CHAMPAIGN COUNTY
REGIONAL PLANNING
COMMISSION

Champaign County Regional Planning Commission

Travel Mode Choice Model Update

Champaign Urbana Urbanized Area Travel Demand Model

Champaign Urbana Urbanized Area Transportation Study

6/29/2012

Executive Summary

The Champaign County Regional Planning Commission (CCRPC) through the Champaign Urbana Urbanized Area Transportation Study (CUUATS) has developed and utilized its travel demand model for the Champaign-Urbana urbanized area since 2003. Accurate demand estimation is critical for planning, designing, and operating transportation systems. The existing Champaign-Urbana model is extensively used for numerous projects and programs implemented by CUUATS and other local agencies. . In addition to forecasting traffic volumes for Long Range Transportation Planning and making policy decisions regarding allocating transportation funding, Travel Demand Models (TDM) can also be used for corridor planning and other micro level planning studies.

The current CUUATS 4-step travel demand model has a “Mode Choice” step which assigns transit trips based on a fixed mode-choice curve. This step does not accurately represent all the active modes of transportation (e.g., walking, bicycling) for the model area and especially for the University District. Upgrading the “Mode Choice” step of the model would more accurately estimate transit, pedestrian, and bicycle trips for the University District and the whole urbanized area.

This study sought to replace the existing incomplete mode choice model with an updated model which is based on input data obtained from a comprehensive travel survey completed by the University of Illinois at Urbana Champaign students, faculty, and staff.

Through this study, the University of Illinois Origin-Destination travel survey results were successfully utilized to update the CUUATS Travel Demand Model steps. The University of Illinois is the chief traffic generator for the Champaign-Urbana Urbanized Area. The traditional approach for estimating trips for the university campus was found inefficient and lacked desired sensitivity and reliability. This report described the detailed steps involved in updating the TDM with the travel survey results. Moreover, appropriate validation tests for every TDM steps were performed to check the reliability of the model. The validation steps provided satisfactory results as the model reliably replicated base year travel behavior for the Champaign-Urbana Urbanized Area.

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1.0 Introduction

The Champaign County Regional Planning Commission (CCRPC) through the Champaign Urbana Urbanized Area Transportation Study (CUUATS) has developed and utilized its travel demand model for the Champaign-Urbana urbanized area since 2003. Accurate demand estimation is critical for planning, designing, and operating transportation systems. The existing Champaign-Urbana model is extensively used for numerous projects and programs implemented by CUUATS and other local agencies. . In addition to forecasting traffic volumes for Long Range Transportation Planning and making policy decisions regarding allocating transportation funding, Travel Demand Models (TDM) can also be used for corridor planning and other micro level planning studies.

The current CUUATS 4-step travel demand model has a “Mode Choice” step which assigns transit trips based on a fixed mode-choice curve. This step does not accurately represent all the active modes of transportation (e.g., walking, bicycling) for the model area and especially for the University District. Upgrading the “Mode Choice” step of the model would more accurately estimate transit, pedestrian, and bicycle trips for the University District and the whole urbanized area.

This study sought to replace the existing incomplete mode choice model with an updated model which is based on input data obtained from a comprehensive travel survey completed by the University of Illinois at Urbana Champaign students, faculty, and staff.

1.1 Objectives

The objectives of the project were to develop a TDM that can reliably provide the following:

- Accurate estimation of transit, bicycle, and pedestrian trips for the urbanized area.
- Improve overall forecasting capabilities of the TDM.
- Sufficient sensitivity to transit service attributes – e.g., service frequency, coverage, travel time – to help make informed future investment decisions in transit.

1.2 Report Organization

This report is organized into the following chapters:

- Chapter 1 – Introduction and Objectives – This chapter provides an introduction to the project and highlights the study objectives.

- Chapter 2 – Existing CUUATS Travel Model – This chapter states the current status of travel demand modeling for CCRPC and identifies the issues regarding TDM step(s) which need to be addressed to increase the model’s forecasting capability and reliability.

- Chapter 3 – Origin-Destination (O-D) Travel Survey for the University of Illinois Campus – This chapter provides the background, development, and administration of the first ever Origin-Destination Travel Survey designed for the University of Illinois campus at Urbana-Champaign.

- Chapter 4 – O-D Travel Survey Findings – This chapter documents the findings of the O-D travel survey for the University of Illinois.

- Chapter 5 – Updating the CUUATS Travel Demand Model – This chapter highlights on the steps involved in updating the CUUATS travel demand model components based on the findings of the University of Illinois O-D travel survey.

- Chapter 6 - Conclusions and Future Work

2.0 Existing CUUATS Travel Demand Model

The CUUATS travel demand model is a four-step model based on CUBE© TDM software package platform for the person and auto trip model. A local household survey was performed in 2002 to analyze the travel characteristics of the region and help develop the travel demand model. The CCRPC travel demand model is used for corridor studies, the Long Range Transportation Plan, Transportation Improvement Program, traffic impact analyses, future roadway structure analyses, and other transportation related studies. Recent projects utilizing the CCRPC travel demand model include the 2035 CUUATS Long Range Transportation Plan: Choices, the University Avenue Corridor Study, the Staley-Rising Corridor Study, the St. Mary's Road Corridor Study, and traffic impact evaluations of proposed major roadway projects.

2.1 Four-Step Travel Demand Model

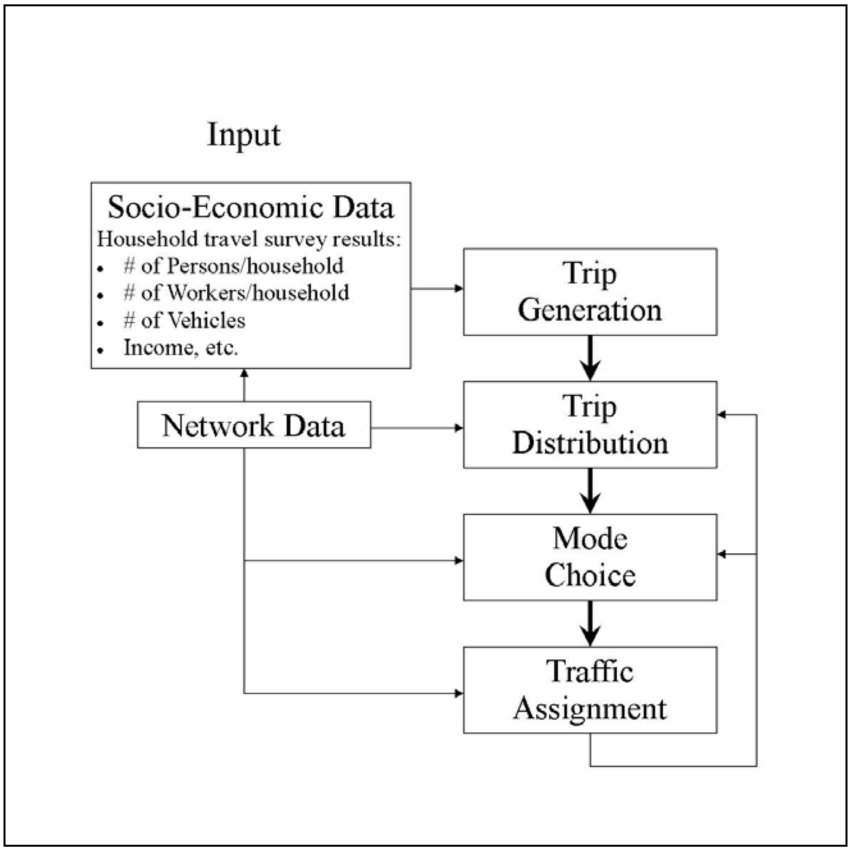
Four-step travel models follow a sequence of steps to answer a series of questions about future travel patterns. The basic questions asked and the corresponding modeling steps involved are as follows[1]:

- What will our community look like in the future?
    - How many people will there be? (Population forecasts)
    - What will they be doing? (Employment forecasts)
    - Where will activities take place? (Land-use forecasts)

- What are the travel patterns in the future?
    - How many trips will be made? (Step 1: Trip Generation)
    - Where will the trips be? (Step 2: Trip Distribution)
    - What modes will be used? (Step 3: Mode Choice)
    - What routes will be used? (Step 4: Traffic Assignment)

Four-step travel model inputs and steps are shown in Figure 1.

