to each TAZ).

To balance the Alternative 1, 3, and 4 policy intent of extending the physical scope of parking management against stakeholder concerns that improperly applied policies would stifle economic activity, staff specified a statistical model that used activity density to forecast future parking charges in TAZ's. The intent of this approach was to choose additional zones beyond those charged in the Baseline and to set their parking charges based on their forecast growth.

The parking charge model was specified to include these variables:

- Total employment density (employees/acre)
- Retail employment density (retail employees/acre)
- Mean income of all workers for a given TAZ (from the 2000 Census Transportation Planning Package-T301C1)
- Mixed use as defined by the Mixed Use Urban Form (UF) input in the bike/walk portion of the travel model's mode choice component (see section 9 below)
- Percent of workers who commute to work by SOV
- Mean time to work for all commuters for a given TAZ

- Percent of TAZ excluding water and parks within ¼ mile of all transit stops by a network buffer.
- Number of off-street parking spaces per the 2006 inventory

This model was estimated both for hourly and daily parking charges using year 2006 population and employment data. That data was estimated from the 2000 Census and the 2005 PSRC Population and Employment Estimates so as to be consistent with the year 2006 PSRC Small Area Forecast (SAF). The 2020 and 2040 years of the SAF were used as inputs to the parking charge model to calculate rates by TAZ for years 2020 and 2040. The forecast parking charges from this method were compared to the Baseline parking charges in each TAZ and the larger of the two charges was retained. The final parking charges used for each TAZ in Alternatives 1, 3, and 4 are tabulated in Addendum E of Appendix A.

These assumptions produced the following average costs per vehicle passenger and per vehicle for all passenger vehicle trips in year 2040 forecasts:

Alternative:	Baseline	1	2	3	4	5
Per Person Cost	$0.38	$0.82	$0.41	$0.72	$0.70	$0.35
Per Vehicle Cost	$0.52	$1.12	$0.56	$0.98	$0.96	$0.48

9 How were bicycle and pedestrian actions analyzed?

The mode choice component of the regional travel model for bike and walk trips includes variables representing various aspects of urban form (UF) that account for the presence of non-motorized facilities and other aspects of the built environment that promote the choice of non-motorized modes. The UF factors are prepared as inputs to the travel model at the TAZ level and are calculated as follows:

1) Facilities - the ratio of non-motorized facilities (buffered to a quarter mile) to total land area by TAZ. (measure of walk and bike friendliness)

2) Mixed land use =A/(ln(N)) where

   $A = (b_1/a) + (b_2/a) + (b_3/a) + (b_4/a) + (b_5/a) + (b_6/a)$

   a = total square feet of land for all six land uses present in buffer

   b_1 = Square ft. of building floor area in education uses

   b_2 = Square ft. of building floor area in entertainment (recreation) uses

   b_3 = Square ft. of building floor area in single-family residential uses

   b_4 = Square ft. of building floor area in multifamily residential uses

   b_5 = Square ft. of building floor area in retail uses

   b6 = Square ft. of building floor area in office uses

   N = number of six land uses with FAR>0

   Note that "mixed land use" approaches 1 if there is an even amount of square feet of floor area of each land used type.

3) Retail floor area ratio (FAR) - Retail building floor area (sq. ft) divided by retail land area (sq. ft.)

4) Intersection Density - Number of street intersections per sq. kilometer.

Staff concluded that the last three factors were unlikely to vary dramatically across the alternatives so all alternatives used "mixed use," "retail floor area ratio," and "intersection density" inputs from the Baseline years 2006, 2020, and 2040.

To calculate the "facility" UF factor (off-road non-motorized facilities) staff mapped the bicycle and pedestrian trail investments tabulated in Addendum G of Appendix A using Geographic Information System (GIS) software and calculated individual non-motorized facility inputs for each Action Alternative for years 2020 and 2040. See Appendix A, Addendum G Part 2 for a tabulation of the facility UF factors for the Transportation 2040 analysis.

10 How were air quality (AQ) impacts analyzed?

The criteria air pollutants were analyzed using EPA's MOBILE6.2 vehicle emissions modeling software. The inputs to MOBILE6.2 include the region's vehicle fleet, Inspection and Maintenance program parameters and other regional attributes as provided by Ecology. The regionwide analysis differed slightly than the analysis conducted to demonstrate transportation conformity in terms of the breakout of the vehicle fleet: for conformity, there are specific modeling parameters that must be followed based on the methodology used in the State Implementation for Air Quality; for the regionwide analysis, the vehicle fleet was separated into three components to more closely match what's included in the travel demand model (passenger vehicles and light trucks, commercial vehicles and light trucks, and heavy duty trucks).

EPA's draft Motor Vehicle Emission Simulator (MOVES) software was used to model greenhouse gas emissions, represented as carbon dioxide equivalents (and hereafter referred to as CO2).

MOVES functions similarly to MOBILE6.2 in that emission factors are produced for different speeds – rather than the individual speeds between 3 and 65 miles per hour, however, MOVES uses 16 speed bins. With the exception of the conformity analysis, both the MOVES emission factors for CO2 and the MOBILE6.2 emission factors for all other pollutants were then incorporated into the BCA tool so that emissions and costs could be calculated and reported in one unifying framework. The conformity analysis was performed using PSRC's standard practice, working with output from the travel demand model outside of the BCA tool.

Emissions for all pollutants were calculated on an individual link basis, based on the vehicle miles traveled and speed of each link. This calculation was performed separately for each of five time periods (a.m. peak, midday, p.m. peak, evening, and nighttime). The calculated emissions of individual links were then summed for each of the five time periods, which in turn were summed for the total daily emissions.

11 How were energy impacts analyzed?

The Energy Analysis conducted for the Transportation 2040 alternatives consisted of both energy consumption from buildings (residential, commercial and industrial) and from on-road mobile sources.

The building energy analysis is based on data from recent surveys conducted by the US Energy Information Administration to estimate annual building-related electricity and fuel use. PSRC used building-level variables generated within the UrbanSim model environment. Consumption for non-residential buildings was estimated using the building floor area, by building type: commercial, industrial, office, or warehouse. Consumption for residential buildings was estimated with a combination of floor area and household size, also by building type: single-family or multifamily, with a flat rate for mobile homes. There are buildings in the region that are not characterized by these primary building types; since these buildings are primarily unchanged among the alternatives, they are unnecessary for comparison purposes and were omitted from the analysis. For this reason PSRC's regional estimates are likely to be lower than measured, regional totals.

EPA's draft MOVES software was utilized to estimate energy consumption from the total vehicle miles traveled in each of the Transportation 2040 alternatives.

12 What actions were not captured or captured only partly in the quantitative analysis?

The plan alternatives include a great variety of programs and investments. While PSRC has significantly upgraded its analytic toolkit, even the new models are not sensitive to all potential programs and investments. In addition to the constraints on modeling technology, some proposals were made at a conceptual level with insufficient detail or an established methodology with which to perform meaningful analysis during the alternatives evaluation portion of the plan update.

Below are listed proposed actions that have been discussed qualitatively rather than quantitatively in the evaluation of the alternatives.

- Travel Demand Management
  - Education and Outreach programs
  - Transit Fare Subsidies
- System Management
  - Transit Signal Priority
- Park and Rides
  - An "outer tier" strategy that rethinks how and when the region supplies costly Park and Ride infrastructure.
  - Charging for parking
- Certain Bicycle Pedestrian programs
  - Education and Outreach
  - Bike Share
  - Regional Wayfinding