Appendix L:

Transportation Analysis Components

T-1 Level of Service (LOS) Definitions

T-2 Queue Observations and Calibration

T-3 King County Link Capacity

T-4 Pedestrian Facilities
(Roadway Shoulder Inventory)

T-5 Sight Distance Memo &
Roadway Profiles

T-6 School Bus Stop Locations

T-7 Visum Outputs

T-8 LOS Summary Table

T-9 WSDOT Left-Turn Lane Chart

Signalized intersection level of service (LOS) is defined in terms of the average total vehicle delay of all movements through an intersection. Vehicle delay is a method of quantifying several intangible factors, including driver discomfort, frustration, and lost travel time. Specifically, LOS criteria are stated in terms of average delay per vehicle during a specified time period (for example, the PM peak hour). Vehicle delay is a complex measure based on many variables, including signal phasing (i.e., progression of movements through the intersection), signal cycle length, and traffic volumes with respect to intersection capacity. Table 1 shows LOS criteria for signalized intersections, as described in the *Highway Capacity Manual* (Transportation Research Board, Special Report 209, 2000).

Table 1. Level of Service Criteria for Signalized Intersections

Level of Service	Control Delay Per Vehicle (Seconds)	General Description (Signalized Intersections)
A	≤10	Free Flow
B	>10 - 20	Stable Flow (slight delays)
C	>20 - 35	Stable flow (acceptable delays)
D	>35 - 55	Approaching unstable flow (tolerable delay, occasionally wait through more than one signal cycle before proceeding)
E	>55 - 80	Unstable flow (intolerable delay)
F	>80	Forced flow (jammed)

Unsignalized intersection LOS criteria can be further reduced into two intersection types: all-way stop-controlled and two-way stop-controlled. All-way, stop-controlled intersection LOS is expressed in terms of the average vehicle delay of all of the movements, much like that of a signalized intersection. Two-way, stop-controlled intersection LOS is defined in terms of the average vehicle delay of an individual movement(s). This is because the performance of a two-way, stop-controlled intersection is more closely reflected in terms of its individual movements, rather than its performance overall. For this reason, LOS for a two-way, stop-controlled intersection is defined in terms of its individual movements. With this in mind, total average vehicle delay (i.e., average delay of all movements) for a two-way, stop-controlled intersection should be viewed with discretion. Table 2 shows LOS criteria for unsignalized intersections (both all-way and two-way, stop-controlled).

Table 2. Level of Service Criteria for Unsignalized Intersections

Level of Service	Average Total Delay (sec/veh)
A	0 - 10
B	>10 - 15
C	>15 - 25
D	>25 - 35
E	>35 - 50
F	>50

Appendix T-2a
Queue Observations and Calibration

WOODINVILLE, WASHINGTON
156TH AVE NE
WOODINVILLE-DUVALL RD

TPG04335M
SB QUEUE OBSERVATIONS

TIME	SB RIGHT TURN	SB LEFT TURN
7:00:05	6	2
7:01:58	9	1
7:03:44	5	3
7:05:33	3	5
7:07:25	11	2
7:09:13	6	4
7:11:00	5	0
7:12:55	6	2
7:14:40	7	2
7:16:35	10	4
7:18:25	4	2
7:20:20	3	4
7:22:05	5	3
7:23:55	0	4
7:25:45	6	1
7:27:30	2	3
7:29:23	1	5
7:31:11	4	5
7:33:03	2	6
7:34:54	5	7
7:36:44	4	4
7:38:36	0	2
7:40:22	7	7
7:42:15	4	7
7:44:03	4	3
7:45:54	3	5
7:47:44	3	6
7:49:34	1	7
7:51:24	4	2
7:53:12	0	3
7:55:00	0	2
7:56:55	0	4
7:58:55	0	1
8:00:35	6	1
8:02:22	2	5
8:04:13	1	3
8:06:04	1	4
8:07:53	5	2
8:09:44	3	3
8:11:34	3	5
8:13:25	5	2
8:15:15	2	2
8:17:05	0	2
8:18:55	1	7
8:20:45	0	6
8:22:35	3	3
8:24:23	2	3
8:26:13	9	5
8:28:05	1	5
8:29:55	4	0
8:31:45	8	1
8:33:35	5	2
8:35:23	5	6
8:37:14	2	3
8:39:03	4	4
8:40:55	2	1
8:42:44	2	2
8:44:33	4	1
8:46:23	1	7
8:48:13	8	3
8:50:04	5	2
8:51:55	2	2
8:53:45	5	1
8:55:33	2	5
8:57:23	1	4
8:59:13	2	0
95th% Queue	**8.75**	**7**