Figure 1: Four-Step Model Inputs and Steps



2.2 Mode Choice Step

Mode Choice is the third step of a typical four-step travel demand model. After the trip distribution step, the mode choice model estimates how many travelers will use public transit and how many will use personal vehicles. Walking and bicycling can also be part of a mode choice model. The existing CUUATS TDM does not have bicycle and walking components (only auto and transit modes are included).

In the existing CUUATS TDM, the transit trips are obtained by splitting the total trips using a mode split curve. The mode split curve gives the percentage of transit trips based on the ratio of the transit impedance to highway impedance. The mode split was created to obtain a total transit trip percentage of 6%. Figure 2 shows the mode-split curves for different trip purposes used in the existing CUUATS TDM.

Figure 2: Mode Split Curves

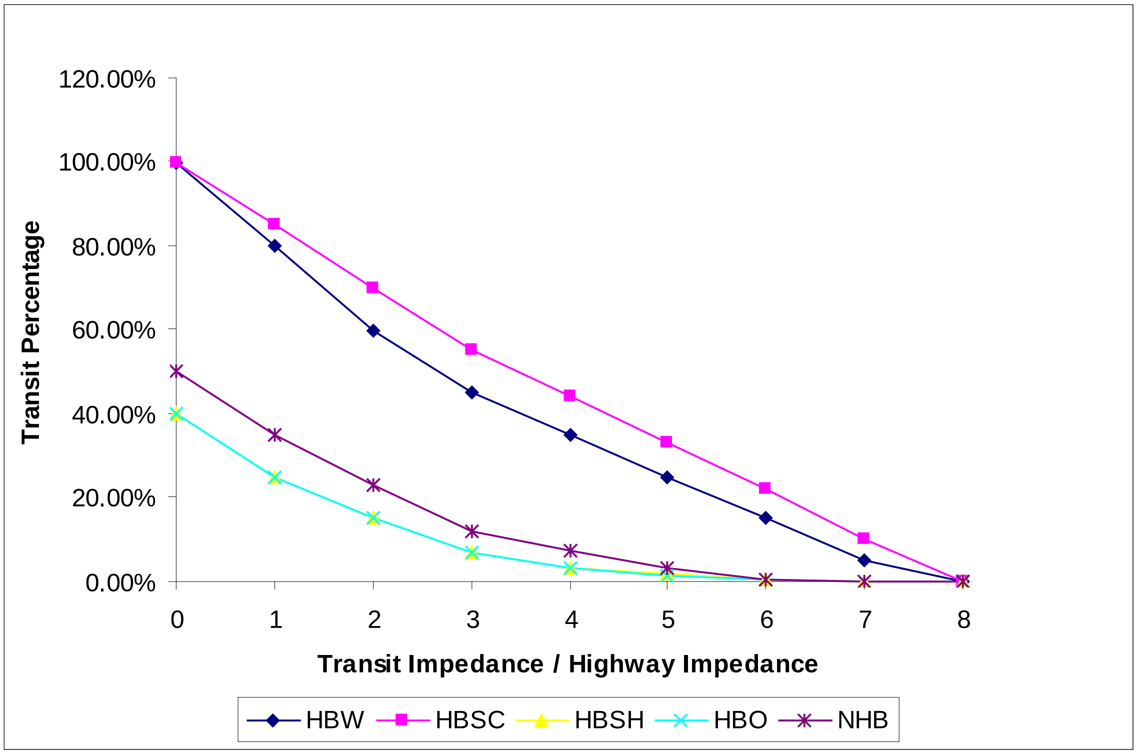


Table 1 shows the percentage of transit trips by each trip purpose. As can be seen in Table 1, Home Based School (HBSc) trips, which include trips made by University of Illinois students, are severely underestimated considering the fact that there are more than 40,000 students at the University of Illinois Urbana-Champaign campus, and a significant percentage of students utilize transit, walking, and bicycle travel modes for their everyday travel purposes.

Table 1: Number of Trips by Purpose (Existing CUUATS TDM)

Purpose	Total Trips	Transit Trips	Transit Trip Percentage
Home Based Work (HBW)	140,945	13,958	9.9
Home Based School (HBSc)	35,472	8,595	24.2
Home Based Shopping (HBSH)	73,106	1,578	2.2
Home Based Other (HBO)	194,257	3,987	2.1
Non-Home Based (NHB)	161,698	7,965	4.9

Moreover, the mode choice model based on a fixed curve lacks sensitivity to evaluate the effects on transit policy, capacity, and operational changes.

2.3 CUMTD miPlan Project and Updated Mode Choice Model

In 2007, the Champaign Urbana Mass Transit District (CUMTD) initiated the Mobility Implementation Plan (miPlan) project in cooperation with the Cities of Urbana and Champaign, University of Illinois, and Champaign County. One of the objectives of Phase II of the project was to develop a complete Mode-Choice model for the CUUATS TDM.

In December 2009, CUUATS staff received the updated mode choice model from the miPlan consultant. Validation tests were run to check the reliability of the updated mode choice model. Table 2 shows network-wide validation, comparing model estimated volumes on freeways, major and minor arterials to field counts.

Table 2: Comparisons with FHWA Guidelines[2]

Facility Type	FHWA Guidelines (+/-)	Updated TDM
Freeway	7%	1.9 %
Major Arterial	10%	6.0 %
Minor Arterial	15%	9.3 %

The percent differences obtained from the updated miPlan model are within the FHWA guidelines.

Seven cutlines were used (as shown in Figure 3) to check the traffic flow across the model region. Four cutlines were oriented in the north-south direction and the rest were oriented in the east-west direction. The cutlines volumes were compared with the observed volumes using the percent deviation. The percent deviations were compared with the maximum desirable deviations recommended in the NCHRP Report 255: Highway Traffic Data for Urbanized Area Project Planning and Design[3]. Table 3 shows a summary of the cutline analysis.

