Planning for Multi-University Educational Activities Based on OSU's Smart Bus Campus Transit Laboratory

Final Report prepared for

Ohio Transportation Consortium

University Transportation Center

U.S. Department of Transportation

Research and Innovative Technologies Administration

by

Mark R. McCord , PhD, Professor, Civil Engineering

Rabi G. Mishalani, PhD, Associate Professor, Civil Engineering

The Ohio State University

470 Hitchcock Hall

2070 Neil Avenue

Columbus, OH 43210

(614.292.2388, mccord.2@osu.edu)

4 September 2008

<u>ACKNOWLEDGEMENTS</u>: Primary funding for this project was provided under Grant DTRT06-G-0037, CRT00010133/60013354 through the University of Akron based Ohio University Consortium University Transportation Center, U.S. Department of Transportation, Research and Innovative Technologies Administration. Partial funding for some of the data collection effort was provided through the US DOT Region V NEXTRANS University Transportation Center under Grant DTRT07-G-0005 and by The Ohio State University.

Problem: In separate efforts, the project investigators have been working with the Ohio State University (OSU) Transportation and Parking Services and Clever Devices, Inc. to implement a "smart bus" system on OSU's Campus Area Bus Service (CABS). This smart bus system will include, among other things, advanced automatic vehicle location (AVL) and automated passenger counting (APC) capabilities. CABS is one of the largest campus bus systems in the U.S., serving three to four million passengers annually, and Clever Devices is arguably the industry leader in equipping and operating advanced information technologies for large public transportation agencies. This effort would be Clever Devices' first implementation on a campus transit system, and the combined effort offers an opportunity to develop a unique infrastructure for education and research – the OSU Campus Transit Lab (CTL).

The original intent of the project reported on here was to begin developing educational exercises based on the CTL that would be of interest to multiple programs in various OTC partner universities. Preliminary communications with the partner universities indicated that focusing on exercises of common interest would not be productive at this time. Therefore, it was decided to first concentrate on identifying and beginning to design educational demonstrations and exercises for use in OSU courses.

The CTL is expected to be operational in autumn 2008, but it was hoped that collection of preliminary, "trial" data would begin in spring 2008. As is common when implementing large projects, delays were encountered, and CTL data were not available during the conduct of this project. Therefore, it was also decided to conceive of exercises that could be conducted with CTL data and to manually collect some data emulating what CTL would generate, thus, allowing experimentation with the ideas forming the basis of the eventual educational exercises and demonstrations.

Approach: Project investigators identified two courses as candidates for implementing exercises and demonstrations based on eventual CTL data – *Civil Engineering 570: Introduction to Transportation Engineering and Analysis* and *Civil Engineering 670: Urban Public Transportation*. *CE 570* is an exclusively undergraduate course that covers multiple transportation modules in sufficient depth to allow quantitative analysis. Being required of all undergraduate civil engineering students at OSU, *CE 570* has enrollments of 75-100 students per year. *CE 670* is a course open to both undergraduate and graduate students. It is a required course in the Civil Engineering-City and Regional Planning Dual Masters Degree Program in Urban Transportation, but is not required for any other programs. *CE 670* has enrollments of 15-20 students per year and provides fundamental knowledge and analytical methods for transit route and network planning, service planning and analysis, performance monitoring, operations control, and frequency and headway determination. One of the requirements of the course is a project conducted in two parts involving the collection of field data and corresponding analyses for various planning and operations purposes.

The investigators worked with an honors undergraduate student who had taken both *CE 570* and *CE 670* to determine possible exercises or demonstrations that would use the upcoming CTL data to complement present topics covered in these courses. It was also considered important that these exercises or demonstrations would not require so much additional instructional time that instruction in other modules would be compromised. The investigators also worked with this student and a graduate student working on another project in need of transit field data to design and implement data collection schemes on a CABS route during spring quarter 2008.

<u>Methodology</u>: The exercises and demonstrations to be used in *CE 570* and *CE 670* were determined from a series of discussions. An initial data collection design was also based on a series of discussions. It was decided that data would be collected on board the Campus Loop South route on the OSU campus. After the initial design, the students collected some preliminary data, and refinements were made to the collection design. The final data collection scheme was designed to allow determination of passenger demand and various dimensions of bus travel time performance.

