

Figure 6 –Tacoma Travel Model Transit Network

The park and ride lots in Pierce County were updated to match current parking space capacity and transit connectivity. A list of the park and ride lots and their capacity is found in **Appendix C**.

TIDEFLATS TRUCK TRIP GENERATION MODULE

Chapter 10 of the PSRC model documentation describes the Truck Model. The PSRC model has a truck trip generation rate for all land uses and a “special generator” for the Port of Tacoma (PSRC TAZs 676, 678, 770). A major enhancement of the TTM is an expansion, validation, and refinement of the Port of Tacoma special generator to include additional TAZs in the Tideflats area. Below were the steps used to develop the expanded “Tideflats Special Generator” for truck trips:

1. The special generator input files from the PSRC model were updated to include more TAZs in the Tideflats area. The special generator files are as follows: SPLHVY.IN, SPLMED.IN, SPLLGT.IN. Figure 7 shows the difference between the PSRC special generator



SPLHVY.IN input file and the same file for the TTM. Note that there are many more TAZs included in the TTM version of the file.

2. Update the truck counts in the special generator input files to match observed truck counts in the Port of Tacoma and Tideflats areas. The numbers shown in the rightmost column of the special generator file (Figure 7) are the number of daily heavy truck trips. These truck trips were based on heavy vehicle truck trip counts taken in 2010 as part of the Tideflats Area Transportation Study. The observed truck trips were distributed to the TAZs in the Tideflats area. **Appendix D** summarizes the data prepared by Heffron Transportation for the special generator input files. The truck count data are stored in a Synchro file that has been transmitted to the City of Tacoma.
3. Factor the truck counts to 2014 conditions. All the 2010 truck counts were factored up assuming a one percent annual increase in truck traffic between 2010 and 2014.

```
File Edit Actions Options Window Help
289
D:\PSRC\2006\TripGen\InputTRK\SPLHVY.IN
C:\Tacoma\2012_110314\TripGen\InputTRK\SPLHVY.IN

00000 * * * Top of File * * *
00001 c Year 2006
00002 t matrices
00003 c Special Generator Trips
00004 c
00005 m matrix=md"splhvy"
00006 c Port of Seattle
00007 all: 160 619
00008 all: 180 2750
00009 all: 181 687
00010 c Port of Tacoma
00011 all: 676 241
00012 all: 678 1203
.....1.....2.....3.....4.....+.....
00013 all: 770 344
00014 c Along SR-167 Corridor Only
00015 all: 451 0
00016 all: 769 41
00017 all: 406 9
00018 all: 407 235
00019 all: 766 13
00020 all: 331 73
00021 all: 764 25
00022 all: 870 37
00023 all: 342 8
00024 all: 433 409
00025 all: 434 172
00026 * * * End of File * * *

00001 c Year 2012
00002 t matrices
00003 c Special Generator Trips
00004 c Regional Heavy Special Generators
00005 c With Port of Tacoma modifications
00006 c Port of Seattle
00007 all: 160 700
00008 all: 180 3100
00009 all: 181 775
00010 c Along SR-167 Corridor Only
00011 all: 451 0
00012 all: 769 46
00013 all: 884 46
00014 all: 885 46
00015 all: 886 46
00016 all: 887 46
00017 all: 888 46
00018 all: 406 9
00019 all: 407 257
00020 all: 766 14
00021 all: 331 80
00022 all: 764 27
.....1.....2.....3.....4.....+.....
00023 all: 870 41
00024 all: 342 9
00025 all: 433 409
00026 all: 434 172
00027 c Port of Tacoma
00028 all: 668 300
00029 all: 669 300
00030 all: 670 1000
00031 all: 671 300
00032 all: 676 600
00033 all: 677 600
00034 all: 678 600
00035 all: 770 300
00036 all: 878 300
00037 all: 879 300
00038 all: 880 300
00039 all: 881 300
00040 all: 882 300
00041 all: 883 300
00042 all: 884 300

=====>
```



Figure 7 – PSRC Version 1.00b (Left) and Tacoma Travel Model (Right) Special Generator Input File for Heavy Trucks (SPLHVY.IN)

Figure 8 shows the truck assignment output of the base year TTM – note that most of the truck flows are on I-5 and SR 16, but there is a noticeable volume generated in the Tideflats area due to the Tideflats Special Generator.