Appendix T-2b
Queue Observations and Calibration

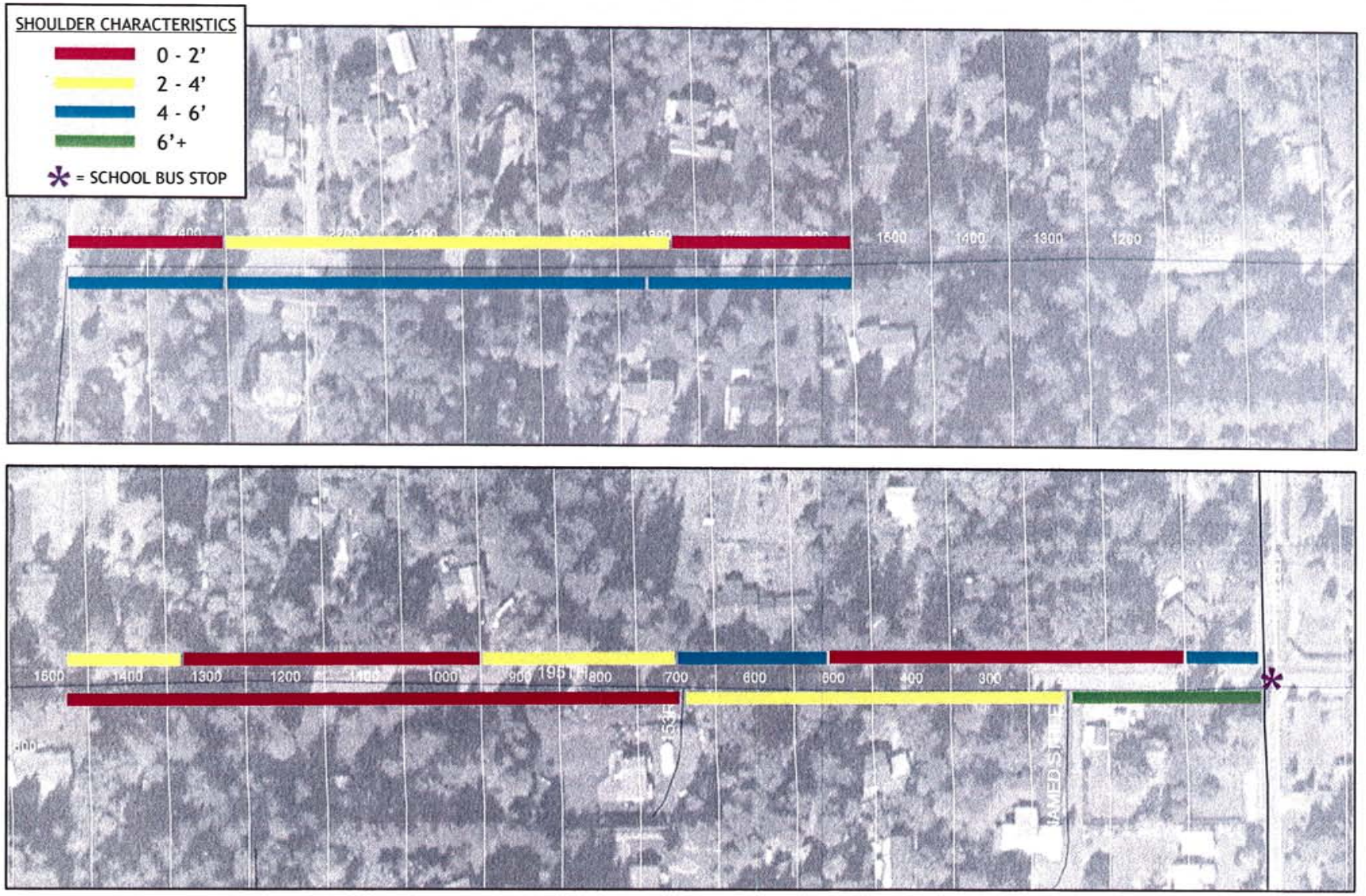
	EXISTING					NO ACTION		PROPOSED ACTION		R-1 ZONING ALT.		ATTACHED HOUSING ALT.	
	Existing AM Peak Synchro 95th% (feet)	Existing AM Peak 95th % Observed (vehicles)	Existing AM Peak 95th % Observed (feet)[1]	Calibration Factor	Calibrated Existing 95th% Queue (feet)	Synchro 95th% Queue	Calibrated 95th% Queue (feet)	Synchro 95th% Queue	Calibrated 95th% Queue (feet)	Synchro 95th% Queue	Calibrated 95th% Queue (feet)	Synchro 95th% Queue	Calibrated 95th% Queue (feet)
SB Left	101	8.75	175	1.73	175	104	180	118	204	108	187	115	199
SB Right	138	7	140	1.01	140	142	144	163	165	147	149	160	162

[1]- Based on on 20 foot average vehicle length/spacing (per field observations)

KING COUNTY
RECOMMENDED LINK TYPE CAPACITY VALUES

TYPE	Number of Lanes	Area	Pavement Type	Width of Traffic Lane	Intersection Control	Other Information	ADT Capacity		Peak Cap. One Direc.
							Two Direc.	One Direc.	
1	Centroid connector						100,000	50,000	5,000
	Arterials								
2	Two Lane	Rural	Oil mat	Less than 20'	Stop sign	Minimal	7,400	3,700	740
			Paved			shoulders			
3	Two Lane	Rural or	Paved	18'-20'	Stop sign	Minimal	9,520	4,760	740
		Urban				shoulders			
4	Two Lane	Rural or	Paved	20'-22'	Any type	Long Dist. Btw	19,000	9,500	1,240
		Urban				Cont. Intersec.			
5	Two Lane	Urban	Paved	22'-24'	Stop Sign	Adequate	11,620	5,810	760
						Shoulders			
6	Two Lane	Urban	Paved	22'-24'	Traffic Signal	Adequate	13,200	6,600	760
						Shoulders			
7	Two Lane	Urban	Paved	22'-24'	Any Type	Long Dist. Btw	21,120	10,560	1,320
						Cont. Intersec.			
8	Two Lane/	Urban	Paved	32'-36'	Traffic Signal	Channel at	16,900	8,450	1,030
	turn channel			at intersection		Intersection			
9	Three Lane	Urban	Paved	32'-40'	Traffic Signal	Two Way	19,220	9,610	1,030
						Turn Lane			
10	Four Lane	Urban	Paved	40'-44'	Traffic Signal		25,380	12,690	1,930
11	Four Lane	Urban	Paved	40'-48'	Any Type	Long Dist. Btw	38,000	19,000	2,600
						Cont. Intersec.			
12	Four Lane/	Urban	Paved	56'-60'	Traffic Signal		30,560	15,280	2,160
	turn channel			at intersection					
13	Five Lane Section	Urban	Paved	56'-60'	Traffic Signal		34,240	17,120	2,160
14	Six Lane	Urban	Paved	60'-72'	Traffic Signal		35,880	17,940	2,850
15	Six Lane/turn chan.	Urban	Paved	78'-84'	Traffic Signal		40,100	20,050	3,060
16	Four Lane/turn	Urban	Paved	60'-72'	Traffic Signal		31,280	15,640	2,450
	chan. Transit/carpool								
	Freeways								
17	Two Lane	Urban	Paved	24'	Interchange		27,500	13,750	1,925
	controlled access								
18	Four Lane frwy	Urban	Paved	48'	Interchange	Full access	72,600	36,300	3,960
						control			
19	Six Lane frwy	Urban	Paved	72'	Interchange	Full access	103,500	51,750	6,210
						control			
20	Eight Lane frwy	Urban	Paved	96'	Interchange	Full access	138,000	69,000	8,280
						control			
21	Four Lane frwy/	Urban	Paved	60' include.	Interchange	Full access	74,940	37,470	5,460
	w/Transit/carpool			shoulder		control			
22	Six Lane frwy w/	Urban	Paved	88' include	Interchange	Full access	105,040	52,520	7,710
	Transit/carpool			shoulder		control			
	External Links								
23	Four-Six Lane	Urban	Paved	88'+	Traffic Signal	20-25 MPH	50,660	25,330	3,800
	Arterial	CBD	Paved						
24	Two Lane Arterial	Rural	Paved		Long Distance		19,000	9,500	1,240
25	Two Lane Arterial	Rural	Paved				9,520	4,760	740
26	Two Lane Arterial	Urban	Paved				13,720	6,860	760
27	Four Lane Arterial	Rural	Paved		Long Distance		38,000	19,000	7,600
28	Four Lane Arterial	Rural	Paved				25,380	12,690	1,930
29	Four Lane Arterial	Urban	Paved				33,720	16,860	2,160
30	Six Lane Arterial	Urban	Paved				42,200	21,100	3,060
31	Eight Lane Arterial	Urban	Paved				50,660	25,330	3,800
	Freeway on/off	Urban	Paved				230,000	115,000	8,280

Source: King County Department of Transportation, Transportation System Planning Section, as reviewed and recommended by the KJS & Associates in 1995.