The demand measures to be determined were passenger boardings and alightings at all stops and passenger loads between stops. The data collectors would count the numbers of passengers on the bus when the collectors first boarded the bus and the number of individuals boarding and alighting at each stop while they rode the bus. They would also count (when feasible) the number of passengers on the bus between consecutive pairs of stops as a check on the passenger bus load determinations. In the event where either load count or the boardings and alightings counts were considered of lower accuracy, a note to this effect was made. The number of passengers on the bus between a consecutive pair of stops i and j could be determined as the sum of the number of passengers on the bus before arriving at stop i, plus the number of passengers boarding at stop i, minus the number of passengers alighting at stop i. These calculated passenger loads could be compared to the passenger loads counted. (The numbers almost always were equal. When not equal, the one calculated from the higher accuracy observations were retained.)

The travel time measures of interest consist of bus running times, dwell times at bus stops, holding times at bus stops, times needed to traverse predetermined "special sections" where some possible hold up was expected (such as at an intersection), and travel times between consecutive bus stops or stops and special sections. The bus running time is the time between consecutive departures from a stop by the same bus on the route. The dwell time is the time a bus devotes to passenger boardings and alightings at a stop. The holding time is the time a bus spends at a predetermined stop, in excess of the dwell time, in an attempt to remain on schedule. The special sections considered were determined from previous experience with the route. Special section traversal times were calculated from the arrival time to the special section and the departure time from the special section. Travel times were considered to be the time when the bus departed a previous point (either a bus stop or a special section) and when it arrived at the next point. The data sheet designed to collect these data is presented in Figure 1.

CAMPUS LOOP SOUTH

DATE:
BUS #:
INITIAL BUS LOAD:

Stop #	Arrival Time h m s	Alighting Passengers	Boarding Passengers	Departure Time h m s	Stationary/Crossing Time h m s	Counted Bus Load	Comments
1							
2							
3							
4							
Carmack @ Kenny							
5							
6							
7							
8							
9							
Cannon @ Med. Center							
10							
11							
12							
13							
Neil @ 12th							
14							
15							
16							
17							
Woodruff @ Ped. X-ing							
17.5							
18							
19							
Carmack @ Kenny							

Figure 1. Data sheet used for on-board data collection

Data were collected on approximately 100 runs during spring quarter 2008. A sample of the raw data collected is presented in Appendix A. These data were processed to produce the measures presented in Appendix B.

Findings: Three ideas that could be supported by the upcoming CTL data were identified as complementing the material presented in *CE 570* and *CE 670*:

- illustration of traffic variable measures through space-time trajectories (CE 570)
- estimation of expected travel times (CE 570)
- modeling of dwell times as a function of passenger boardings and alightings (CE 670)

The measures produced in Appendix B could be used in educational activities designed around the last two ideas.

Illustration of traffic variable measures through space-time trajectories: Space-time vehicle trajectories are presented in *CE 570* to illustrate concepts of space-mean and time-mean speeds of general vehicular, not necessarily bus, traffic. Vehicle speeds are determined as the slopes of the trajectories. Space-mean speeds are presented as the arithmetic means of these speeds taken at an instant in time (a fixed point on the time axis) over space (an interval of the space axis). Time-mean speeds are presented as the arithmetic means of the speeds taken at a fixed location in space (a fixed point on the distance axis) over time (an interval of the time axis). The trajectories are currently presented as abstractions. Although pertaining only to CABS buses, the automatic vehicle location (AVL) data collected from the CTL could be used to illustrate vehicle trajectories and the concepts of space- and time-mean speeds in lecture material.

In addition, concepts of vehicle headways (times between successive vehicles at a fixed location) and vehicle spacings (distances between successive vehicles at an instant in time) and their relationships to flow rates and vehicle densities are presented in *CE 570* without the use of space-time diagrams. However, the concepts have direct graphical representations when considering space-time trajectories, and it was determined that it could be of value to present these concepts using trajectories produced from the CTL data.