Figure 3: Cutlines

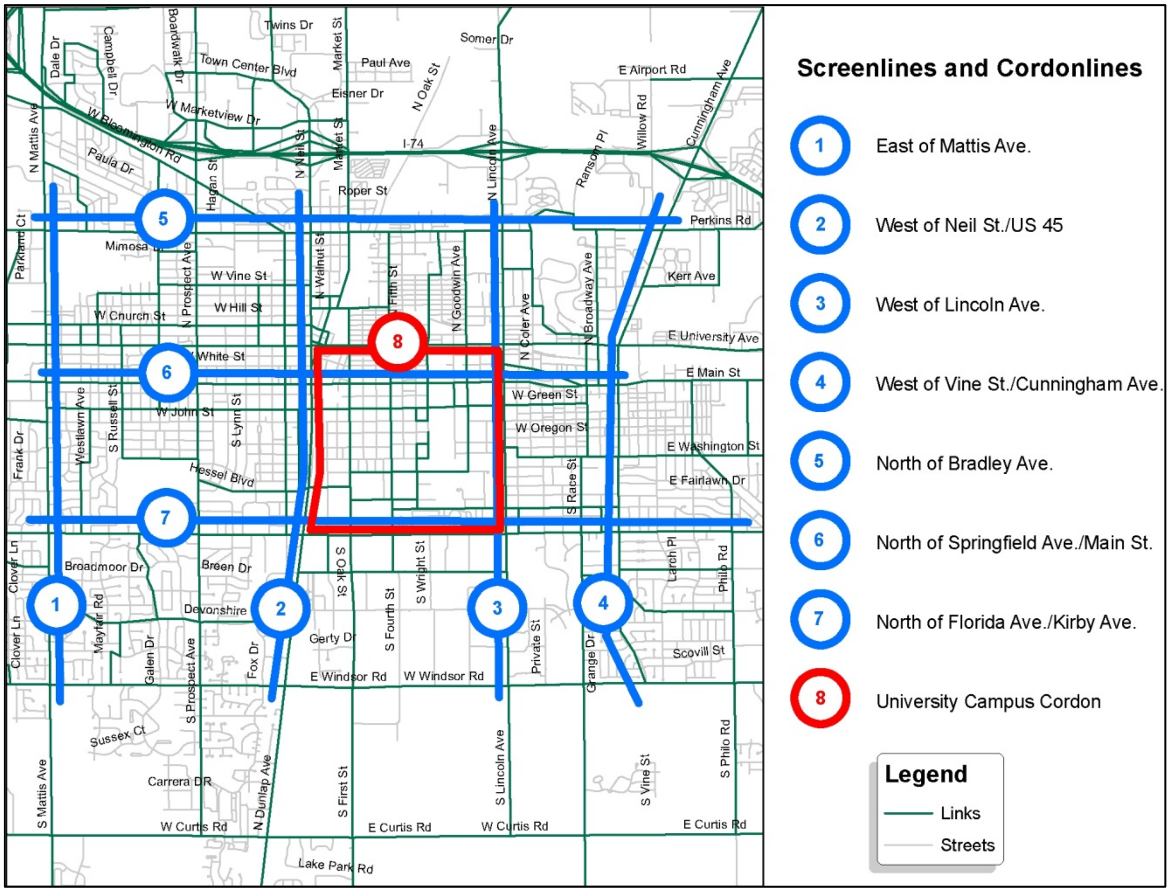


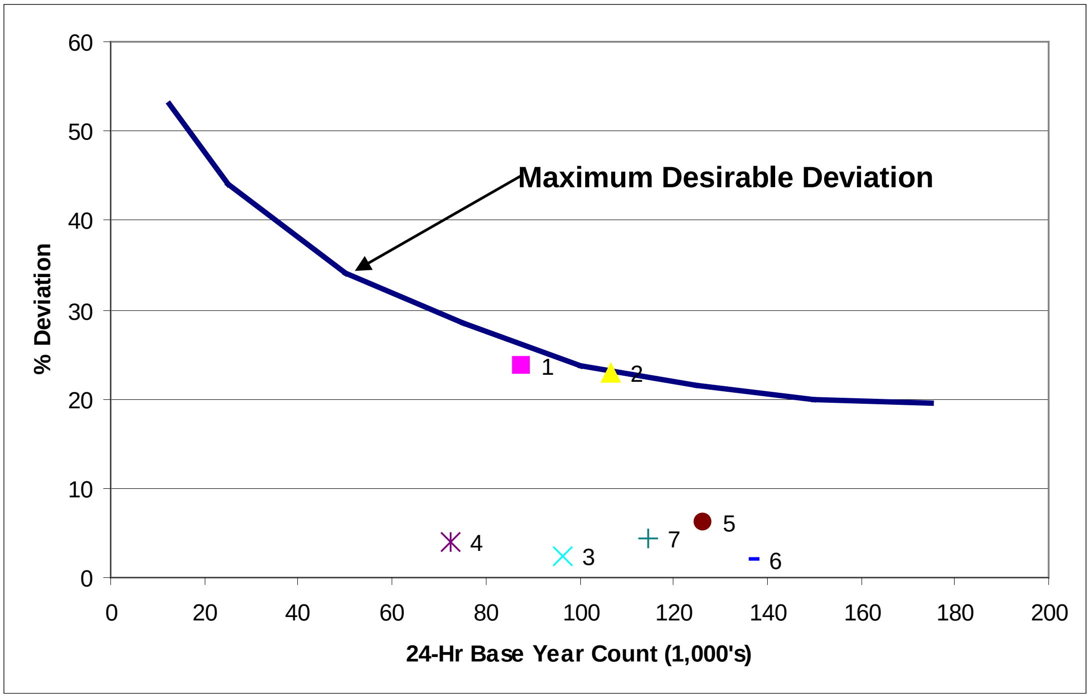
Table 3: Cutlines Summary

Cutlilne	Volumes		Difference	% Deviation
	Estimated	Observed		
1	66,763	87,514	20,751	24
2	82,269	106,657	24,388	23
3	98,593	96,309	2,284	2
4	75,438	72,612	2,826	4
5	134,008	126,228	7,780	6
6	133,416	136,137	2,721	2
7	109,628	114,654	5,026	4

As can be seen in Table 3, for most of the roadways observed traffic volumes are higher than the estimated traffic volumes obtained from the TDM.

Figure 4 shows the relative positions of cutline volumes with respect to FHWA's recommended maximum desirable deviation line.

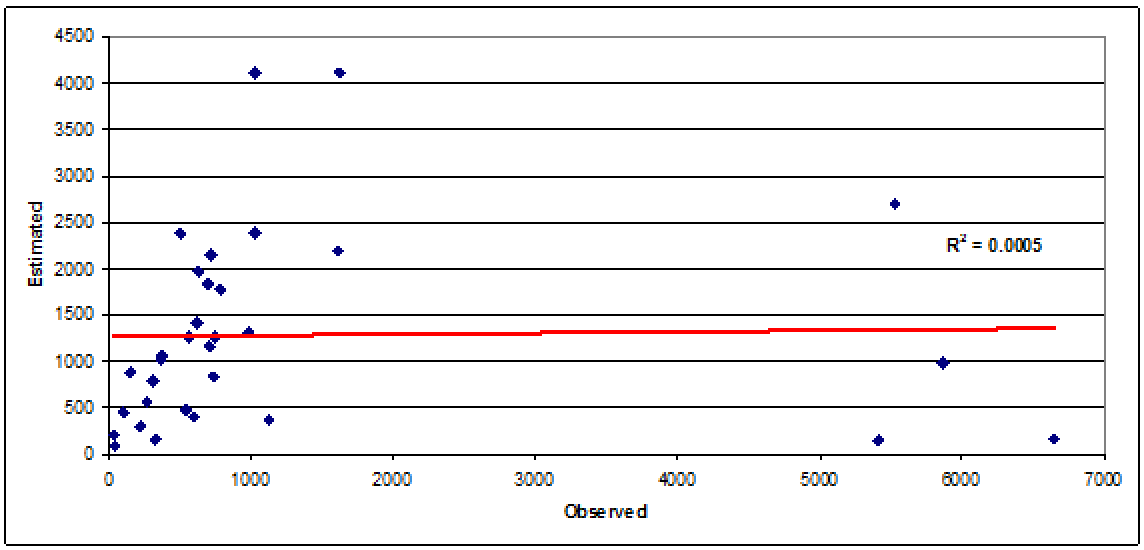
Figure 4: Cutline Volumes and the Maximum Desirable Deviation Line



As can be seen in Figure 4, screenline 1 and screenline 2 are very close to the maximum desirable deviation line.

