Appendix F

Parking Policy Report
Appendix B

Methodology for Calculating Parking Demand

This technical appendix includes two worksheets for calculating parking demand for general office uses. Worksheet A should be used to derive demand generated by office uses and Worksheet B should be used to calculate demand for manufacturing uses. The methodology requires that three out of four data items are known, or can be obtained. Data needed for all office and manufacturing uses include:

- Total gross square feet (gsf) of space;
- Overall occupancy rate (inverse of the overall vacancy rate);
- Average employee density or the number of employees per 1000 gross leased square feet of space;
- Total number of employees.

With three of four data items, the missing fourth item can be calculated via one of the following formulae:

$$\text{Total 1,000 gsf} = \frac{\text{total employees}}{(\text{occupancy rate} \times \text{employee density})}$$

$$\text{Overall occupancy rate} = \frac{\text{total employees}}{(\text{total 1,000 gsf} \times \text{employee density})}$$

$$\text{Average employee density} = \frac{\text{total employees}}{(\text{total 1,000 gsf} \times \text{occupancy rate})}$$

$$\text{Total employees} = (\text{total 1,000 gsf} \times \text{occupancy rate} \times \text{employee density})$$

Additional statistics required to calculate or project parking demand include average employee density (employee per thousand gross leased square feet) and the average occupancy rate (inverse of the overall vacancy rate).

Calculations shown in worksheets A and B are based on known or estimated numbers of employees and estimated percentage splits of different travel modes. The examples provided are suburban non-CBD area with some transit service. The mode split assumptions were taken from actual data collected in King County. The figures for average employee density were taken from a Metro parking study conducted in October 1991. More locally relevant mode split, employee density and average occupancy data should be substituted.

The worksheets show calculations for deriving total parking demand in spaces per 1,000 gross leased square feet of space. The final demand rates are bolded for easy reference. General assumptions made in both worksheets include the following:

- A maximum of 85 percent of employees are present at one time. This accounts for absences due to vacation, illness and parental leave.

- Calculated demand is adjusted upward by ten percent to account for practical capacity. Practical capacity takes into account the widely accepted principle that only 85-90 percent of supply is effectively utilized because of inherent circulation problems within

parking areas during peak times and misparked vehicles.[1] Unused capacity is greater in CBD areas than in outlying suburbs, and affects visitor parking slightly more than employee parking.

Table A provides examples of parking demand per 1,000 gross leased square footage based on different levels of employee density. In order to convert to spaces per 1,000 gross square feet of space, it is necessary to multiply these figures by the overall occupancy rate.

This methodology can be used to estimate future parking demand by applying employee or total square footage projections. Mode split assumptions should be adjusted to correspond with expected shifts resulting from the achievement of commute trip reduction goals.

[1]Robert Weant and Herbert Levinson, Parking, ENO Foundation, 1990.

Projecting Employee Parking Demand Reductions and High-Occupancy Vehicle (HOV) Demand

Assuming a suburban non-CBD, suburban CBD, or high-density scenario, Worksheets C, D, and E present methodology for projecting employee parking demand reductions and HOV parking demand. This methodology was applied to obtain the figures presented in Tables 5 and 6 in Appendix A of this report.

The projections are based on the assumption that goals for reducing the use of single-occupant vehicles are met in 1995, 1997, and 1999. The mode split assumptions were based on real TDM examples in each of the scenarios and the SOV rates shown for future years represent 15 percent, 25 percent, and 35 percent reductions from the base year SOV rate. The base number of employees under all scenarios – 5,000 employees -- is arbitrary, but does not affect the relative changes in parking demand projected here. The employee growth rate assumed was 2 percent per year. More relevant mode split and employee growth projections could be substituted locally.

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[1]Robert T. Dunphy, "Traffic and Parking: A New Generation of Information," *Urban Land*, May 1988, p. 8.

[2] Marya Morris, "Parking Standards - Problems, Solutions, Examples," *Planning Advisory Services Memo*, American Planning Association, July 1989, p. 1.

[3] Ibid., p. 1.

[4] Ibid., p. 2.

[5] Washington State Transportation Center, *Land Use-Transportation Linkage: Working Paper*, August 1991, p. 36.

[6] Ibid., pp. 36-37.

[7] Municipality of Metropolitan Seattle, *Parking Utilization Study*, unpublished results, Seattle, Washington, 1992.

[8] Municipality of Metropolitan Seattle, *HOV/TSM Study: Parking Generation Data*, memo written by Paul Roybal, 1990.