The raw AVL data will be processed to produce time-stamped distances along the route from a reference point. For operational passenger information purposes, the data will be communicated in real-time at relatively low frequency. However, because of the desire to use the system as an educational and research facility, arrangements have been made to store data obtained at high sampling frequencies on the bus for downloading on a regular basis for off-line analysis. Plotting these high frequency distance-time points will produce space-time trajectories of the bus movements. Using trajectories of vehicles, students can identify with traveling over locations and times with which they are familiar should make the concepts more interesting and meaningful.

The trajectory information cannot be determined from the empirical data collected in this project (Appendix A). However, the information will be available when the CTL is operational.

Estimation of expected travel times: This idea would involve using empirical data collected from the CTL to produce numerical values for a student exercise.

One *CE 570* module involves the computation of "expected times to destination" for a public transportation system operating on a dedicated right-of-way. These times-to-destination are calculated by decomposing the times into components. Two of the primary components consist of the time spent waiting for the vehicle at the boarding station and the line haul time (the time spent on the vehicle between the boarding and alighting station). The expected passenger wait time at the boarding station is determined from an assumed passenger arrival pattern and an assumed headway between vehicles. A line haul time between a pair of stations is assumed to be a deterministic value calculated from given acceleration, deceleration, cruise speeds, and dwell times at intermediate stations. The variability in passengers' line haul times between a specified boarding and a random alighting station is derived from the distribution of the alighting stations, which is specified using some simplifying assumptions.

In the course, this module is framed in the context of determining times-to-destination as a function of number and placement of stations. Considering the use of a dedicated right-of-way system makes it possible to both present concepts and conduct reasonable analysis in a short period of time (roughly four lecture hours). This context will likely be continued in the foreseeable future. Nevertheless, the CTL data will allow estimations of empirical distributions of bus headways at stops, travel times between stop pairs, and passenger demands. Students could then calculate empirical mean wait times and mean travel times between boarding and alighting stops. The importance of distinguishing between determining these values for design level analysis of a system on a dedicated right-of-way and determining the values for empirical analysis of an existing bus transit system operating in mixed traffic on surface streets would be an interesting concept that could be briefly introduced in the course. The concept would be reinforced by adding an empirical exercise dealing with the empirical calculation of the values.

As mentioned above, the objective of this project is to determine ideas that could be presented without consuming much additional class or student time. As of now, it is anticipated that discrete sets of headways, dwell times, and travel times between consecutive stops would be produced from the CTL data by personnel working on future research and development projects and made available to the *CE 570* students. It is possible that these data sets could eventually be prepared from the AVL data by students as required exercises in more advanced courses, but determining how to do so in a specific class is beyond the scope of this project.

For the exercise in *CE 570*, the empirical realizations of the measures will all be assumed to be mutually independent and representative of exhaustive realizations occurring with equal probability. The students will be asked to compute mean times from these distributions based on specified passenger arrival patterns at the boarding station (which will not be available from the CTL). A route-level origin destination matrix will need to be used for this purpose. Under separate funding, we have been determining such matrices from boarding and alighting data measured with the automatic passenger counting (APC) system with alternative methods and investigating the performance of these methods. (We also expect to develop improved methods.)

For the *CE 570* exercise, the origin-destination matrix simply needs to be a realistic matrix, which the present methods produce, and some method can be chosen to transform the APC data into a matrix to be provided to the *CE 570* students. Because of the size of the class, the wide range of topics covered in the course, and the background of the students in this introductory course, it would be infeasible to expect the *CE 570* students to process the CTL data into the bus travel time and demand data needed for the exercises. However, the CTL data (initially the manually collected data) will be briefly introduced and the students will be made aware that the data are being collected (initially could be collected) by the various technologies at hand.

The processed data of Appendix B demonstrate that sets of headways, dwell times, and stop-to-stop travel times can be calculated from the empirical data that were already collected during this project. As mentioned above, the boarding and alighting passenger data collected can be combined with an origin-destination estimation algorithm to produce the estimates of probabilities that a random passenger boarding at a specified stop will alight at the various downstream stops. That is, preliminary data required to implement this exercise are now available, and the exercise could be tried in the next offering of the course in preparation for implementation when CTL data become regularly available.