Figure 8 –Tacoma Travel Model Truck (Medium and Heavy Vehicle) Assignment



UPDATED SOCIODEMOGRAPHIC AND TRIP GENERATION FILES

Sociodemographic Data

As described in Chapter 5 of the PSRC model documentation, a key element of the overall model structure is the sociodemographic characteristics of households. This data influences model components such as vehicle availability, mode choice, and trip generation. Version 1.00b of the PSRC model was based on sociodemographic data from the 2000 US Decennial Census. As part of the TTM development, the sociodemographic data were updated using the most recent 2010 Decennial Census data from the US Census Bureau. This data updates the proportions of the households in each of the 256 household cross-classification categories defined in the model.

Trip Generation Rates

In conjunction with the updated sociodemographic information, the PSRC updated the trip generation rates in the 4K model based on data in the 2006 household travel survey. While we have adopted these trip generation rates in the TTM, there is no current documentation on how the PSRC developed these rates. However, our independent analysis of the performance of the PSRC model does indicate that the 4K model trip generation results more closely match observed traffic and transit data. Due to the complex nature of the trip generation rate input file structure, a screenshot comparison of the PSRC Version 1.00b and TTM rates is not practical (since there are many land use categories and trip purposes); however, the new 4K rates are about 10 percent higher than the Version 1.00b rates. **Table 2** lists the trip generation rate input file names to facilitate a direct comparison between the prior and new PSRC rates.

Table 2 – Trip Generation Rate Input File Names

Trip Rate Category	PSRC Version 1.00b	Tacoma Travel Model
Residential Trip Rates	Xcrates.ma2	HH-triprates.in
Non-Residential Trip Rates	NRRATES.ma2	nonhh_triprates.in
Household Three-Way Classification File	XCHH.ma2	pumsxc_income-size-workers.in
Households with School Age Children	XCSC.ma2	pumsxc_income-k12students.in
Households with College Students	XCCO.ma2	pumsxc_income-collegestudents.in



Even with the updated trip generation rates, the early model validation results indicated that while regional roadways (I-5 and SR 16) had reasonable traffic levels, many city streets had too little traffic compared to observed counts. To improve the model performance, several additional modifications were made to the TTM macros:

1. **NEWVECS.MAC:** This macro initializes all the matrices in the trip generation emmebank. It was revised to create new matrix/vector files to accept the Tacoma-specific trip rate adjustments (see lines 81 and 115).
2. **DATRATIN.MAC:** This macro reads in all pertinent input files to run the trip generation model. The macro was revised to read in the Tacoma-specific trip rate adjustments (and store them in the empty matrices generated by the NEWVECS.MAC file). The production rate adjustment for Tacoma is: TACO_FLAG_TGP.IN and the attraction rate adjustment is TACO_FLAG_TGA.IN. See lines 63 through 68. The adjustments apply to all City of Tacoma TAZs and the factor is 1.3 for the TAZs north of SR 16/I-5 and 1.15 for the TAZs south of SR 16/I-5. These adjustment factors were developed through iterative runs of the TTM to improve the model validation statistics.
3. **Balance.mac:** This macro was revised to multiply the unbalanced productions and attractions with the expansion factors (TACO_FLAG_TGP.IN and TACO_FLAG_TGA.IN). See lines 26 through 43.

In working with other jurisdictions with the 4K trip generation rates (e.g., Bothell, Federal Way), these types of adjustments are common, suggesting that the 4K model still requires additional refinement before it is practical for widespread application.

TRAVEL ASSIGNMENT

Traffic Assignment

Fehr & Peers updated the volume delay functions (VDFs) to improve the performance of the traffic assignment portion of the TTM. While we have no documentation on the original background for updating the VDFs, they were developed in conjunction with WSDOT for Fehr & Peers' work on the I-405 Corridors project. The VDFs were specifically developed to reduce the PSRC model's tendency to "over-assign" traffic to the freeway corridors compared to adjacent arterial corridors with less congestion. In other words, the standard PSRC VDFs tend to make major regional roadways more "attractive" compared to typical city arterials and collectors. These



VDFs have been used on more than 20 model updates over the past 15 years due to their superior performance for forecasting local traffic patterns¹.