[9] Wayne Swanson, "Parking: How Much Is Enough?", *Planning*, July 1989, p. 16.

[10] Ibid., p. 16.

[11] Washington State Transportation Center, *Land Use-Transportation Linkage: Working Paper*, August 1991, p. 34.

[12] Gruen, Green & Associates, Employment and Parking in Suburban Business Parks: A Pilot Study, Urban Land Institute, Washington, DC, 1986.

[13] Robert T. Dunphy, "Traffic and Parking: A New Generation of Information," *Urban Land*, May 1988, p. 8.

[14] Wayne Swanson, "Parking: How Much Is Enough?", *Planning*, July 1989, p. 16.

[15] Ibid., p. 16.

[16] Ibid., p. 1.

[17] Robert Weant, ENO Foundation, 1987.

[18] Cy Ulberg, *Local Option Commercial Parking Tax Analysis*, Washington State Transportation Center, January 1992, P. xviii.

[19] Municipality of Metropolitan Seattle, *The Effects of Parking on Mode Choice in Downtown Seattle and Bellevue*, unpublished draft, December 1991.

WORKSHEET A: PARKING DEMAND CALCULATIONS - - OFFICE USES

Input of locally relevant data required for bolded figures.

General Assumptions:	**1000 Gross Square Feet or space (kGSF)**:	**2000.00 kGSF**
	Average Occupancy Rate:	**x 95%**
	1000 Gross Leased SqFt (kGLSF):	1900.00 kGLSF
	Average Employee Density:	**3.97 employee per kGLSF***
	Percent Present at one Time (PAOT):	85%
	Visitor Parking Rate:	0.25 spaces/employee **
	3.97 employees per kGLSF* 1900 kGLSF =	7543 employees
		x 85% PAOT
	Peak Present at one Time:	6412 employees

Mode Split Assumptions:	Modal Share	Persons	Persons Trips (A X B)	AVO#	Vehicles (C/D)
Single Occupant Vehicle	85.0%	6412	5450	1	5450
Carpool/Vanpool	12.5%	6412	801	2.1	382
Transit	2.0%	6412	128		
Walk/Bike/Telecommute	0.5%	6412	32		
	100.0%		6412		5831

Peak Employee Parking Demand:	5120 vehicles + 359 vehicles =	5831 spaces + 10% (practical capacity) =	6415 spaces
Peak Visitor Parking Demand:	7087 employees X 0.25 spaces per employee divided by 4 (turnover rate) X 85% (%SOV) =	401 spaces + 10% (practical capacity) =	441 spaces
Total Peak Parking Demand:			6855 spaces

Employee Parking Rate:	6415 emp. spaces/1900 kGLSF =	3.38 spaces/kGLSF
Total Parking Rate/Employee:	6855 total spaces/7087 emp's =	0.91 spaces/emp.
Total Parking Rate/kGLSF:	6855 total spaces/1900 kGLSF =	3.608 space/kGLSF
Total Parking Rate/kGSF	3.608 (spaces/kGLSF) X 0.95 (occupancy rate) =	**3.428 spaces/kGSF**

* Average employee density from Metro Parking Study for suburban office sites in King and S. Snohomish Counties.
** Represents high end of visitor demand found in Metro Parking Study, 1991.
# Average Vehicle Occupancy

WORKSHEET B: PARKING DEMAND CALCULATIONS - - MANUFACTURING USES

Input of locally relevant data required for bolded figures.

General Assumptions:		
	1000 Gross Square Feet or space (kGSF):	**2000.00 kGSF**
	Average Occupancy Rate:	**x 95%**
	1000 Gross Leased SqFt (kGLSF):	1900.00 kGLSF
	Average Employee Density:	**3.97 employee per kGLSF***
	Percent Present at one Time (PAOT):	85%
	Percent employees on shifts 1 & 2, or 1 & 3:	80% **
	Visitor Parking Rate:	0.25 spaces/employee #

2.15 employees per kGLSF * 1900 kGLSF = 4731 employees x 80% (shift overlap) = 3784.8
x 85% PAOT
Peak Present at one Time: 3217 employees

Mode Split Assumptions:	Modal Share	Persons	Persons Trips (A X B)	AVO# #	Vehicles (C/D)
Single Occupant Vehicle	85.0%	3217	2735	1	2735
Carpool/Vanpool	12.5%	3217	402	2.1	191
Transit	2.0%	3217	64		
Walk/Bike/Telecommute	0.5%	3217	16		
	100.0%		3217		2926