Appendix T-4a

Roadway Shoulder Inventory (195th Street)

Wood Trails

The Transpo Group

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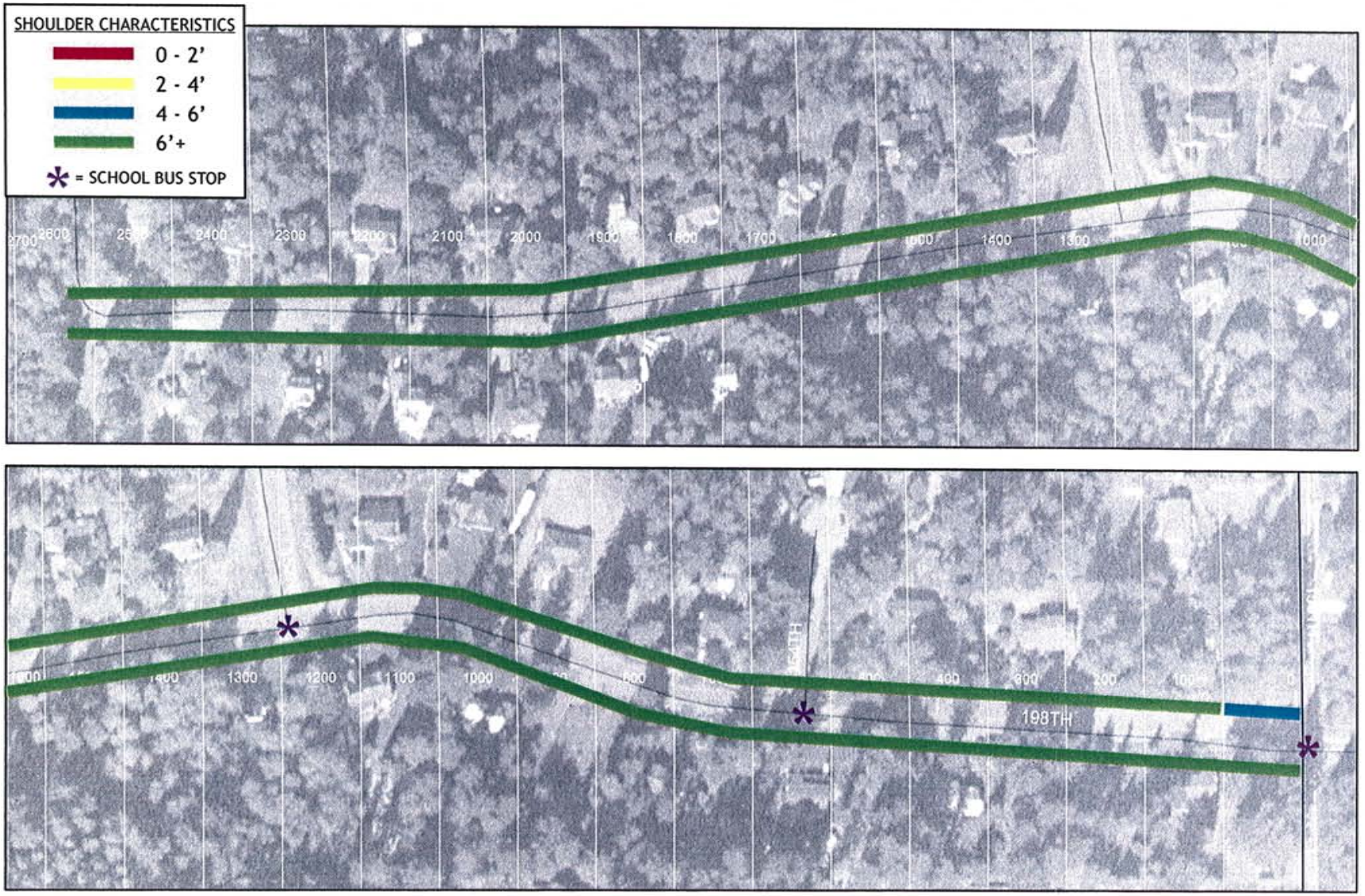

Appendix T-4b

Roadway Shoulder Inventory (198th Street)