The VDFs were developed based on the current Highway Capacity Manual's recommendations for VDFs for large regional travel demand models. The new VDFs are based on functional class and speed. The VDFs used in the PSRC Version 1.00b and TTM are shown in **Table3**.

Transit Assignment

The transit assignment process has been modified from the approach used by PSRC in the regional travel model. The transit assignment methodology used in the TTM mirrors the methodology used in the Sound Transit Incremental Transit Ridership Model. Specifically, the TTM adopts Sound Transit's Boarding Penalty, Wait Time Factor shown in Table 3-1 in **Appendix E**. As noted in the Appendix documentation, the Sound Transit methodology better accounts for passenger bias in selecting both mode and station locations for boarding/alighting based on factors other than transit headways/speeds that are considered in the PSRC model framework. See the AMTRANHW.MAC file, line 18 for the specific change. To work with the updates in the transit assignment macro, the transit nodes in the network file have been flagged to identify the following, consistent with the Sound Transit methodology:

- Regular bus stops
- Transit centers (for bus boardings—including Tacoma Dome, Tacoma Community College, Lakewood, and Tacoma Commerce Street)
- Rail stations (e.g., Sounder and Tacoma Link)

The approach in the Sound Transit model has been approved by the FTA and provides greater flexibility in how different stations are represented in the model and more accurately reflects observed boarding and transfer patterns.

¹ Updating the VDFs in conjunction with increasing the trip generation rates is consistent with the PSRC model's tendency to over-assign freeway volumes with the standard VDFs. As more traffic is spread out from the freeways and major highways (what PSRC validates to), additional vehicle trips are necessary to reproduce traffic counts.



Table 3 –Volume Delay Functions

Speed (MPH)	PSRC Version 1.00b	Tacoma Travel Model
< 30	$fd5 = (\text{length} * 60 / \text{ul2}) * (1 + 0.60 * (\text{HRFAC} * \text{volau} / (\text{ul1} * \text{lanes}))^{5.8} + e11 / ((1 - \text{get}(1)).\text{max}.0.01))$	$fd1 = (\text{length} * 60 / \text{ul2}) * (1 + 1.5 * (\text{HRFAC} * (\text{volau} / (\text{lanes} * \text{ul1}))^4)$
30		$fd2 = (\text{length} * 60 / \text{ul2}) * (1 + 1.2 * (\text{HRFAC} * (\text{volau} / (\text{lanes} * \text{ul1}))^5)$
35		$fd3 = (\text{length} * 60 / \text{ul2}) * (1 + 1 * (\text{HRFAC} * (\text{volau} / (\text{lanes} * \text{ul1}))^5)$
40		$fd4 = (\text{length} * 60 / \text{ul2}) * (1 + 0.7 * (\text{HRFAC} * (\text{volau} / (\text{lanes} * \text{ul1}))^5)$
45		$fd5 = (\text{length} * 60 / \text{ul2}) * (1 + 0.72 * (\text{HRFAC} * (\text{volau} / (\text{lanes} * \text{ul1}))^5)$
50	$fd3 = \text{put}((\text{length} * 60 / \text{ul2}) * (1 + 0.56 * (\text{HRFAC} * \text{volau} / (\text{ul1} * \text{lanes}))^{6.0})) + \text{length} * ((0.5639 + \text{put}(\text{get}(1) / \text{length}) * (0.6398 + \text{get}(2) * (-0.0712 + \text{get}(2) * (0.0004 + 0.00009 * \text{get}(2))))))$	$fd6 = (\text{length} * 60 / \text{ul2}) * (1 + 0.74 * (\text{HRFAC} * (\text{volau} / (\text{lanes} * \text{ul1}))^5)$
55		$fd7 = (\text{length} * 60 / \text{ul2}) * (1 + 0.1 * (\text{HRFAC} * (\text{volau} / (\text{lanes} * \text{ul1}))^{10})$
60	$fd1 = \text{put}((\text{length} * 60 / \text{ul2}) * (1 + 0.72 * (\text{HRFAC} * \text{volau} / (\text{ul1} * \text{lanes}))^{7.2})) + \text{length} * (0.\text{max}(-.5639 + \text{put}(\text{get}(1) / \text{length}) * (0.6398 + \text{get}(2) * (-0.0712 + \text{get}(2) * (0.0004 + 0.00009 * \text{get}(2))))))$	$fd8 = \text{put}((\text{length} * 60 / \text{ul2}) * (1 + 0.72 * (\text{HRFAC} * (\text{volau} / (\text{lanes} * \text{ul1}))^{7.2})) + \text{length} * (0.\text{max}(-0.5639 + \text{put}(\text{get}(1) / \text{length}) * (0.6398 + \text{get}(2) * (-0.0712 + \text{get}(2) * (0.0004 + 0.00009 * \text{get}(2))))))$
70		$fd10 = (\text{length} * 60 / \text{ul2}) * (1 + .32 * (\text{HRFAC} * (\text{volau} / (\text{lanes} * \text{ul1}))^7)$
Centroid	$fd9 = (\text{length} * 60 / \text{ul2})$	$fd9 = (\text{length} * 60 / \text{ul2}) * (1 + 1.5 * (\text{HRFAC} * (\text{volau} / (\text{lanes} * \text{ul1}))^4) \text{ or } (\text{length} * 60 / \text{ul2})$
<p>Notes:</p> <ul style="list-style-type: none"> • fd: Function Definition (part of EMME macro language) • length: Link distance • UL2: Speed in EMME model • HRFAC: EMME Time Period Peak Hour Factor (AM=.375, PM=.35,MD=.184,EV=.354,NI=.255) • Volau: EMME Total Vehicle Demand for Time Period • Lanes: Number of Lanes • UL1: EMME Capacity (vphpl) <p>Generally, the speed to function relation is usually used. During the validation effort some facilities had their VDFs modified to reflect congestion. The VDF for 60 miles per hour was created by WSDOT/TRAC to reflect reliability in freeway operations.</p>		