In an effort to validate the production and distribution of the transit trips, the model estimated transit trips were compared against the observed average weekday transit trip data received from CUMTD. The model estimated transit data was extracted for each bus route. The total number of estimated boarding (ON) and alighting (OFF) trips were calculated to identify the passenger count/trips for each route. The ON and OFF data was slightly different and was averaged to get the estimated boarding. The week-long transit survey performed by CU-MTD in April 2009 was used to derive the weekday average boarding. The total average boarding for the whole transit system is similar, but the boarding for the individual routes are observed to vary significantly ranging from -98% to 469%. Figure 5 shows an XY plot with route level weekday observed boarding in the X axis and the miPlan mode choice model estimated boarding on the Y axis.

Figure 5: Observed and Estimated Boarding



As can be seen in Figure 5, there is no correlation between observed and estimated transit load data.

2.4 Issues Identified

The following issues were identified regarding the validation test failure of the miPlan mode choice model:

- This model created a new trip purpose: Home-Based University (HBU), which is a subgroup of the Home-Based School (HBSc) trip purpose. As shown in Table 1, the total HBSc trips for the model area was approximately 35,500 and that resulted in approximately 7,500 HBU trips. Considering that more than 40,000 students attend the University of Illinois Urbana-Champaign campus, 7,500 HBU trips was severely underestimated.

- This model utilized a few trip adjustment factors to account for bicycle and walking trips. As a result, auto trips were reduced significantly on many road segments.

2.5 Next Steps

Based on the issues identified in Section 2.4, it was evident that the total number of trips generated in the model for the University of Illinois campus was very low. To address this issue, a travel survey among the University of Illinois students should be completed to more precisely estimate the number of trips generated from the campus area. This survey would also help with updating and validating the mode choice model.

3.0 Origin-Destination Travel Survey for the University of Illinois Campus

The University of Illinois at Urbana-Champaign with approximately 42,000 students and more than 11,000 faculty and staff is the biggest employer in Champaign County. The University students, faculty, and staff represent 44% of the overall population of 135,000 (approximately) of the Champaign Urbana Urbanized Area (source: Census 2010). Traveling to and from the campus area to different parts of the Champaign county dominates daily travel patterns for the urbanized area. It is imperative to accurately account this travel pattern in the long range travel forecasting process for Champaign County.

University campus area travel is characterized by a significant percentage of trips made by transit, walking, and bike modes. Many of these trips are relatively shorter in length and often utilize more than one mode. Because of these complexities, trip generation characteristics in the campus area are not fully captured by the trip generation sub-model of the Champaign-Urbana Travel Demand Model. Campus related travel patterns need to be incorporated in the CUUATS Travel Demand Model to identify future transportation needs and evaluate transportation alternatives.

This survey was conducted through a joint effort with the University of Illinois at Urbana Champaign administration and the Champaign County Regional Planning Commission. The survey was conducted online.

3.1 Development of the Survey

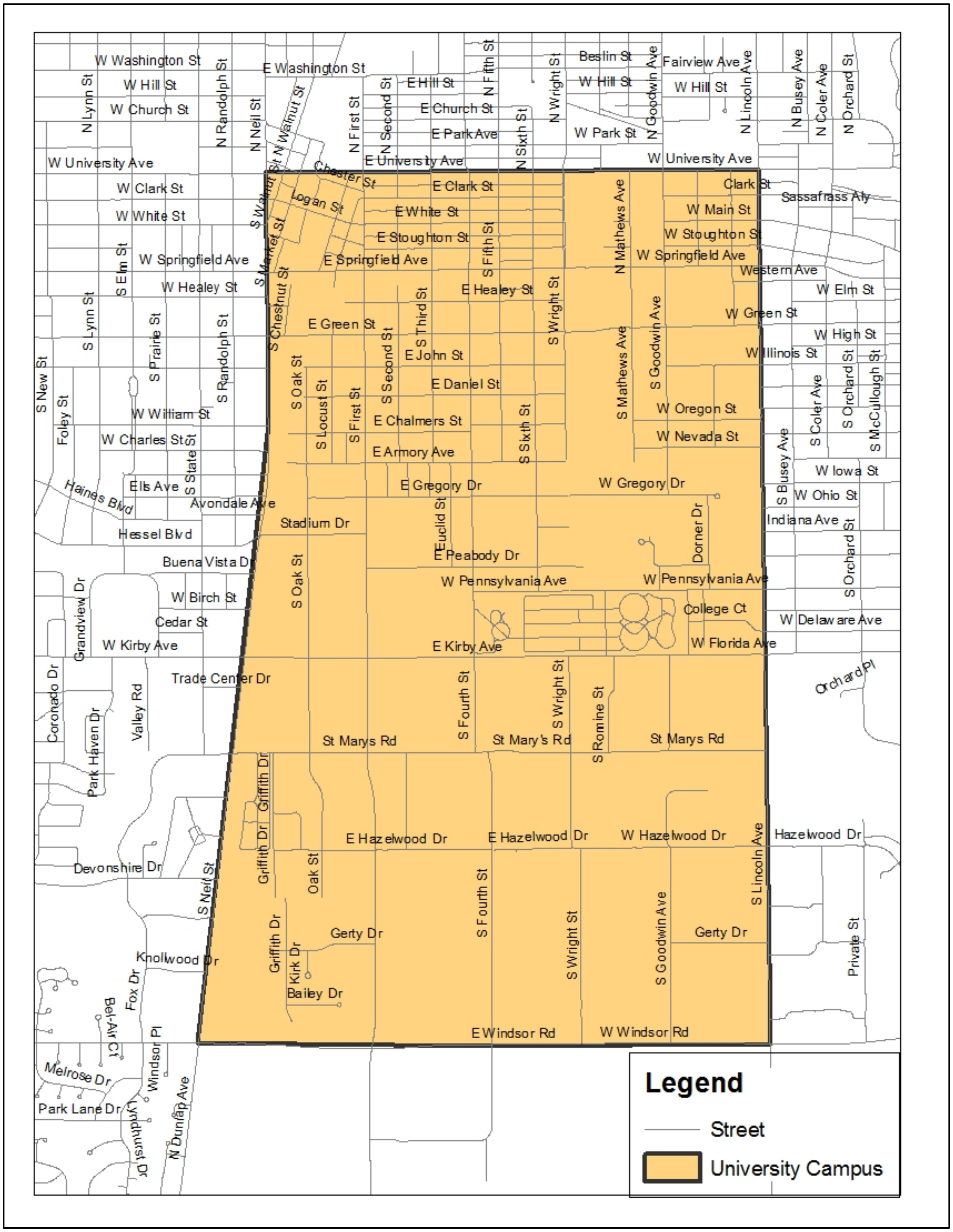
The survey content was carefully selected to collect the following information:

- role in the campus
- residential location
- mode choice
- typical travel behavior for a regular weekday

The online survey was prepared using the Qualtrics online survey software (www.qualtrics.com). The survey had ten questions. The survey questions were based on similar campus wide travel survey performed in the Indiana University, Bloomington, Indiana as part of the long-range transportation plan update for the Bloomington Metropolitan Area, Indiana[4]. The complete survey can be seen in Appendix A. As the survey was designed as a self-administered survey, two maps were provided as visual aids with questions related to residential locations and daily O-D trip activities. Figure 6 shows the University of Illinois campus district. This figure was provided with Question#3 of the survey as a visual aid.