Wood Trails & Montevallo

The Transpo Group

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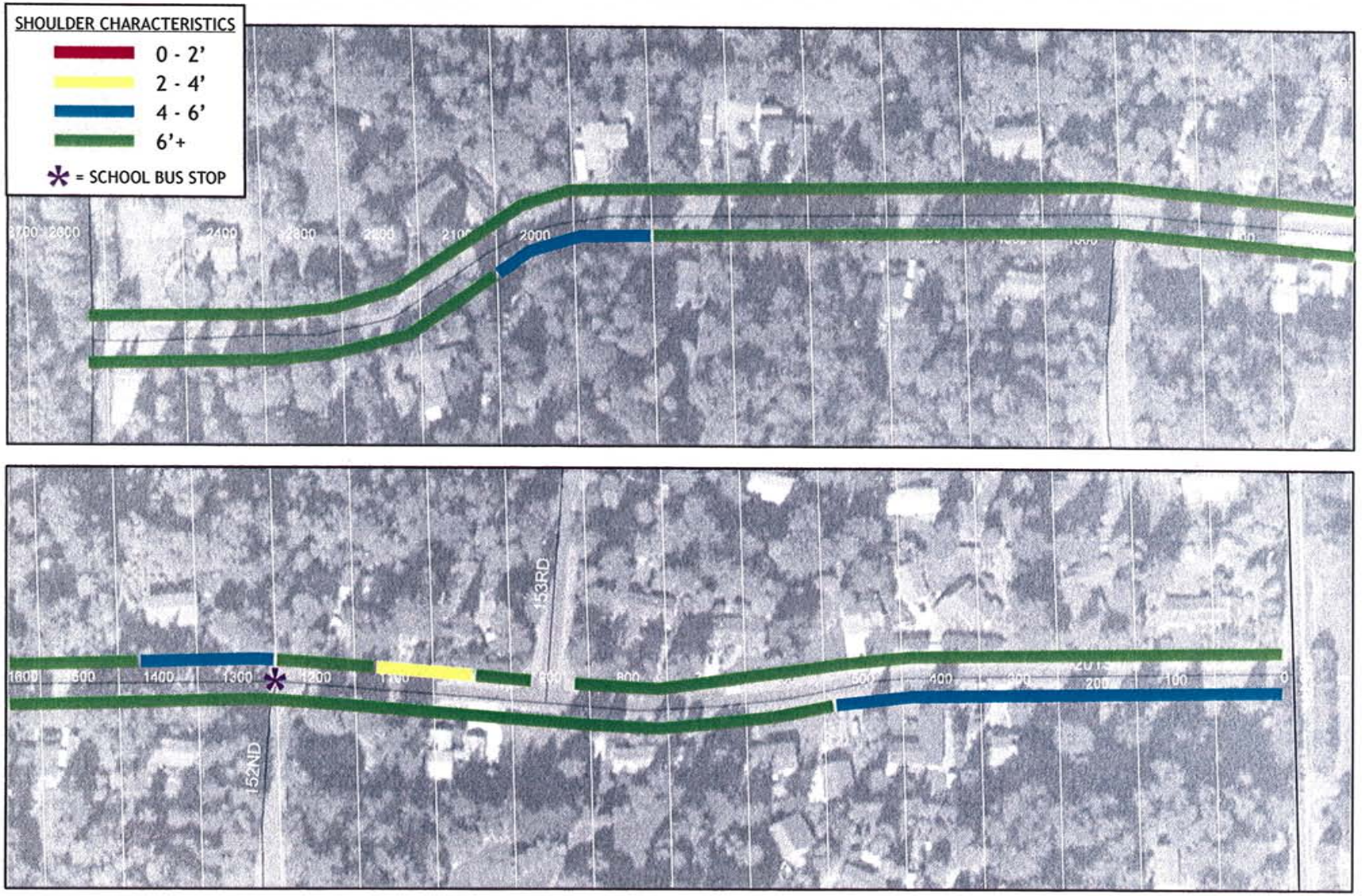

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Appendix T-4c

Roadway Shoulder Inventory (201st Street)

Wood Trails & Montevallo

The Transpo Group

M:\04\04007 Wood trails\Graphics\graphic02.cdr (C)

Appendix T-4d

Roadway Shoulder Inventory (202nd Street)

Wood Trails

The Transpo Group

M:\04\04007 Wood trails\Graphics\graphic02.cdr (D)

APPENDIX T-5: TECHNICAL MEMORANDUM

To:	File	Date:	February 15, 2005
From:	Mike Swenson, P.E., P.T.O.E. Brandon Moen, AICP	TG:	04007.00
Subject:	Wood Trails/Montevallo EIS: Sight Distance Conditions		

The purpose of this technical memorandum is to provide a summary of the stopping sight distance conditions of local residential roadways in the area of the proposed developments, particularly the roadways that could connect the Wood Trails site to 156th Avenue NE, including:

- NE 202nd Street
- NE 201st Street
- NE 198th Street
- NE 195th Street

The estimated stopping sight distance along each roadway is discussed below.

Sight Distance

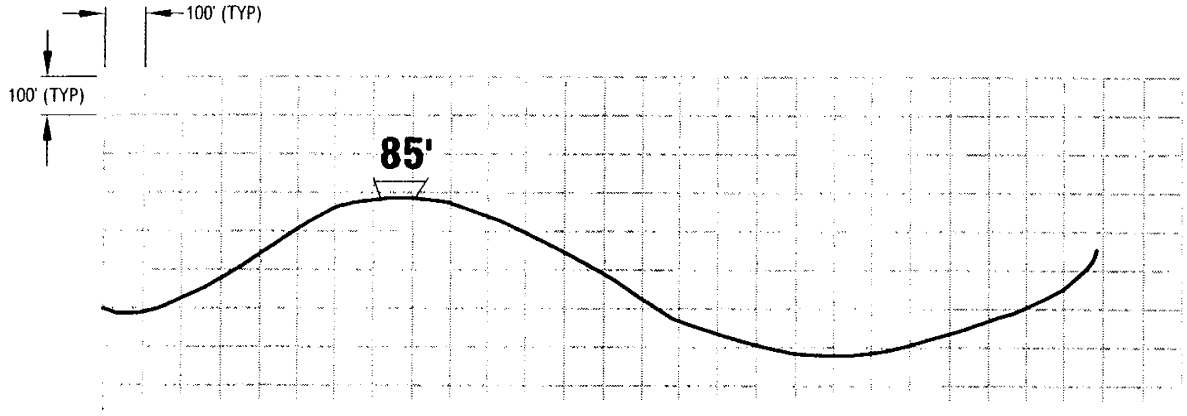
Stopping sight distance along NE 202nd Street, NE 201st Street, NE 198th Street, and NE 195th Street was calculated using information obtained through field collection efforts. Existing roadway profiles were estimated using Global Positioning System (GPS) technology. All four roadways were traveled multiple times while collecting GPS data using a handheld GPS unit. This GPS unit has an accuracy within one to two meters depending on the positioning of the satellites and current coverage. The roadway profiles and subsequent sight distance calculations reflect only the vertical alignment of the roadway. If a horizontal curve exists (such as on the west end of NE 201st Street) that would influence the SSD, it is not reflected in these calculations. Observations in the field indicated both horizontal curves and vertical curves at the west end of NE 201st Street.

The calculated sight distance measurements were then compared to City of Woodinville sight distance requirements, which are based on American Association of State Highways and Transportation Officials (AASHTO) standards. The design speed of the roadway used in the calculations was assumed to be the posted speed limit (25 mph) plus eight mph, per City of Woodinville standards. Using these assumptions, City of Woodinville stopping sight distance standards are met at all locations along NE 201st Street with the exception of the west end of the road, near the connection to the proposed development. Along NE 198th Street only one location, extending 85 feet, is shown to be deficient in the estimated stopping sight distance. Along NE 195th Street, one segment of 468 feet in length is shown to be deficient. Along NE 202nd Street, two segments are shown to be deficient, each extending 357 feet and 389 feet

in length. A graphical representation of the most restricted stopping sight distance location along NE 198th Street and NE 201st Street are shown in Figure C-5a, while Figure C-5b shows the same information for NE 195th Street and NE 202nd Street.