Correlation of dwell times with passenger boardings and alightings: Similar to the previous item, this idea would involve using empirical data collected from the CTL to form the basis of a student exercise. As part of a field exercise in *CE 670*, students presently record, among other things, the numbers of passengers boarding and alighting at select bus stops and the corresponding bus dwell times. They then investigate whether the bus dwell times appear to depend on the boarding and alighting activity.

Boarding and alighting data, as well as dwell times, can be obtained from CTL data. Again, the amount of class time that would need to be freed up to instruct students on processing the CTL data into the data needed for this exercise, compared to the educational benefits of doing so, is considered too large to justify having *CE 670* students do this processing. The processing would again be performed by personnel on other projects. Nevertheless, as before, the smart bus system and the AVL data would be briefly described so that students can gain an appreciation of the unique system. Alternatively, the CTL data could be partially processed to a point where CE 670 students could more manageably calculate the measures needed to conduct the analysis.

It is anticipated that students would continue to collect data manually at select bus stops. Comparisons between the manually collected data and the AVL-based data could be made. The comparisons would likely be made at a general level, since the AVL-data would be prepared before the beginning of the course to ensure that the data sets are available at the appropriate times. Continuing to collect data manually would also allow the students to gain an appreciation of the spatial and temporal extensiveness that can be obtained with AVL-based data collection.

The boarding, alighting, and dwell time data in Appendix B again demonstrate that data for this anticipated exercise can be obtained from the empirical data illustrated in Appendix A. Therefore, preliminary data required to complement the present exercise in *CE 670* are now available, and the exercise could be tried in the next offering of the course in preparation for implementation when CTL data become regularly available.

Conclusions: Trying to determine a common set of educational exercises among the OTC partner universities that could benefit from the unique CTL being implemented on the OSU campus was found not to be productive at this time. It seemed preferable to first develop exercises for OSU courses and discuss ways in which the partner universities could benefit from the CTL in an informal manner until specific interest in collaboration could be identified. The educational exercises developed in this project can serve as concrete examples that could be pointed to in these future discussions.

Three ideas were identified for two OSU courses. One idea consisted of using empirical space-time vehicle (bus) trajectories formed from the high frequency location-time data collected with the CTL AVL system to illustrate traffic concepts in a large, required, undergraduate transportation course. These concepts are presently illustrated with abstract trajectories. The other two ideas consisted of using data collected from the CTL in student exercises. In one idea, passenger data collected from the CTL APC system and headway, dwell time, and travel time data collected from the AVL system would yield data sets that students in the required undergraduate transportation course would investigate to determine empirical mean times for a random passenger to travel from a specified boarding station to his or her (random) alighting station. In the other idea, the dwell time and passenger boarding and alighting data would be used by students in an elective public transportation course when investigating the effect of boarding and alighting activity on the length of the dwell time.

In addition, empirical data were collected that would support two of the identified educational ideas. The data were collected manually, since the CTL has not yet been implemented. (A portion of the data collection was funded by another project to meet the needs of that project.) However, the data used to support the two educational ideas are similar to data that would be made available from the CTL. As such, they represent a type of field-derived database for these ideas.

Recommendations: It is recommended that the three educational ideas be refined and operationalized for use in the identified OSU courses. The manually collected data should also be prepared for use in the identified student exercises.

The success in identifying what appear to be promising ideas also motivates investigating the potential to use the CTL in other educational exercises in the two courses identified during this project and in other courses at OSU.

It is also recommended that additional efforts be made to identify ways in which the OTC partner universities (and other universities across the country) could benefit from the unique CTL that is expected to be completed on the OSU campus in the upcoming year. The ideas identified in this project could serve as concrete examples in discussions among the universities.