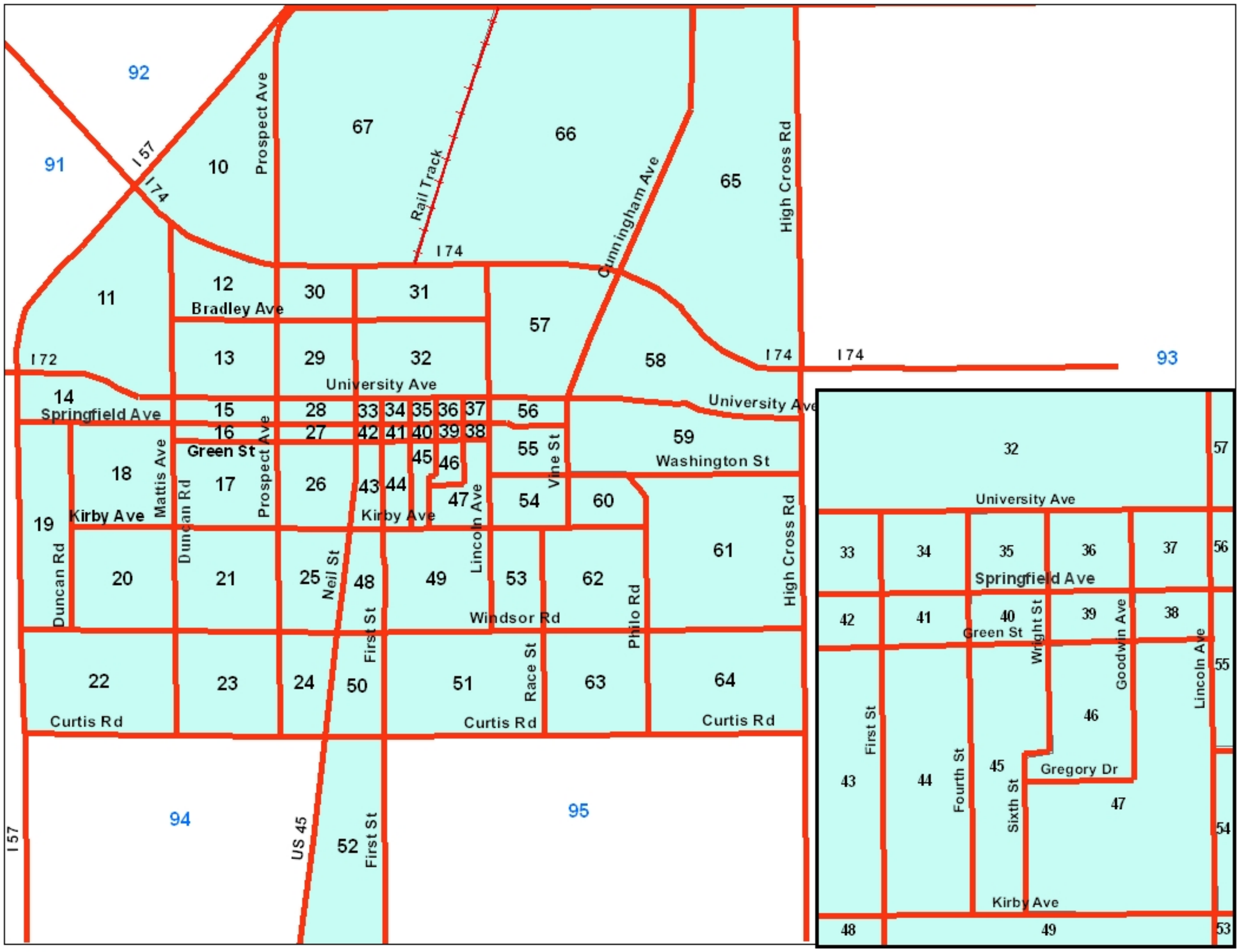
The draft survey was pretested with an in-house focus group and with the University of Illinois officials involved in this study. Appropriate changes were made based on feedback received during the pretesting period.

Figure 6: The University of Illinois Campus District



The Champaign-Urbana urbanized area was divided into 62 smaller zones for identifying residence locations and O-D trip distributions. These zones are shown in Figure 7.

Figure 7: Zones for O-D Survey



The map shown in Figure 7 was attached with survey Question#4 and 10 as visual aids for survey respondents.

3.2 Sampling

The sample frame for this survey was the faculty, staff, and students living within Champaign County. Considering this sample frame, the main objective of the sampling procedure was to select an appropriate sample for dependable statistical estimates within the different groups traveling to campus on a typical working day. Different groups within the campus are classified as follows:

- Freshmen
- Sophomores
- Juniors
- Seniors
- Masters/Professional Students
- PhD students
- Faculty
- Staff

Table 4 shows the total number of members in each of these groups based on the enrollments for the Academic Year 2010-11 (Source: University of Illinois).

Table 4: Total Number of Members in each Group

Group	Total Numbers
Freshmen	7,477
Sophomores	6,938
Juniors	7,624
Seniors	8,682
MS/Professional	5,441
PhD	5,107
Faculty	3,125
Staff	7,780
Total	**52,174**

3.3 Minimum Sample Size

Minimum sample size estimates for the survey were based on the following assumptions:

- 95% Confidence Interval
- Variance equals to 0.5

Table 5 shows the minimum sample sizes for each of the groups. The minimum sample size was determined using the standard statistical formula which can be accessed in Appendix 2. Assuming at least 20% responses from the survey within each strata, sample sizes for survey distribution are also shown in Table 5.

Table 5: Minimum Sample Size and Sample Size for the Survey

Group	Minimum Sample Size	Sample Size for Survey
Freshmen	365	1,827
Sophomores	364	1,820
Juniors	366	1,829
Seniors	368	1,839
Masters/Professional	359	1,794
PhD	357	1,786
Faculty	342	1,711
Staff	366	1,830
Total	**2,887**	**14,437**

3.4 Selecting Stratified Sample

The University of Illinois' Division of Management Information provided an email list of students, faculty, and staff living within Champaign County. The student email list was arranged based on student levels and the required number of samples was selected randomly using MS Excel.

3.5 Survey Administration

On April 19th, 2011 the survey invitation was sent to selected faculty, staff, and students via email by the University of Illinois' Sustainability and Transportation Coordinator with an introductory message highlighting the objectives and importance of the survey. As an incentive to the participants, a $75 Visa gift card was offered to one of the participants who successfully completed the survey. A reminder was sent to the selected people on April 28th, 2011. The survey link was deactivated on May 4th, 2011.

3.6 Survey Response

A total of 4,058 respondents attempted the survey (meaning that they at least provided an answer to Question 1). Out of them, 3,190 completed the survey through Question 9. The overall response rate (respondents completed at least through Question 9) was 22%, which is slightly higher than the initial assumed response rate of 20%. Table 6 shows the number of valid responses, corresponding weighing and expansion factors for each of the surveyed group.

Table 6: Survey Responses and Factors Calculations

Role Group	**Population, (N)**	**Valid Response, (n)**	**Weight Factor, $(N_i/N)/(n_i/n)$**	**Weighted Valid Response**	**Expansion Factor (N_i/n_i)**
Freshmen	7,477	374	1.222	457	19.99
Sophomore	6,938	308	1.377	424	22.53
Junior	7,624	326	1.430	466	23.39
Senior	8,682	277	1.916	531	31.34
Masters	5,441	385	0.864	333	14.13
PhD	5,107	626	0.499	312	8.16
Staff	7,780	515	0.924	476	15.11
Faculty	3,125	379	0.504	191	8.25
Total	**52,174**	**3,190**	**1**	**3,190**	**16.36**

Weight factors in Table 6 were introduced to address the oversampling issue with the surveyed role groups.