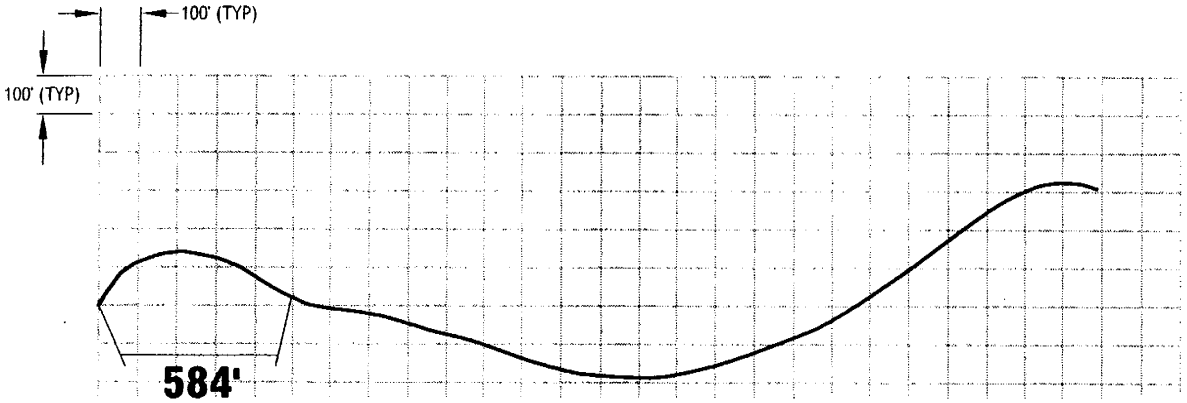
As noted, the roadway profiles generated for this analysis are not exact and were not surveyed. Thus, the precise location and extents of the sight distance restrictions are provided for general information only.

A review of historic accident records along each roadway over the past three complete years of which data is available (2001-2003), shows that two accidents were reported along these four roadways. However, neither accident appears to have been affected by sight distance limitations. One of the accidents involved a vehicle striking a pole, which likely wasn't affected by sight distance. The other accident occurred 150 feet west of the 156th Avenue NE/NE 201st Street intersection, which has not been identified as an area with a sight distance deficiency. Therefore, the accident records provided suggest that no accident history directly attributable to sight distance limitations exists along these four local roadways.



198TH STREET

WEST EAST



201ST STREET

WEST EAST

LEGEND

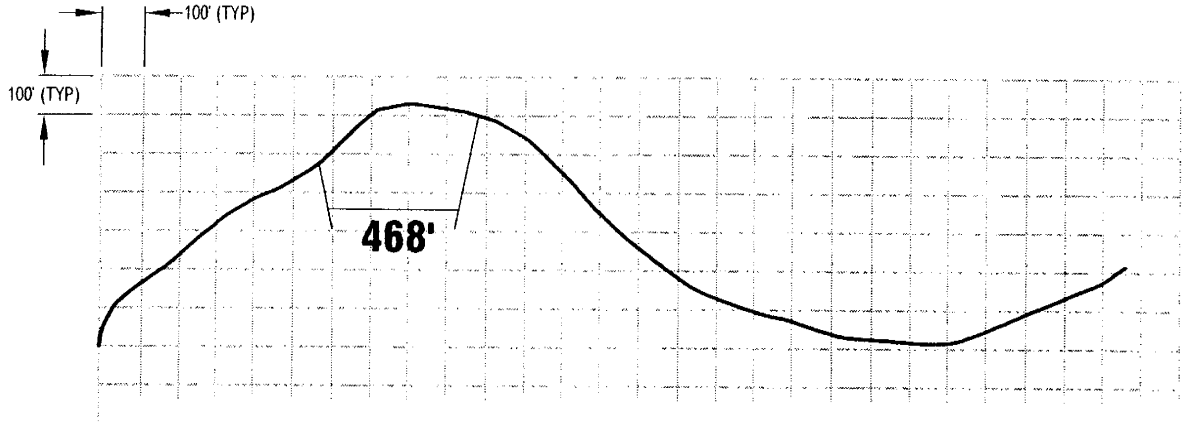
XX' = LENGTH OF ROADWAY WITH A SIGHT DISTANCE LIMITATION (FEET)