Peak Employee Parking Demand: 5120 vehicles + 359 vehicles = 2926 spaces + 10% (practical capacity) = 3219 spaces
Peak Visitor Parking Demand: 7087 employees X 0.25 spaces per employee
divided by 4 (turnover rate) X 85% (%SOV) = 251 spaces + 10% (practical capacity) = 276 spaces
Total Peak Parking Demand: 3495 spaces

Employee Parking Rate: 3219 emp. spaces/1900 kGLSF = 1.69 spaces/kGLSF
Total Parking Rate/Employee: 3495 total spaces/7087 emp's = 0.74 spaces/emp.
Total Parking Rate/kGLSF: 3495 total spaces/1900 kGLSF = 1.840 space/kGLSF
Total Parking Rate/kGSF 1.840 (spaces/kGLSF) * 0.95 (occupancy rate) = **1.748 spaces/kGSF**

* Average employee density from Metro Parking Study for suburban office sites in King and S. Snohomish Counties.
** Use whichever combination has greatest shift overlap of employees.
\# Represents high end of visitor demand found in Metro Parking Study, 1991.
Average Vehicle Occupancy

TABLE A. PARKING DEMAND BY EMPLOYEE DENSITY

Employees per 1000 GLSF	PARKING DEMAND PER 1000 GLSF		
	Rural Scenario	Non-CBD Scenario	CBD Scenario
4.00	3.49	3.22	2.96
3.75	3.25	3.02	2.77
3.50	3.03	2.82	2.67
3.25	2.82	2.62	2.40
3.00	2.69	2.42	2.22
2.75	2.38	2.21	2.03
2.50	2.17	2.01	1.85
2.25	1.86	1.81	1.67
2.00	1.73	1.61	1.48

WORKSHEET C: PROJECTED CTR PARKING REDUCTIONS - - SUBURBAN NON-CBD SCENARIO

Scenario: **SUBURBAN NON-CBD**
Parking Type: Employees

Case A: 1992 Base		**Case B: 1995 Estimated Demand**	
Land Use(s) All Office Uses		All Office Uses Goal: 15% reduction in SOV modal share	
Total:	5000 Employees		5306 Employees
Max Present:			(Assumes 2% annual growth)
At one time:	85%		85%
Peak Present:	4250 Employees		4510 Employees

	A	B	C	D	E	A	B	C	D	E
Mode Split Assumptions:	**Modal Share**	**Persons**	**Persons Trips (A X B)**	**AVO**	**Vehicles (C/D)**	**Modal Share**	**Persons**	**Person Trips (A x B)**	**AVO**	**Vehicles**
Single Occupant Vehicle	85.0%	4250	3613	1	3613	72.3%	4510	3259	1	3259
Carpool/Vanpool	12.5%	4250	531	2.1	253	23.2%	4510	1044	2.3	454
Transit	2.0%	4250	85	- -	- -	3.7%	4510	167	- -	- -
Walk/Bike/Telecommute	0.5%	4250	21	- -	- -	0.9%	4510	41	- -	- -
	100.0%		4250		3865	100.0%		4510		3713

Peak Employee Parking Demand:	3865	3713

Percentage Change in

Peak Parking Demand:		**- 4.0%**
HOV Parking Demand (percent of total demand)	**6.5%**	**12.2%**

WORKSHEET C: PROJECTED CTR PARKING REDUCTIONS - - SUBURBAN NON-CBD SCENARIO

Suburban Non-CBD Scenario (Page 2)

Case C: 1997 Estimated Demand

All Office Uses
Goal: 25% reduction in SOV modal share

Total:	5520 Employees
Max Present:	(Assumes 2% annual growth)
At one time:	85%
Peak Present:	4692 Employees

Case D: 1999 Estimated Demand

All Office Uses
Goal: 35% reduction in SOV modal share

5743 Employees
(Assumes 2% annual growth)
85%
4882 Employees

	A	B	C	D	E	A	B	C	D	E
Mode Split Assumptions:	**Modal Share**	**Persons**	**Persons Trips (A X B)**	**AVO**	**Vehicles (C/D)**	**Modal Share**	**Persons**	**Person Trips (A x B)**	**AVO**	**Vehicles**
Single Occupant Vehicle	63.8%	4692	2991	1	2991	55.3%	4882	2697	1	2697
Carpool/Vanpool	30.3%	4692	1419	2.4	591	37.3%	4882	1819	2.5	727
Transit	4.8%	4692	225	- -	- -	6.0%	4882	293	- -	- -
Walk/Bike/Telecommute	1.2%	4692	56	- -	- -	1.5%	4882	73	- -	- -
	100.0%		4692		3583	100.0%		4882		3425