4.0 O-D Travel Survey Findings

The survey was focused on gathering information on the following:

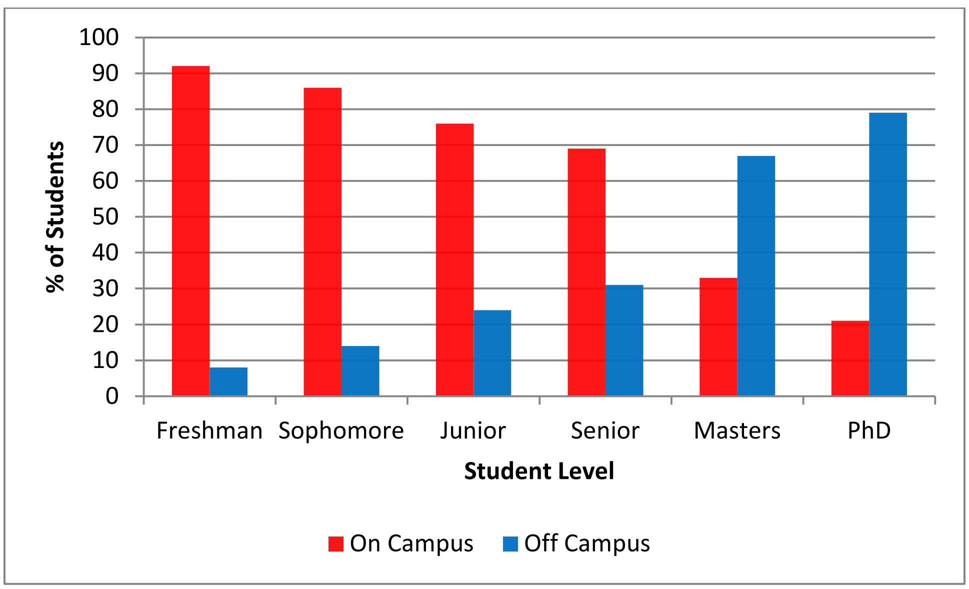
- Respondents role in the campus
- Respondents residential location
- Respondents travel mode choice
- Respondents typical travel behavior for a regular weekday

Survey findings are summarized in the following sections. . Throughout these sections many survey findings are shown by role groups (e.g., freshman, sophomore). All of the data presented are weighed by role, as mentioned in Section 3.6.

4.1 Residential Locations

Figure 8 shows the student residence locations by student level.

Figure 8: Residence Locations by Student Level



As can be seen in Figure 8, the majority of the students in undergraduate levels reside within the campus area and the majority of the Masters and PhD students reside outside the campus area.

Figure 9 shows freshmen residence locations within the urbanized area. The campus area is zoomed in and showed as an inset.

Figure 9: Freshmen Residence Locations

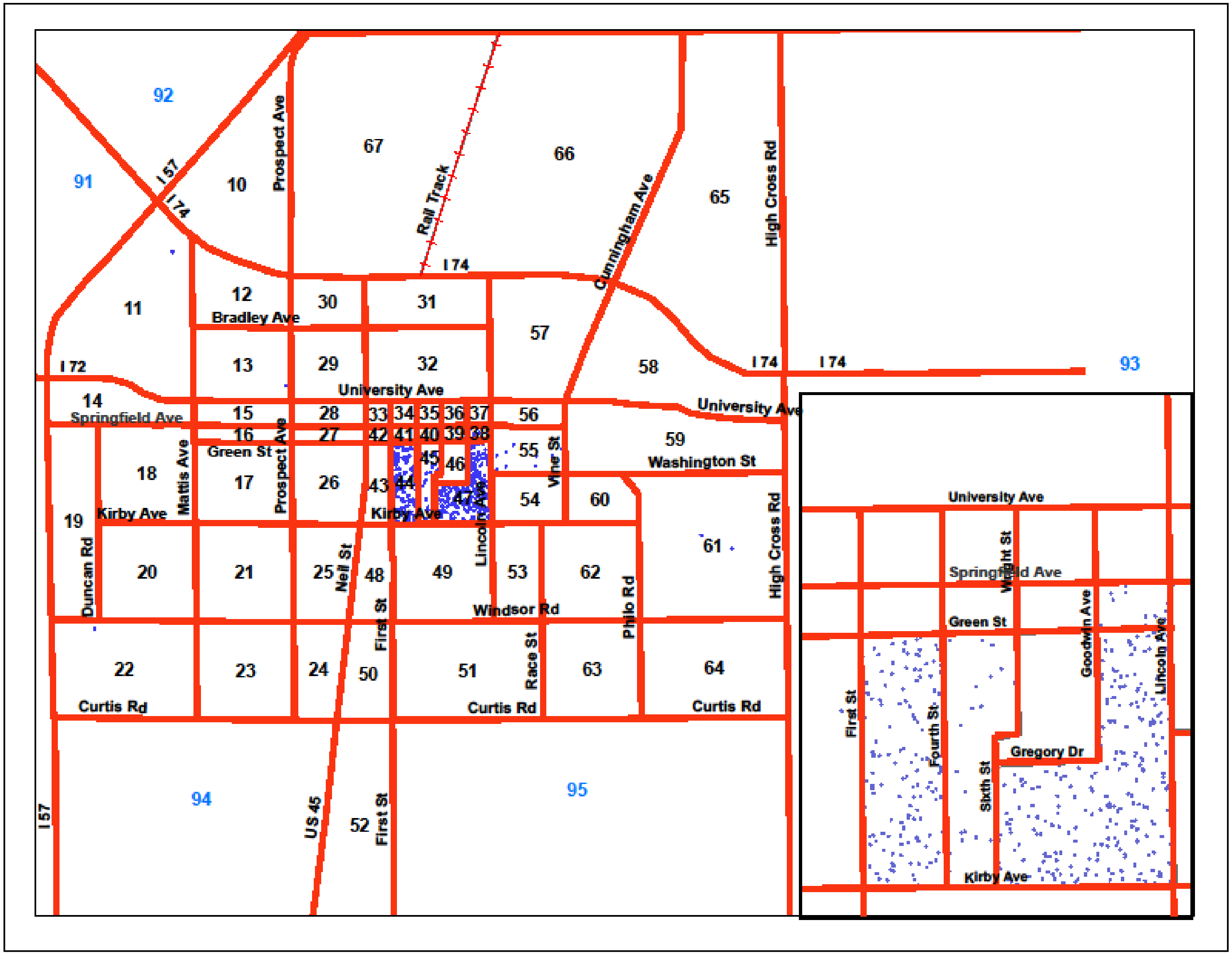
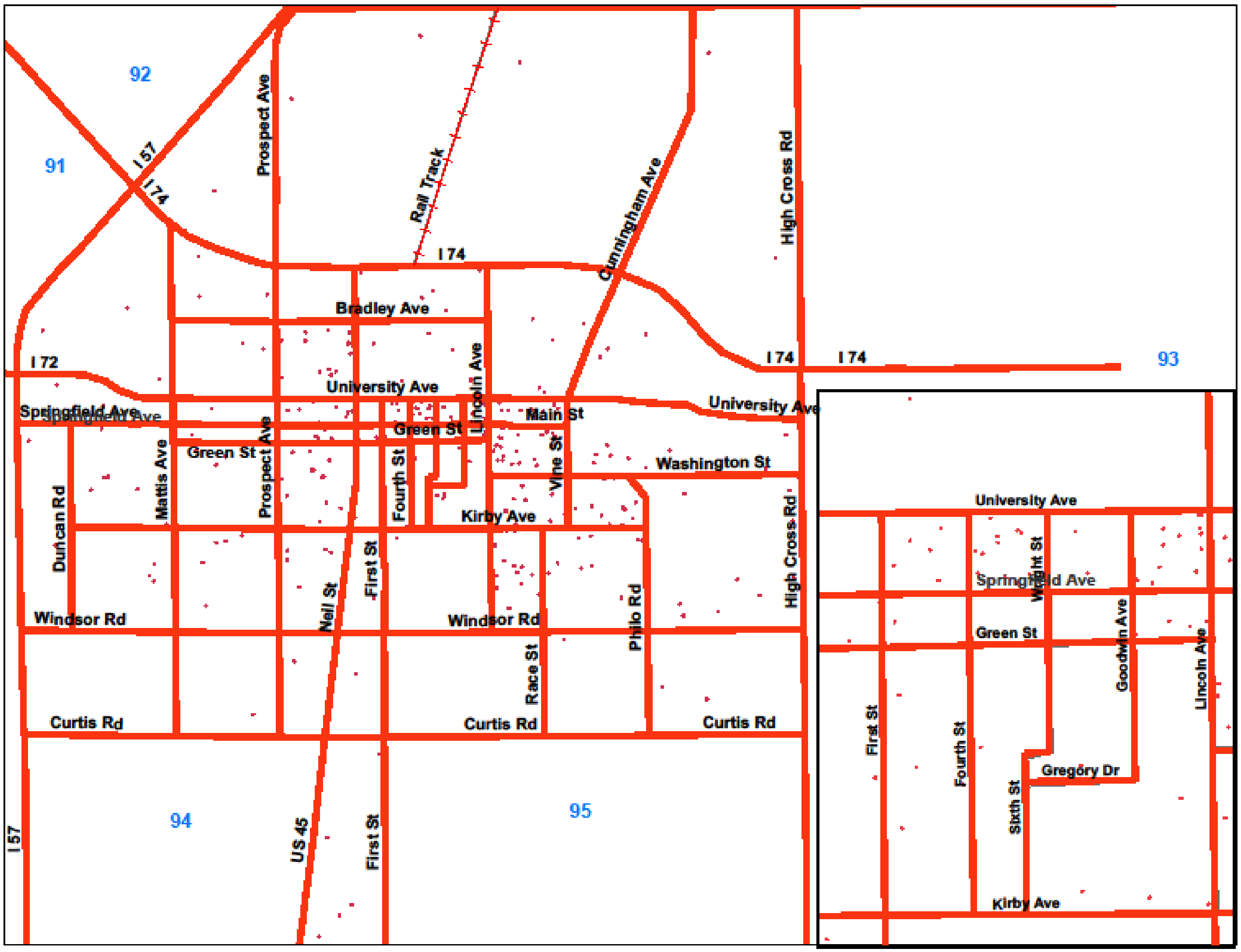