Appendix A

Sample empirical passenger demand

and bus arrival and departure time data collected

CAMPUS LOOP SOUTH

DATE: 5-12-08
BUS #: 2439
INITIAL BUS LOAD: 7

Stop #	Arrival Time h	m	s	Alighting Passengers	Boarding Passengers	Departure Time h	m	s	Stationary/Holding Time h	m	s	Counted Bus Load	Comments
8	6	52	39	0	0	6	53	0				7	
9	6	54	14	3	0	6	54	22				4	
Med Cen	6	56	14			6	56	55	6	57	2		No queue
10	6	57	17	0	0	6	57	20				4	
11	6	57	52	1	0	6	58	4				3	
12	6	59	22			6	59	25				3	
13	7	1	11	3	0	7	1	24	7	1	39	0	
N/12th	7	1	44			7	2	18	7	2	38		7 car queue
14	7	3	11	0	0	7	3	15				0	
15	7	3	42	0	0	7	3	45				0	
16	7	5	7	0	0	7	5	18	7	6	5	0	
17	7	7	36	0	0	7	7	42				0	
Ped Xing	7	8	20			7	8	20	7	8	20		
17.5	7	8	33	0	0	7	8	36				0	
18	7	9	56	0	0	7	10	2				0	
19	7	10	59	0	0	7	11	7	7	12	42	0	
Kenny	7	14	7			7	14	33	7	14	39		No queue
1	7	15	13	0	0	7	15	18				0	
2	7	15	38	0	0	7	15	42				0	
3	7	16	16	0	2	7	16	30	7	18	6	2	
4	7	19	20	0	2	7	19	38	7	20	3	4	
Kenny	7	20	59			7	20	59	7	20	59		
5	7	21	10	0	1	7	21	18				5	
6	7	22	17	1	0	7	22	24				4	
7	7	23	21	0	0	7	23	25				4	
8	7	24	59	2	1	7	25	10	7	25	52	3	
9	7	28	47	1	0	7	28	53				2	
Med Cen	7	30	35			7	30	53	7	30	59		No queue
10	7	31	12	0	0	7	31	17				2	
11	7	31	49	1	0	7	31	55				1	
12	7	33	28	0	1	7	33	36				2	
13	7	34	59	0	1	7	35	8				3	
N/12th	7	35	23			7	35	23	7	35	23		
14	7	35	58	0	9	7	36	22				12	
15	7	36	46	1	14	7	37	23				25	
16	7	38	34	0	1	7	38	43				26	
17	7	40	7	1	1	7	40	17				26	
Ped Xing	7	40	59			7	40	59	7	40	59		
17.5	7	41	11	0	0	7	41	14				26	
18	7	41	52	17	0	7	42	24				9	
19	7	43	17	5	0	7	43	31	7	45	14	4	No queue
Kenny	7	46	58			7	48	34	7	48	41		
1	7	49	14	1	0	7	49	21				3	
2	7	49	43	0	1	7	49	49				4	
3	7	50	24	1	6	7	50	54	7	51	4	9	
4	7	52	11	2	7	7	52	33	7	52	44	14	1 car queue
Kenny	7	53	40			7	54	34	7	54	42		
5	7	54	52	0	1	7	55	2				15	
6	7	56	31	3	1	7	56	42				13	
7	7	57	41	0	1	7	57	50				14	
8	7	59	38	2	1	7	59	52				13	
9	8	0	46	4	0	8	1	1				9	
Med Cen	8	1	58			8	3	42	8	3	48		No queue
10	8	4	2	0	0	8	4	5				9	
11	8	4	37	2	0	8	4	46				7	
12	8	5	56	1	8	8	6	19				14	
13	8	7	29	4	1	8	7	43				11	
N/12th	8	7	52			8	8	56	8	9	11		5 car queue
14	8	9	45	0	1	8	9	50				12	
15	8	10	14	0	9	8	10	40				21	
16	8	12	5	9	1	8	12	20	8	13	18	13	change drivers
17	8	15	15	6	4	8	15	32				11	
Ped Xing	8	16	23			8	16	31	8	16	41		2 car queue
17.5	8	16	54	1	0	8	17	1				10	
18	8	18	5	1	0	8	18	12				9	
19	8	19	10	6	0	8	19	24				3	5 car queue
Kenny	8	20	39			8	20	42	8	20	56		