Appendix T-5a

Stopping Sight Distance - Roadway Profiles

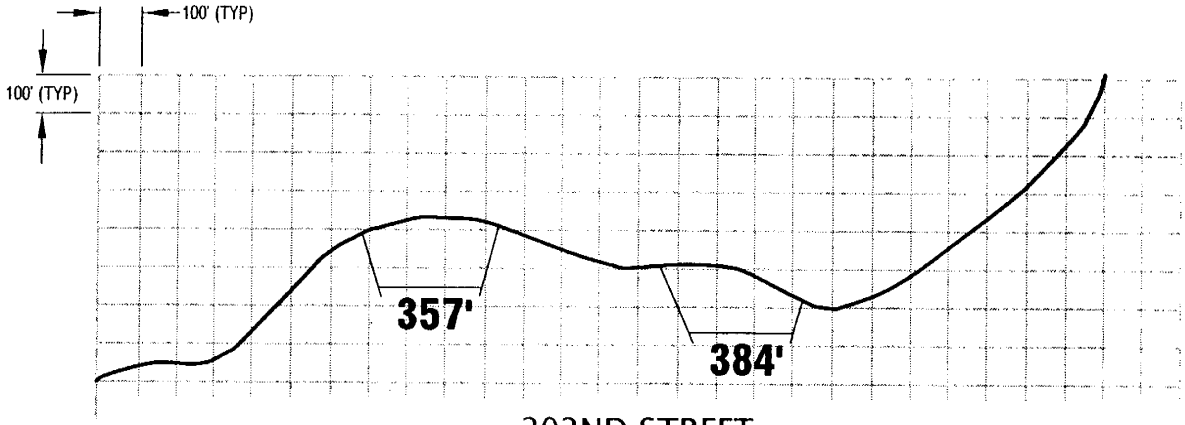
Wood Trails & Montevallo

The Transpo Group



195TH STREET

WEST EAST



202ND STREET

WEST EAST

LEGEND

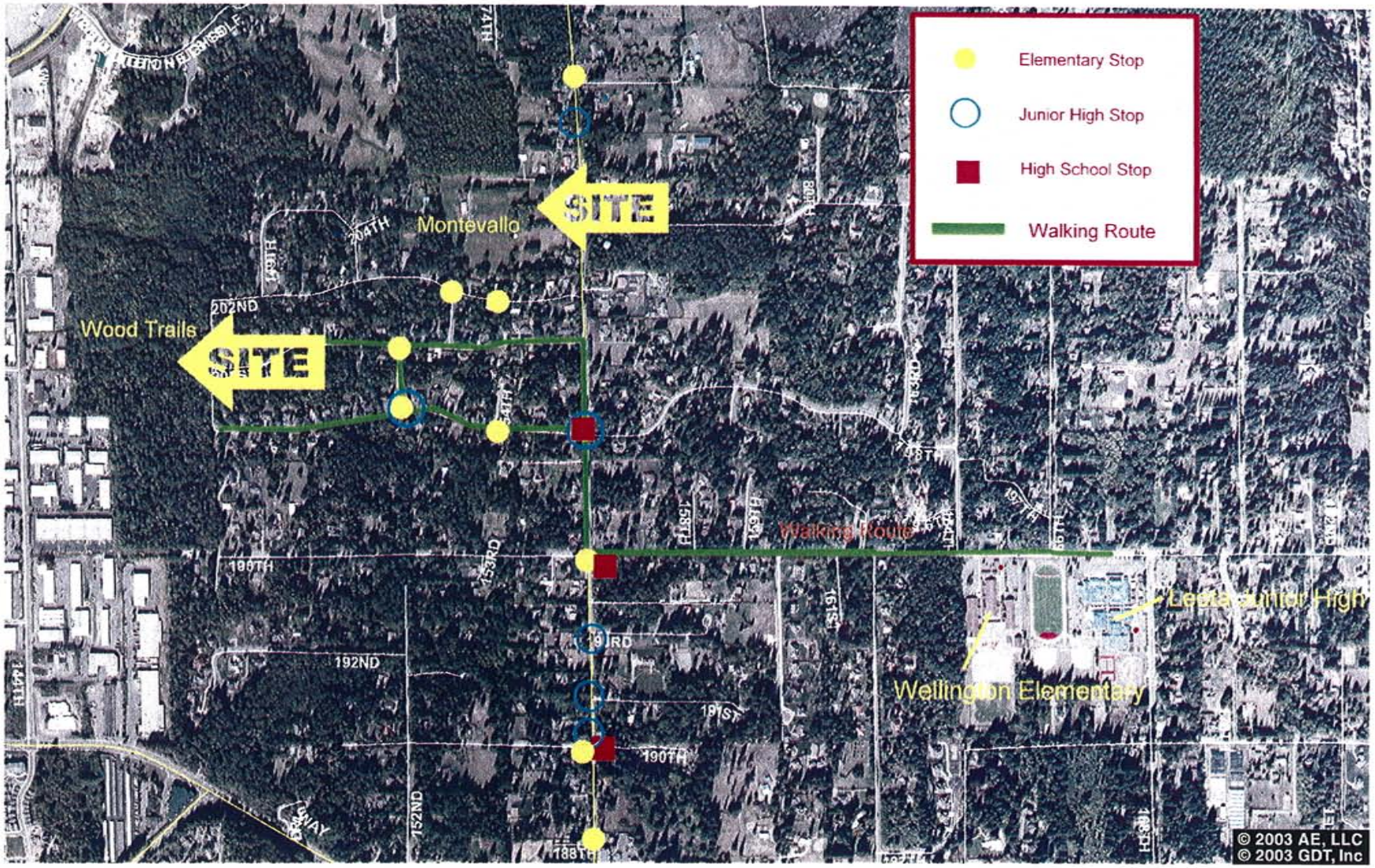
XX' = LENGTH OF ROADWAY WITH A SIGHT DISTANCE LIMITATION (FEET)

Appendix T-5b

Stopping Sight Distance - Roadway Profiles

Wood Trails & Montevallo

The Transpo Group



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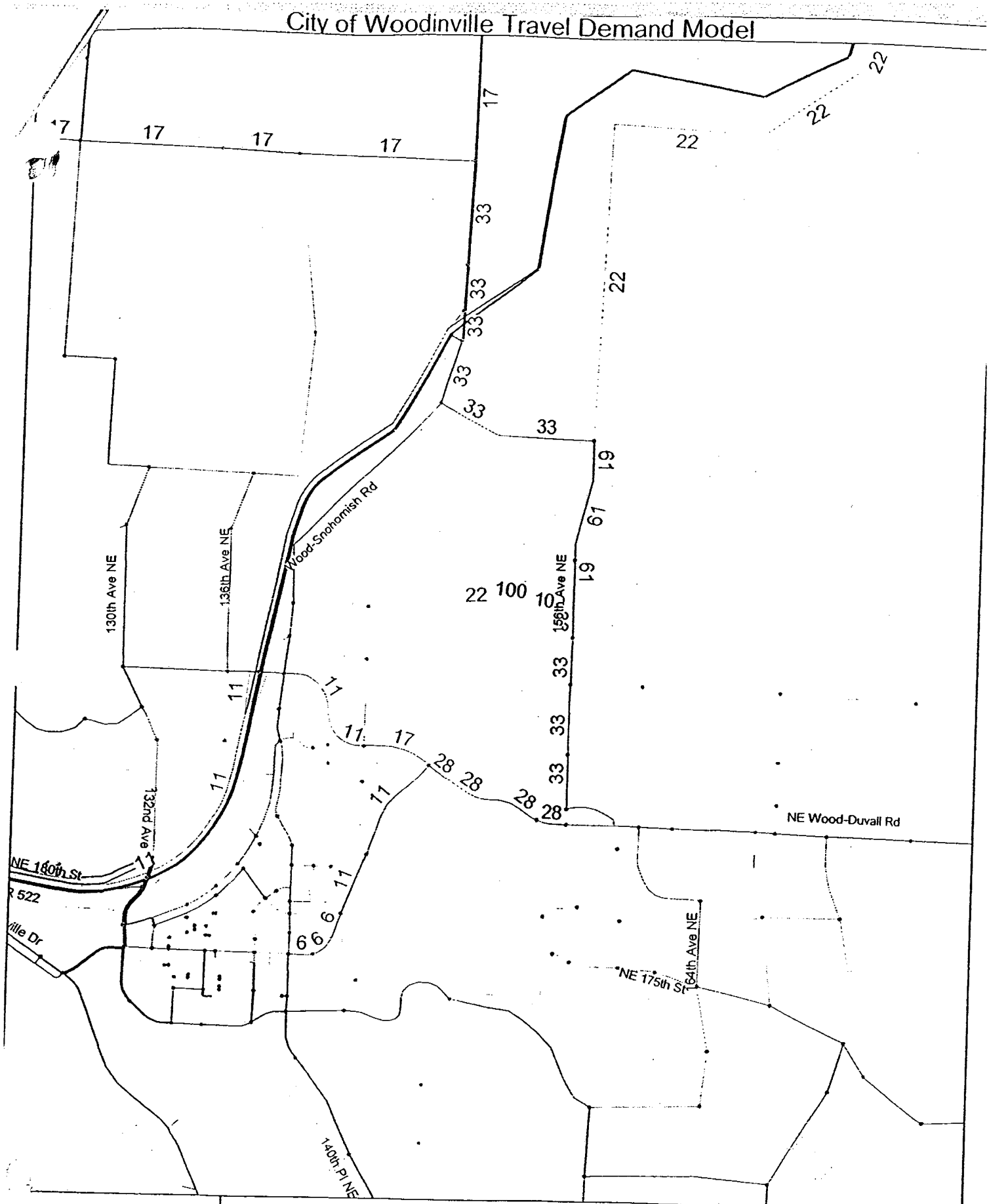
Appendix T-6