Park-and-Ride

The process to determine demand at park-and-ride lots was also modified. The PSRC model assumes that all park and ride lots have the same attractiveness and capacity (approximately 300 stalls). The TTM has an attractiveness factor that better reflects observed utilization by modifying the following files:

- PRFAC.311 – This input file was created for the TTM and creates a par-and-ride lot capacity factor that is based on dividing the total park-and-ride lot capacity by 250. This results in a capacity result ranging between 0 and 10 for all lots in the region.
- The PRSPLIT.MAC macro was updated to read and apply the PRFAC.311 input file when estimating usage. **Figure 9** compares the Version 1.00b PRSPLIT.MAC file to the TTM version of the file. The main difference is the deletion of line 33 of the Version 1.00b file (which set all the PRFAC values to 1). By including capacity in the park-and-ride assignment routine, we get much more realistic results. **Figure 10** shows a comparison of utilization of the Tacoma Dome park-and-ride lot when applying the Version 1.00b and the TTM methodologies. As shown, the TTM method produces superior results (134 entries in the AM peak period for the PSRC model compared to 2,212 entries for the TTM – the most recent WSDOT data from Fall 2013 indicates daily usage of about 2,270 stalls at peak utilization²).

² http://www.wsdot.wa.gov/NR/rdonlyres/7F57E292-9768-4E9E-AE8B-F95268966C21/0/PugetSoundParknRide_Fall2013.pdf



```
KEDIT
File Edit Actions Options Window Help
289
D:\PSRC\2006\Bank1\Run1Mac\PRSPPLIT.MAC
00023 --+|1y|ms92|n|mf"hbwdp"|||n|+|2
00024 --+|1y|md91|n|md"prcap"/0.59*(ms92/ms91*1.05).max.1).max.10||n|2
00025 --+|1y|mf"prexcs"|n|0|||n|2
00026 q
00027 /
00028 --/ Calculate utilities and set attractiveness factor to 1 for all lots
00029 /
00030 3.21
00031 --+|1y|mf91|n|exp(-0.199*mf"aulcos")|||y|1,1000|1001,1200||2
00032 --+|1y|mf92|n|exp(-0.034*(mf"attrwa".min.1000))|||y|1001,1200|1,1000||2