Appendix B

Sample demand measures and bus travel, dwell, and hold times calculated from empirical data

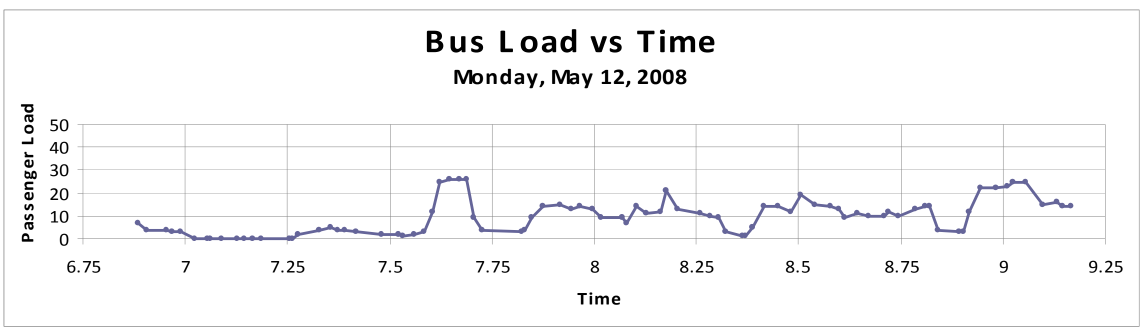
DATE	5-12-08	Campus Loop South	BUS #	2439
TIME	6:52 AM to 9:10 AM			
DAY	Monday			

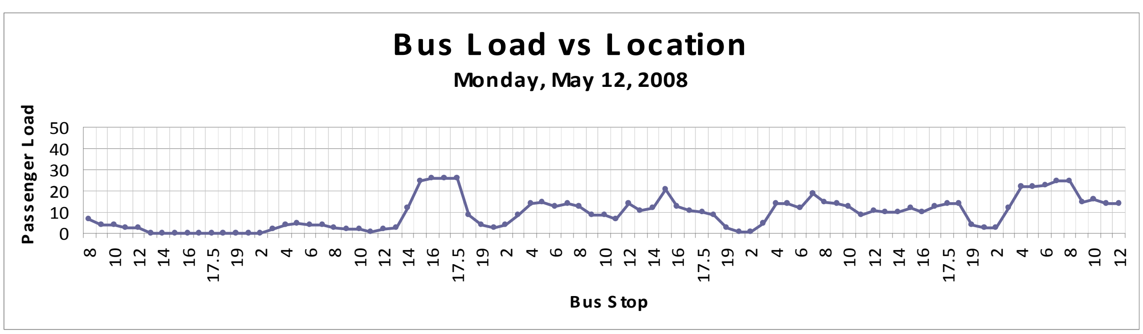
Dwell Time with Holding (seconds)				
Stop	Average	Minimum	Maximum	Observations
1	12.50	5	24	4
2	4.75	2	7	4
3	49.75	23	110	4
4	36.75	25	46	4
5	6.00	3	10	4
6	11.00	7	13	4
7	9.75	4	18	4
8	23.60	14	53	5
9	12.00	6	19	5
10	5.40	3	10	5
11	10.20	6	13	5
12	15.40	3	25	5
13	16.75	9	28	4
14	11.25	4	24	4
15	19.25	3	37	4
16	45.75	9	73	4
17	12.75	6	18	4
17.5	4.75	3	7	4
18	12.50	5	32	4
19	63.50	14	117	4

Dwell Time without Holding (seconds)				
Stop	Average	Minimum	Maximum	Observations
1	8.75	5	14	4
2	4.75	2	7	4
3	23.25	14	30	4
4	24.00	18	31	4
5	6.00	3	10	4
6	11.00	7	13	4
7	9.75	4	18	4
8	15.20	11	21	5
9	12.00	6	19	5
10	5.40	3	10	5
11	10.20	6	13	5
12	15.40	3	25	5
13	13.00	9	16	4
14	11.25	4	24	4
15	19.25	3	37	4
16	11.25	9	15	4
17	12.75	6	18	4
17.5	4.75	3	7	4
18	12.50	5	32	4
19	14.00	8	20	4