School Bus Stop Locations

Wood Trails & Montevallo

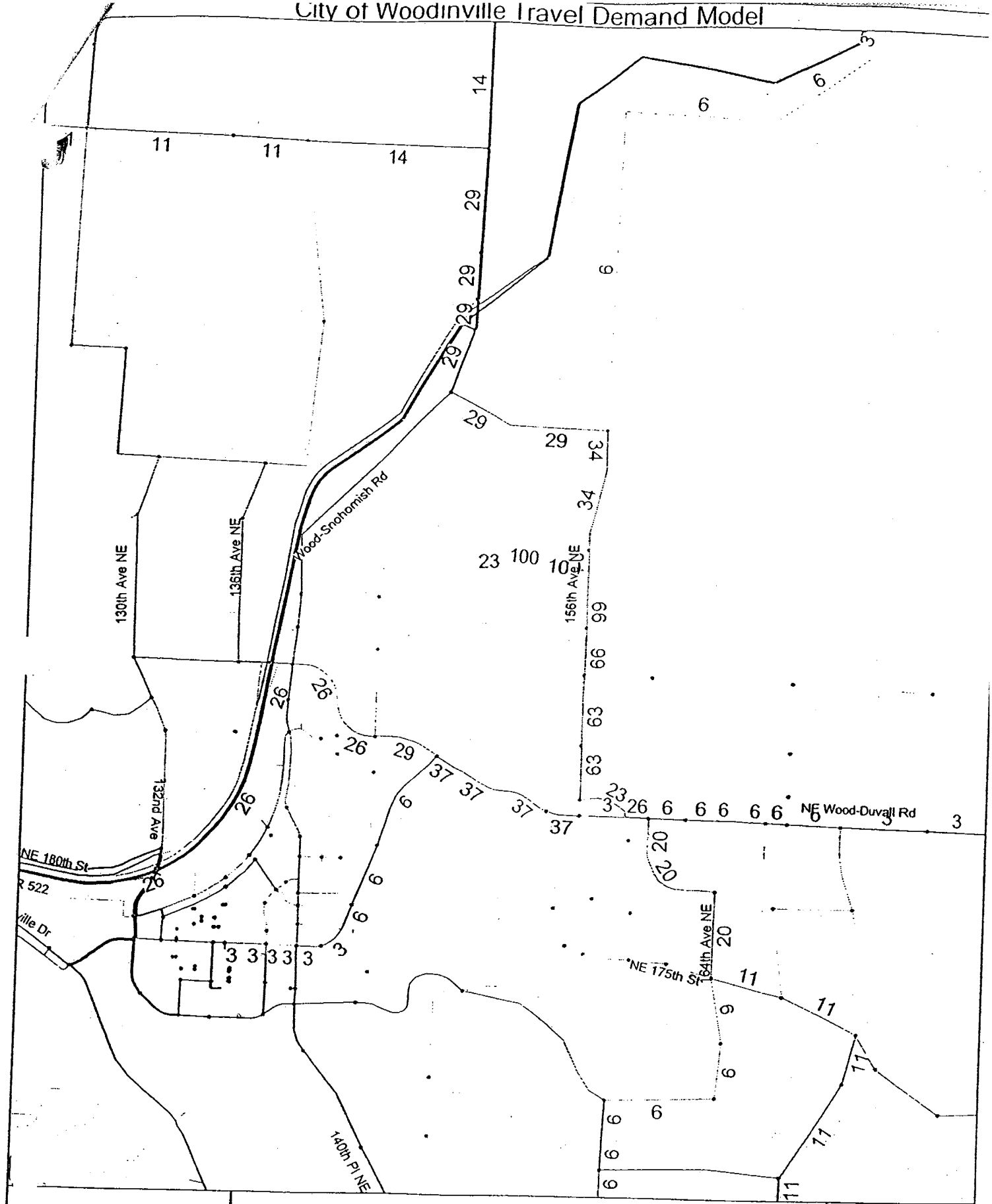
The Transpo Group

City of Woodinville Travel Demand Model



VISUM 8.10 PTV AG	Transpo	WD_Master_2012HE (Wood
Date:01/23/04	2000 Travel Assignment	1 : 16967

City of Woodinville Travel Demand Model



VISUM 8.10 PTV AG	Transpo	WD_Master_2012HE (Wood
Date:01/23/04	2000 Travel Assignment	1 : 16967