Peak Employee Parking Demand:	3583	3425
Percentage Change in Peak Parking Demand:	**-7.3%**	**-11.4%**

HOV Parking Demand

(percent of total demand)	**16.5%**	**21.2%**

WORKSHEET D: PROJECTED CTR PARKING REDUCTIONS - - SUBURBAN CBD SCENARIO

Scenario: **SUBURBAN CBD**
Parking Type: Employees

	Case A: 1992 Base	**Case B: 1995 Estimated Demand**
Land Use(s)	All Office Uses	All Office Uses Goal: 15% reduction in SOV modal share
Total:	5000 Employees	5306 Employees
Max Present:		(Assumes 2% annual growth)
At one time:	85%	85%
Peak Present:	4250 Employees	4510 Employees

	A	B	C	D	E	A	B	C	D	E
Mode Split Assumptions:	**Modal Share**	**Persons**	**Persons Trips (A X B)**	**AVO**	**Vehicles (C/D)**	**Modal Share**	**Persons**	**Person Trips (A x B)**	**AVO**	**Vehicles**
Single Occupant Vehicle	76.0%	4250	3230	1	3230	64.6%	4510	2914	1	2914
Carpool/Vanpool	15.0%	4250	638	2.1	304	21.1%	4510	952	2.3	414
Transit	8.0%	4250	340	- -	- -	12.3%	4510	555	- -	- -
Walk/Bike/Telecommute	1.0%	4250	43	- -	- -	2.0%	4510	90	- -	- -
	100.0%		4250		3534	100.0%		4510		3327

Peak Employee Parking Demand:	3534	3327

Percentage Change in

Peak Parking Demand:		**- 5.8%**
HOV Parking Demand (percent of total demand)	**8.6%**	**12.4%**

WORKSHEET D: PROJECTED CTR PARKING REDUCTIONS - - SUBURBAN CBD SCENARIO

Suburban CBD Scenario (Page 2)

Case C: 1997 Estimated Demand

All Office Uses
Goal: 25% reduction in SOV modal share

Total:	5520 Employees
Max Present:	(Assumes 2% annual growth)
At one time:	85%
Peak Present:	4692 Employees

Case D: 1999 Estimated Demand

All Office Uses
Goal: 35% reduction in SOV modal share

5743 Employees
(Assumes 2% annual growth)
85%
4882 Employees

	A	B	C	D	E	A	B	C	D	E
Mode Split Assumptions:	**Modal Share**	**Persons**	**Persons Trips (A X B)**	**AVO**	**Vehicles (C/D)**	**Modal Share**	**Persons**	**Person Trips (A x B)**	**AVO**	**Vehicles**
Single Occupant Vehicle	57.0%	4692	2675	1	2675	49.4%	4882	2412	1	2412
Carpool/Vanpool	29.9%	4692	1168	2.4	487	28.6%	4882	1396	2.5	558
Transit	15.3%	4692	718	- -	- -	18.4%	4882	898	- -	- -
Walk/Bike/Telecommute	2.8%	4692	131	- -	- -	3.6%	4882	176	- -	- -
	100.0%		4692		3161	100.0%		4882		2970

Peak Employee Parking Demand:	3161	2970
Percentage Change in Peak Parking Demand:	**-10.5%**	**-15.9%**

HOV Parking Demand

(percent of total demand)	**15.4%**	**18.8%**

WORKSHEET E: PROJECTED CTR PARKING REDUCTIONS - - HIGH DENSITY SCENARIO

Scenario: **HIGH DENSITY (e.g. First Hill, Seattle)**
Parking Type: Employees

	Case A: 1992 Base	**Case B: 1995 Estimated Demand**
Land Use(s)	All Office Uses	All Office Uses Goal: 15% reduction in SOV modal share
Total:	5000 Employees	5306 Employees
Max Present:		(Assumes 2% annual growth)
At one time:	85%	85%
Peak Present:	4250 Employees	4510 Employees