Running Time (minutes)				
Stop	Average	Minimum	Maximum	Observations
1	32.71	31.75	34.02	3
2	32.82	31.88	34.08	3
3	32.81	31.80	34.13	3
4	32.31	31.95	32.85	3
5	32.63	32.02	33.70	3
6	32.70	31.70	34.23	3
7	32.68	31.43	34.33	3
8	32.63	31.00	34.65	4
9	32.83	31.00	34.55	4
10	32.65	31.80	33.92	4
11	32.66	31.88	33.95	4
12	32.57	31.28	34.10	4
13	32.94	32.50	33.80	3
14	33.08	32.68	33.78	3
15	33.10	32.77	33.47	3
16	33.11	32.37	33.52	3
17	33.12	31.70	35.13	3
17.5	33.31	31.57	35.72	3
18	33.08	31.08	36.22	3
19	33.07	31.03	35.88	3

Stop to Stop Travel Time (seconds)				
From/To	Average	Minimum	Maximum	Observations
1 to 2	21.50	20	23	4
2 to 3	33.75	33	35	4
3 to 4	68.25	63	74	4
4 to 5	113.50	67	142	4
5 to 6	80.25	59	96	4
6 to 7	57.00	48	64	4
7 to 8	103.50	94	114	4
8 to 9	111.80	54	175	5
9 to 10	136.00	65	181	5
10 to 11	31.60	30	32	5
11 to 12	79.20	55	100	5
12 to 13	85.00	70	106	4
13 to 14	98.50	50	130	4
14 to 15	24.25	22	27	4
15 to16	78.50	71	85	4
16 to 17	99.75	84	117	4
17 to 17.5	65.00	51	82	4
17.5 to 18	54.50	36	80	4
18 to 19	56.25	53	58	4
19 to 1	173.00	132	240	4