Figure 10 shows PhD student residence locations within the urbanized area. The campus area is zoomed in and showed as an inset.

Figure 10: PhD Student Residence Locations

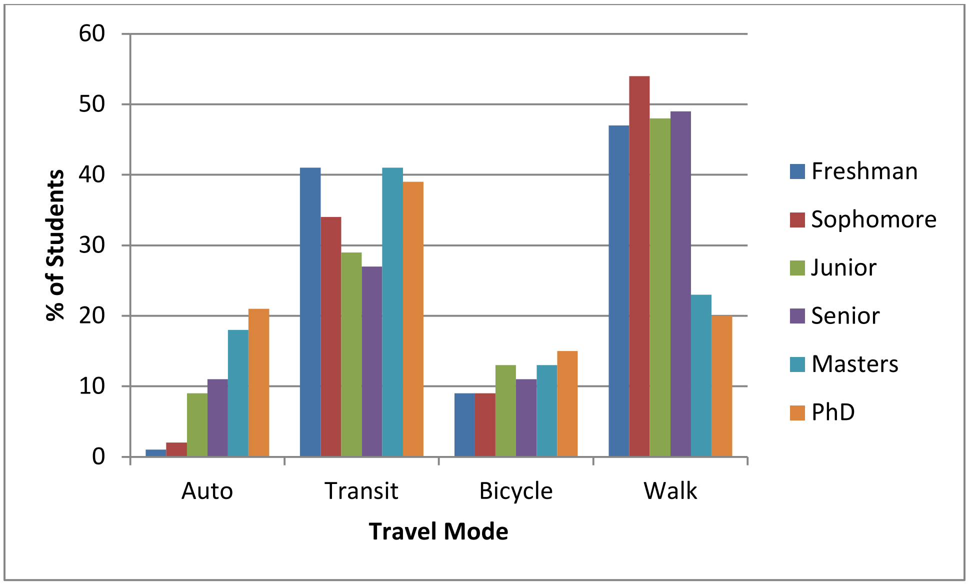


As can be seen in Figure 10, the residence location distribution of PhD students is more evenly distributed throughout the urbanized area instead of being concentrated within the campus area. Appendix 3 contains residence location maps for the rest of the student levels.

4.2 Primary Mode of Transportation

Figure 11 shows the primary mode of transportation for students at different levels from their homes to their first campus destination on a typical weekday.

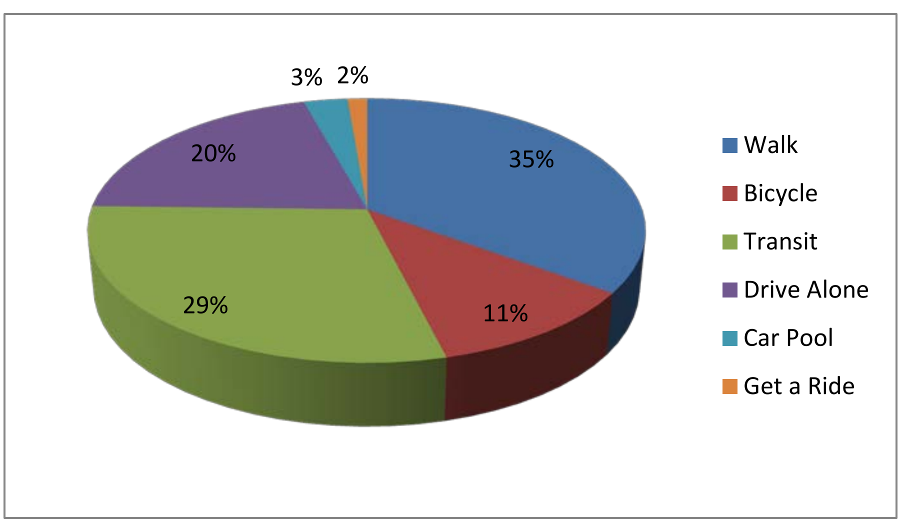
Figure 11: Primary Mode of Transportation for Students



As can be seen in Figure 11, walking is the most utilized travel mode for students in different undergraduate levels. As discussed in Section 4.1, the majority of the undergraduate level students live within or in close proximity of the campus area. For these students walking is the most viable travel mode considering commute distance, convenience, flexibility, and cost.

Figure 12 shows the overall travel mode share distribution for students, faculty, and staff.

Figure 12: Overall Travel Mode Share for Students, Faculty, and Staff



4.3 O-D Trips

Table 7 shows the number of trips made by students of different levels on a typical weekday.

Table 7: Number of Trips per Person

Role Group	Trips/person
Freshmen	4.4
Sophomore	4.7
Junior	4.8
Senior	3.8
Masters	3.4
PhD	3.3

Figure 13 shows trip origins and destinations for freshmen on a typical weekday. As can be seen in Figure 13, most of the trip ends are within the University of Illinois campus area.