	A	B	C	D	E	A	B	C	D	E
Mode Split Assumptions:	**Modal Share**	**Persons**	**Persons Trips (A X B)**	**AVO**	**Vehicles (C/D)**	**Modal Share**	**Persons**	**Person Trips (A x B)**	**AVO**	**Vehicles**
Single Occupant Vehicle	59.0%	4250	2508	1	2508	50.2%	4510	2262	1	2262
Carpool/Vanpool	18.0%	4250	765	2.1	364	19.9%	4510	896	2.3	390
Transit	20.0%	4250	850	- -	- -	25.8%	4510	1164	- -	- -
Walk/Bike/Telecommute	3.0%	4250	128	- -	- -	4.2%	4510	189	- -	- -
	100.0%		4250		2872	100.0%		4511		2652

Peak Employee Parking Demand:	2872	2652

Percentage Change in

Peak Parking Demand:		**- 5.8%**
HOV Parking Demand (percent of total demand)	**12.7%**	**14.7%**

WORKSHEET E: PROJECTED CTR PARKING REDUCTIONS - - HIGH DENSITY SCENARIO

High Density Scenario (Page 2)

Case C: 1997 Estimated Demand		**Case D: 1999 Estimated Demand**	
All Office Uses		All Office Uses	
Goal: 25% reduction in SOV modal share		Goal: 35% reduction in SOV modal share	
Total:	5520 Employees		5743 Employees
Max Present:	(Assumes 2% annual growth)		(Assumes 2% annual growth)
At one time:	85%		85%
Peak Present:	4692 Employees		4882 Employees

	A	B	C	D	E	A	B	C	D	E
Mode Split Assumptions:	**Modal Share**	**Persons**	**Persons Trips (A X B)**	**AVO**	**Vehicles (C/D)**	**Modal Share**	**Persons**	**Person Trips (A x B)**	**AVO**	**Vehicles**
Single Occupant Vehicle	44.3%	4692	2076	1	2076	38.4%	4882	1872	1	1872
Carpool/Vanpool	21.6%	4692	1014	2.4	422	23.2%	4882	1130	2.5	452
Transit	29.1%	4692	1363	- -	- -	32.5%	4882	1587	- -	- -
Walk/Bike/Telecommute	5.1%	4692	239	- -	- -	6.0%	4882	293	- -	- -
	100.0%		4692		2499	100.0%		4882		2324

Peak Employee Parking Demand:	2499	2324
Percentage Change in Peak Parking Demand:	**-13.0%**	**-19.1%**
HOV Parking Demand (percent of total demand)	**16.9%**	**19.4%**

[i] Robert T. Dunphy, "Traffic and Parking: A New Generation of Information," *Urban Land*, May 1988, p. 8.

[ii] Marya Morris, "Parking Standards - Problems, Solutions, Examples," *Planning Advisory Services Memo*, American Planning Association, July 1989, p. 1.

[iii] Ibid., p. 1.

[iv] Ibid., p. 2.

[v] Washington State Transportation Center, *Land Use-Transportation Linkage: Working Paper*, August 1991, p. 36.

[vi] Ibid., pp. 36-37.

[vii] Municipality of Metropolitan Seattle, *Parking Utilization Study*, unpublished results, Seattle, Washington, 1992.

[viii] Municipality of Metropolitan Seattle, *HOV/TSM Study: Parking Generation Data*, memo written by Paul Roybal, 1990.

[ix] Wayne Swanson, "Parking: How Much Is Enough?", *Planning*, July 1989, p. 16.

[x] Ibid., p. 16.

[xi] Washington State Transportation Center, *Land Use-Transportation Linkage: Working Paper*, August 1991, p. 34.

[xii] Gruen, Green & Associates, Employment and Parking in Suburban Business Parks: A Pilot Study, Urban Land Institute, Washington, DC, 1986.

[xiii] Robert T. Dunphy, "Traffic and Parking: A New Generation of Information," *Urban Land*, May 1988, p. 8.

[xiv] Wayne Swanson, "Parking: How Much Is Enough?", *Planning*, July 1989, p. 16.

[xv] Ibid., p. 16.

[xvi] Ibid., p. 1.

[xvii] Robert Weant, ENO Foundation, 1987.

[xviii] Cy Ulberg, *Local Option Commercial Parking Tax Analysis*, Washington State Transportation Center, January 1992, p. xviii.

[xix] Municipality of Metropolitan Seattle, *The Effects of Parking on Mode Choice in Downtown Seattle and Bellevue*, unpublished draft, December 1991.