CAMPUS LOOP SOUTH

DATE: 5-12-08
BUS #: 2439
INITIAL BUS LOAD: 7

Stop #	Arrival Time			Departure Time			Stationary/Holding Time			Alighting Passengers	Boarding Passengers	Calculated Bus Load	Dwell Time (sec)	Holding Time (sec)	Dwell Time w/ Holding
	h	m	s	h	m	s	h	m	s						
8	6	52	39	6	53	0				0	0	7	21	0	21
9	6	54	14	6	54	22				3	0	4	8	0	8
Med Cen	6	56	14	6	56	55	6	57	2			4	41	7	48
10	6	57	17	6	57	20				0	0	4	3	0	3
11	6	57	52	6	58	4				1	0	3	12	0	12
12	6	59	22	6	59	25						3	3	0	3
13	7	1	11	7	1	24	7	1	39	3	0	0	13	15	28
N/12th	7	1	44	7	2	18	7	2	38			0	34	20	54
14	7	3	11	7	3	15				0	0	0	4	0	4
15	7	3	42	7	3	45				0	0	0	3	0	3
16	7	5	7	7	5	18	7	6	5	0	0	0	11	47	58
17	7	7	36	7	7	42				0	0	0	6	0	6
Ped Xing	7	8	20	7	8	20	7	8	20			0	0	0	0
17.5	7	8	33	7	8	36				0	0	0	3	0	3
18	7	9	56	7	10	2				0	0	0	6	0	6
19	7	10	59	7	11	7	7	12	42	0	0	0	8	95	103
Kenny	7	14	7	7	14	33	7	14	39			0	26	6	32
1	7	15	13	7	15	18				0	0	0	5	0	5
2	7	15	38	7	15	42				0	0	0	4	0	4
3	7	16	16	7	16	30	7	18	6	0	2	2	14	96	110
4	7	19	20	7	19	38	7	20	3	0	2	4	18	25	43
Kenny	7	20	59	7	20	59	7	20	59			4	0	0	0
5	7	21	10	7	21	18				0	1	5	8	0	8
6	7	22	17	7	22	24				1	0	4	7	0	7
7	7	23	21	7	23	25				0	0	4	4	0	4
8	7	24	59	7	25	10	7	25	52	2	1	3	11	42	53
9	7	28	47	7	28	53				1	0	2	6	0	6
Med Cen	7	30	35	7	30	53	7	30	59			2	18	6	24
10	7	31	12	7	31	17				0	0	2	5	0	5
11	7	31	49	7	31	55				1	0	1	6	0	6
12	7	33	28	7	33	36				0	1	2	8	0	8
13	7	34	59	7	35	8				0	1	3	9	0	9
N/12th	7	35	23	7	35	23	7	35	23			3	0	0	0
14	7	35	58	7	36	22				0	9	12	24	0	24
15	7	36	46	7	37	23				1	14	25	37	0	37
16	7	38	34	7	38	43				0	1	26	9	0	9
17	7	40	7	7	40	17				1	1	26	10	0	10
Ped Xing	7	40	59	7	40	59	7	40	59			26	0	0	0
17.5	7	41	11	7	41	14				0	0	26	3	0	3
18	7	41	52	7	42	24				17	0	9	32	0	32
19	7	43	17	7	43	31	7	45	14	5	0	4	14	103	117
Kenny	7	46	58	7	48	34	7	48	41			4	96	7	103
1	7	49	14	7	49	21				1	0	3	7	0	7
2	7	49	43	7	49	49				0	1	4	6	0	6
3	7	50	24	7	50	54	7	51	4	1	6	9	30	10	40
4	7	52	11	7	52	33	7	52	44	2	7	14	22	11	33
Kenny	7	53	40	7	54	34	7	54	42			14	54	8	62
5	7	54	52	7	55	2				0	1	15	10	0	10
6	7	56	31	7	56	42				3	1	13	11	0	11
7	7	57	41	7	57	50				0	1	14	9	0	9
8	7	59	38	7	59	52				2	1	13	14	0	14
9	8	0	46	8	1	1				4	0	9	15	0	15
Med Cen	8	1	58	8	3	42	8	3	48			9	104	6	110
10	8	4	2	8	4	5				0	0	9	3	0	3
11	8	4	37	8	4	46				2	0	7	9	0	9
12	8	5	56	8	6	19				1	8	14	23	0	23
13	8	7	29	8	7	43				4	1	11	14	0	14
N/12th	8	7	52	8	8	56	8	9	11			11	64	15	79
14	8	9	45	8	9	50				0	1	12	5	0	5
15	8	10	14	8	10	40				0	9	21	26	0	26
16	8	12	5	8	12	20	8	13	18	9	1	13	15	58	73
17	8	15	15	8	15	32				6	4	11	17	0	17
Ped Xing	8	16	23	8	16	31	8	16	41			11	8	10	18
17.5	8	16	54	8	17	1				1	0	10	7	0	7
18	8	18	5	8	18	12				1	0	9	7	0	7
19	8	19	10	8	19	24				6	0	3	14	0	14
Kenny	8	20	39	8	20	42	8	20	56			3	3	14	17
1	8	21	36	8	21	50				2	0	1	14	0	14
2	8	22	13	8	22	20				0	0	1	7	0	7
3	8	22	53	8	23	16				1	5	5	23	0	23
4	8	24	19	8	24	50	8	25	5	0	9	14	31	15	46
Kenny	8	25	58	8	26	36	8	26	47			14	38	11	49
5	8	27	2	8	27	5				0	0	14	3	0	3
6	8	28	41	8	28	54				2	0	12	13	0	13
7	8	29	58	8	30	16				1	8	19	18	0	18
8	8	32	10	8	32	25				4	0	15	15	0	15
9	8	34	33	8	34	45				1	0	14	12	0	12
Med Cen	8	35	32	8	35	32	8	35	32			14	0	0	0
10	8	35	50	8	36	0				1	0	13	10	0	10
11	8	36	30	8	36	41				4	0	9	11	0	11
12	8	38	21	8	38	39				4	6	11	18	0	18
13	8	40	0	8	40	16				3	2	10	16	0	16
N/12th	8	40	28	8	41	41	8	41	50			10	73	9	82
14	8	42	26	8	42	38				3	3	10	12	0	12