00033 --+|1y|md"prfac"|n|1|||n|2
00034 q
00035 /
00036 --/ Call macro to split table, using the following matrices:
|...+...1...+...2...+...3...+...4...+...5...+...6...+...7...+...8...+...9...+...10...+...11...+...12...+...
00037 --/ mf"hbwdp" - Demand md91 - P&R capacities
00038 --/ mf91 - auto utility md92 - P&R use
00039 --/ md"prfac" - P&R attractiveness (==1) mf93 - tempf3 >> mf"hbwtaw"
00040 --/ mf92 - transit utility mf94 - tempf4 >> mf"hbwtaw"
00041 --/ md99 - >> md"prbal"
00042 3.21
00043 --+|1y|md92|n|0|||n|2
00044 --+|1y|mf"hbwtaw"|n|0|||n|2
00045 --+|1y|mf"hbwtaw"|n|0|||n|2
00046 q
00047 -t1=1,1000 / Origin TAZs
====>

C:\Tacoma\2012_110314\Bank1\Run1Mac\PRSPPLIT.MAC
00029 --+|1y|mf"prexcs"|n|0|||n|2
00030 q
00031 /
00032 --/ Calculate utilities and set attractiveness factor to 1 for all lots
00033 /
00034 3.21
00035 --+|1y|mf91|n|exp(-0.199*mf"aulcos")|||y|1,1000|20001,25000|1001,1200||2
00036 --+|1y|mf92|n|exp(-0.034*(mf"attrwa".min.1000))|||y|1001,1200|1,1000|20001,25000||2
00037 q
00038 /
00039 --/ Call macro to split table, using the following matrices:
00040 --/ mf"hbwdp" - Demand md91 - P&R Capacities
00041 --/ mf91 - auto utility md92 - P&R use
00042 --/ md"prfac" - P&R attractiveness (BOB) mf93 - tempf3 >> mf"hbwtaw"
|...+...1...+...2...+...3...+...4...+...5...+...6...+...7...+...8...+...9...+...10...+...11...+...12...+...
00043 --/ mf92 - transit utility mf94 - tempf4 >> mf"hbwtaw"
00044 --/ md99 - >> md"prbal"
00045 3.21
00046 --+|1y|md92|n|0|||n|2
00047 --+|1y|mf"hbwtaw"|n|0|||n|2
00048 --+|1y|mf"hbwtaw"|n|0|||n|2
00049 q
00050 --/ Origin TAZs
00051 -t1=1,1000|20001,25000
00052 --/ PR lot TAZs
00053 -t2=1001,1200
====>

Line=42 Col=1 Alt=0,0,0 Size=79 Files=2 Windows=2 OVR R/W 12:04 PM
```

Figure 9 – PRSPPLIT.MAC Comparison: Version 1.00b (top), TTM (bottom)

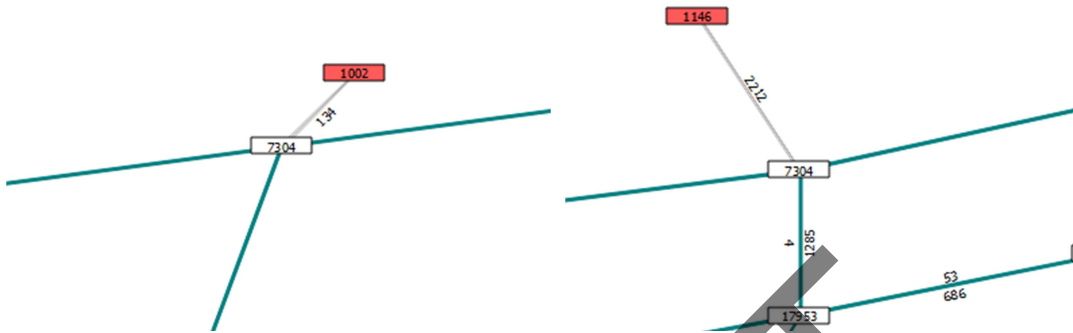


Figure 10 – Comparison of Tacoma Dome Park-and-Ride Lot Utilization: Version 1.00b (left), TTM (right)