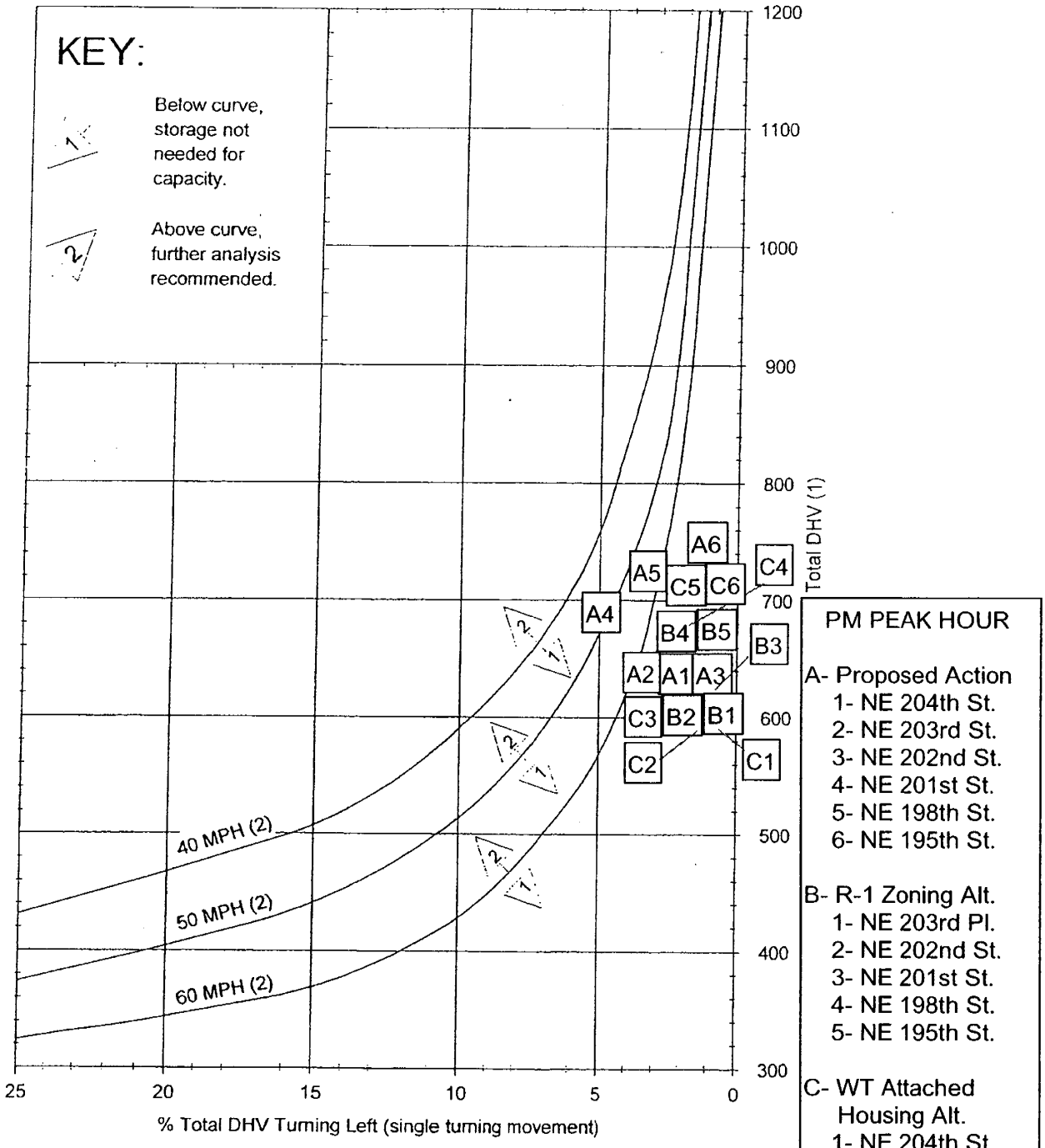
APPENDIX T-8: Development LOS Summary

Weekday AM Peak Hour	2006 No Action Conditions			2006 with Proposed Action			2006 with R-1 Zoning			2006 with Attached Housing		
	LOS[1]	Delay[2]	WM or V/C[3]	LOS	Delay	WM OR V/C	LOS	Delay	WM OR V/C	LOS	Delay	WM OR V/C
156th Ave NE/NE 203rd Pl	B	10.0	WB App.	B	10.2	WB App.	B	10.7	EB App.	B	10.2	WB App.
156th Ave NE/NE 202nd St	B	10.1	EB App.	B	10.3	EB App.	B	10.2	EB App.	B	10.3	EB App.
156th Ave NE/NE 201st St	B	10.5	EB App.	B	11.1	EB App.	B	10.6	EB App.	B	10.9	EB App.
156th Ave NE/NE 198th St	B	11.7	WB App.	B	12.6	WB App.	B	11.9	WB App.	B	12.3	WB App.
156th Ave NE/NE 195th St	B	12.5	WB App.	B	13.1	WB App.	B	12.7	WB App.	B	13.1	WB App.
156th Ave NE/NE Woodinville-Duvall Rd	C	20.5	0.79	C	21.6	0.82	C	20.9	0.80	C	21.4	0.81
NE Woodinville-Duvall Rd/NE Woodinville Wy	A	6.9	0.45	A	7.0	0.46	A	6.9	0.45	A	6.9	0.46
NE Woodinville-Snohomish Rd/NE 195th St	C	29.8	0.91	C	30.0	0.91	C	29.8	0.91	C	30.0	0.91

Weekday PM Peak Hour	2006 No Action Conditions			2006 with Proposed Action			2006 with R-1 Zoning			2006 with Attached Housing		
	LOS[1]	Delay[2]	WM or V/C[3]	LOS	Delay	WM OR V/C	LOS	Delay	WM OR V/C	LOS	Delay	WM OR V/C
156th Ave NE/NE 203rd Pl	B	11.3	WB App.	B	11.7	WB App.	B	12.3	EB App.	B	11.5	WB App.
156th Ave NE/NE 202nd St	B	11.0	EB App.	B	11.4	EB App.	B	11.3	EB App.	B	11.5	EB App.
156th Ave NE/NE 201st St	B	11.3	EB App.	B	12.2	EB App.	B	11.5	EB App.	B	11.9	EB App.
156th Ave NE/NE 198th St	C	15.3	WB App.	C	17.9	WB App.	C	15.8	WB App.	C	16.9	WB App.
156th Ave NE/NE 195th St	C	15.3	WB App.	C	17.2	WB App.	C	15.9	WB App.	C	16.8	WB App.
156th Ave NE/NE Woodinville-Duvall Rd	C	26.3	0.93	C	32.7	0.97	C	27.5	0.94	C	30.7	0.94
NE Woodinville-Duvall Rd/NE Woodinville Wy	C	28.8	0.83	C	30.3	0.85	C	29.2	0.83	C	29.9	0.85
NE Woodinville-Snohomish Rd/NE 195th St	C	30.0	0.81	C	30.7	0.82	C	30.2	0.81	C	30.6	0.82

1. Level of Service
2. Average vehicle delay (seconds)
3. Volume to capacity ratio reported at signalized intersections; worst movement at unsignalized intersections.

APPENDIX T-9



(1) DHV is total volume from both directions.

(2) Speeds are posted speeds.

Left-Turn Storage Guidelines (Two-Lane, Unsignalized)

Figure 910-9a