MODEL VALIDATION

The validation effort for the base year TTM model runs was focused on PM peak hour travel demand at a collection screenlines in and around Tacoma. The TTM does not explicitly generate PM peak hour volumes, so the PM peak three-hour volumes are factored to represent PM peak hour conditions. The factor used to scale the PM peak hour from the three-hour data is 0.38, which is based on a Tacoma-specific adjustment of Fehr & Peers typical peak hour factor developed to estimate peak hour traffic volumes in the Central Puget Sound. **Appendix F** contains an excerpt from a peer review of Fehr & Peers' version of the Seattle Travel Model, which is also based on the Version 1.00b platform. As described in the Appendix, a PM peak hour factor of 0.37 was developed by comparing PM peak hour to peak period counts throughout Seattle. Initial testing of the TTM indicated that this factor was too low and better validation results were obtained by using a 0.38 factor. The higher factor is reasonable for Tacoma given that Tacoma would be expected to experience less peak period spreading than Seattle.

The map shown in **Figure 11** shows the screenline locations. Further validation was performed for downtown and citywide mode splits. Truck volumes were checked against the observed data at several key locations, shown in **Figure 12** although no specific model validation efforts were made for truck volumes.

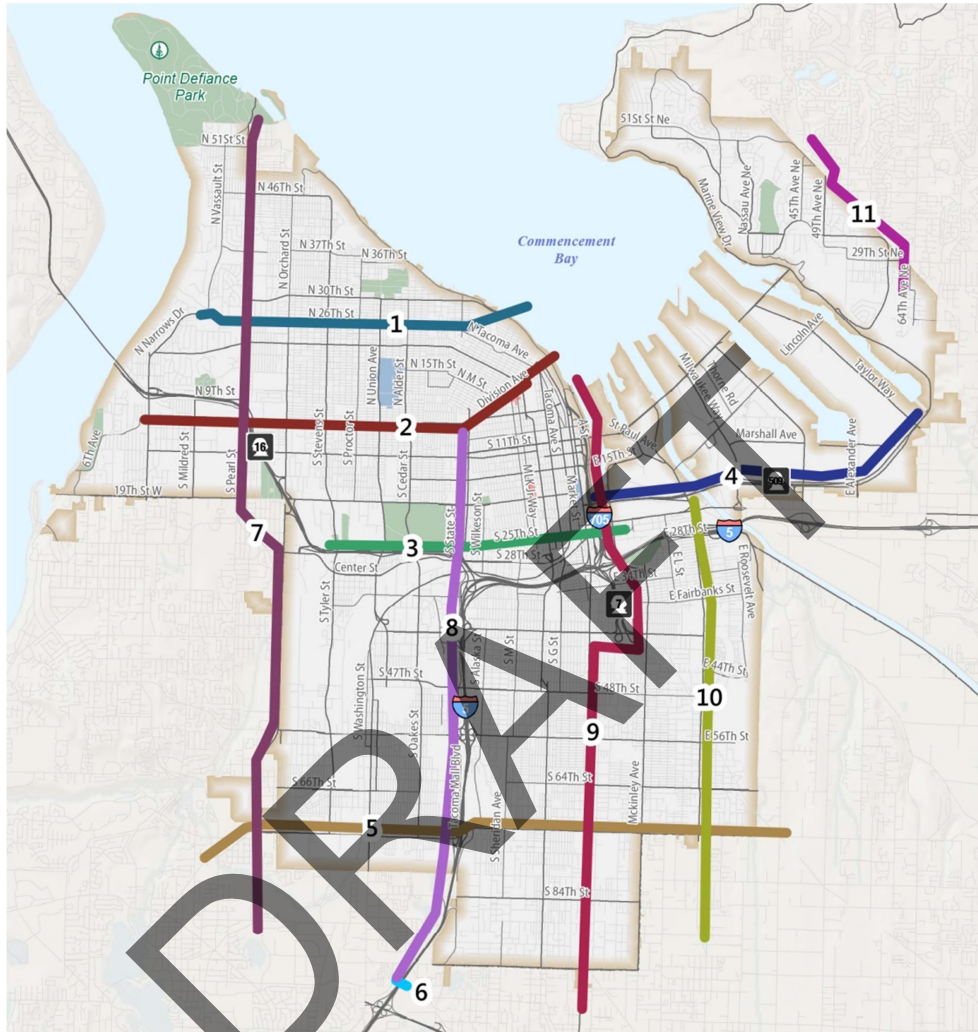


Figure 11 –Tacoma Travel Model Screenline Locations