Figure 14 shows trip origins and destinations for PhD students on a typical weekday. The main reasons for more spread out O-D distributions for PhD students include:

- As shown in Figure 9 that the majority of the PhD students live off campus
- As shown Figure 10 that PhD students have the highest rate of automobile usage

Figure 13: Trip Origin and Destinations for Freshmen

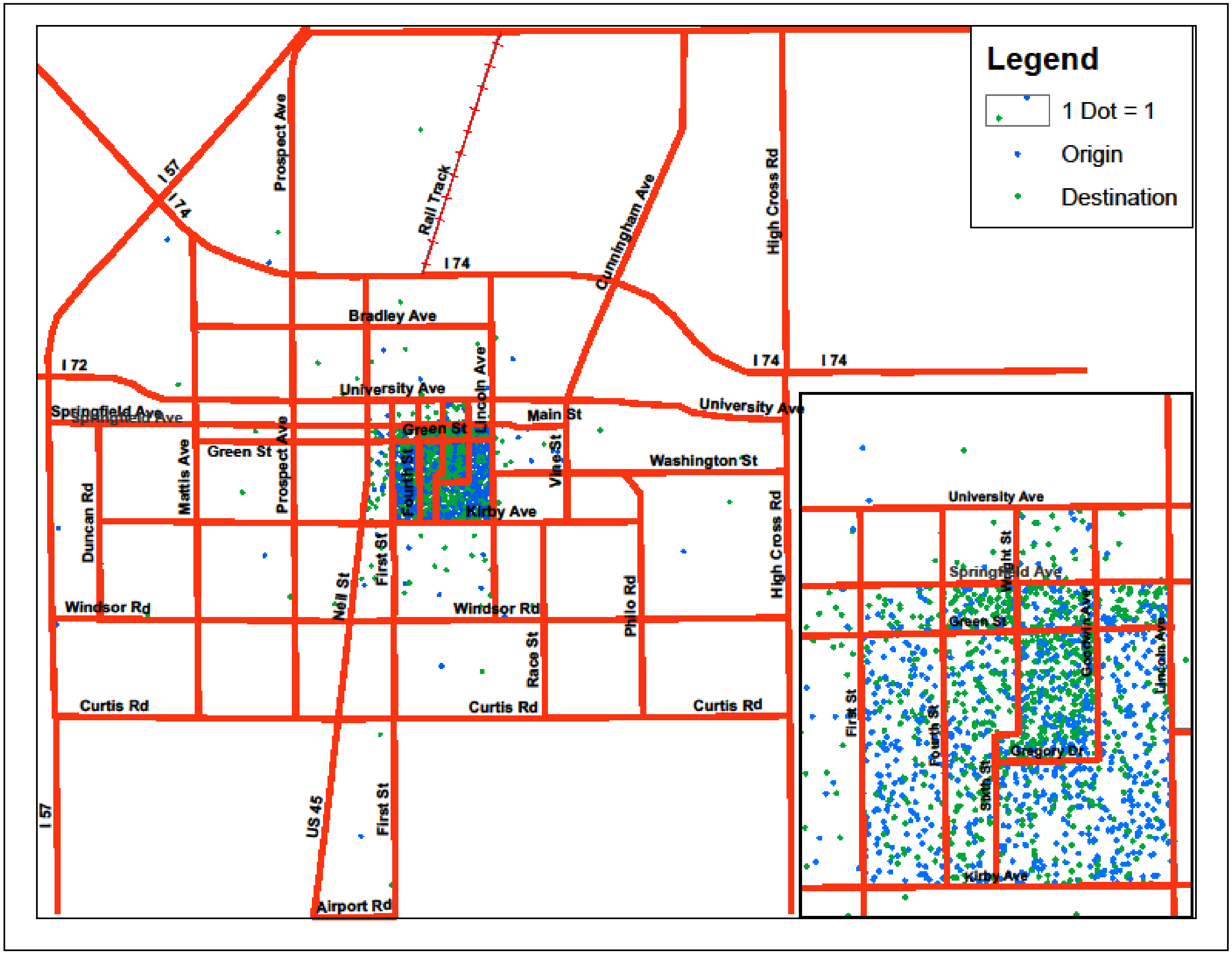
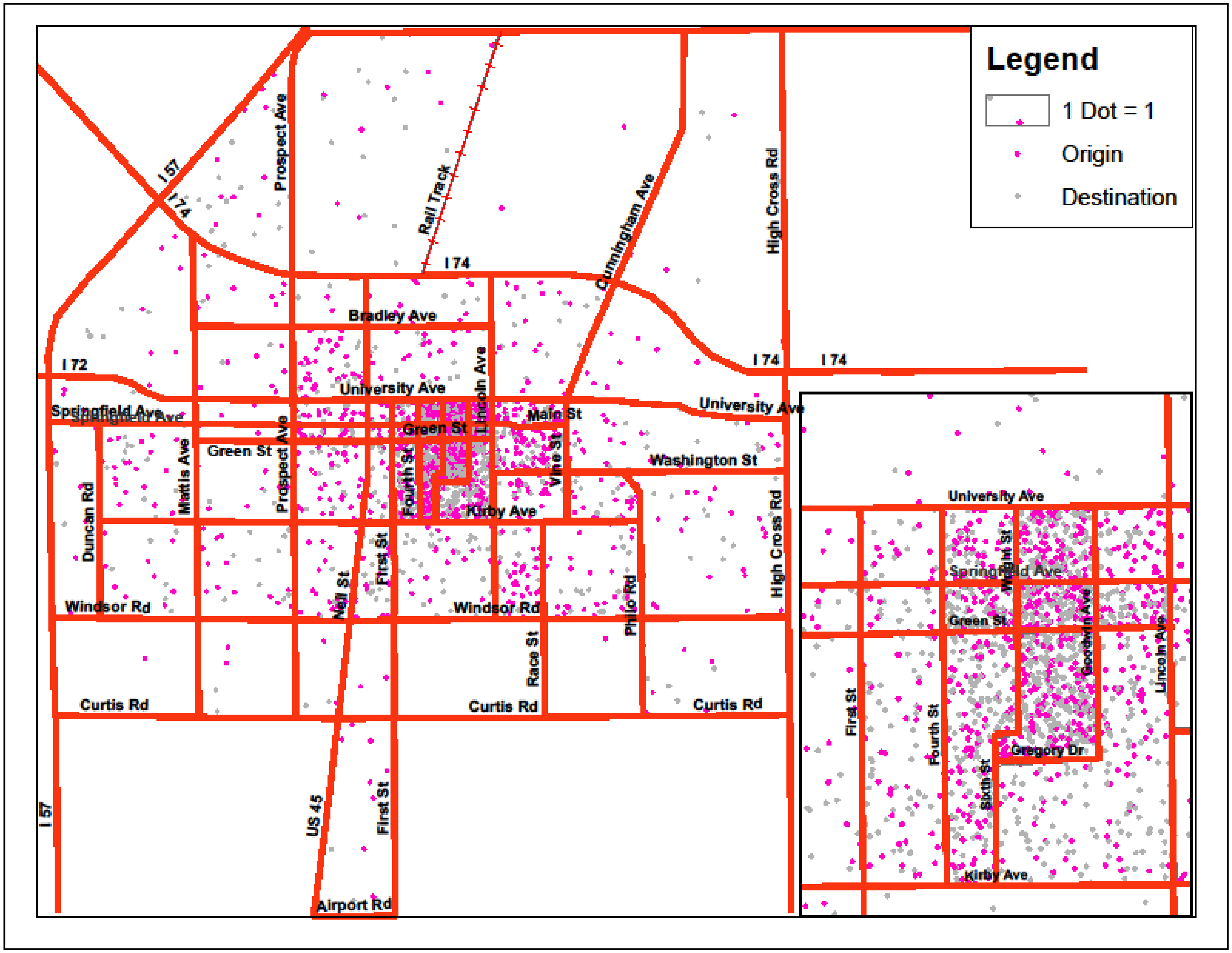


Figure 14: Trip Origin and Destination for PhD Students



5.0 Updating the CUUATS Travel Demand Model

5.1 Trip Generation

Based on the information received from the University of Illinois O-D travel survey, trip generation equation for the Home-Based School trips was adjusted to account for the trips made by the University of Illinois students. The CUUATS TDM Traffic Analysis Zone (TAZ) boundaries are different than the zones used in the University O-D travel survey. Appropriate adjustments were made to transfer the survey zonal information to the CUUATS TDM TAZs.

Figure 15 shows the CUUATS TDM TAZs. The University campus area is also shown in the map.

Figure 15: CUUATS TDM TAZs

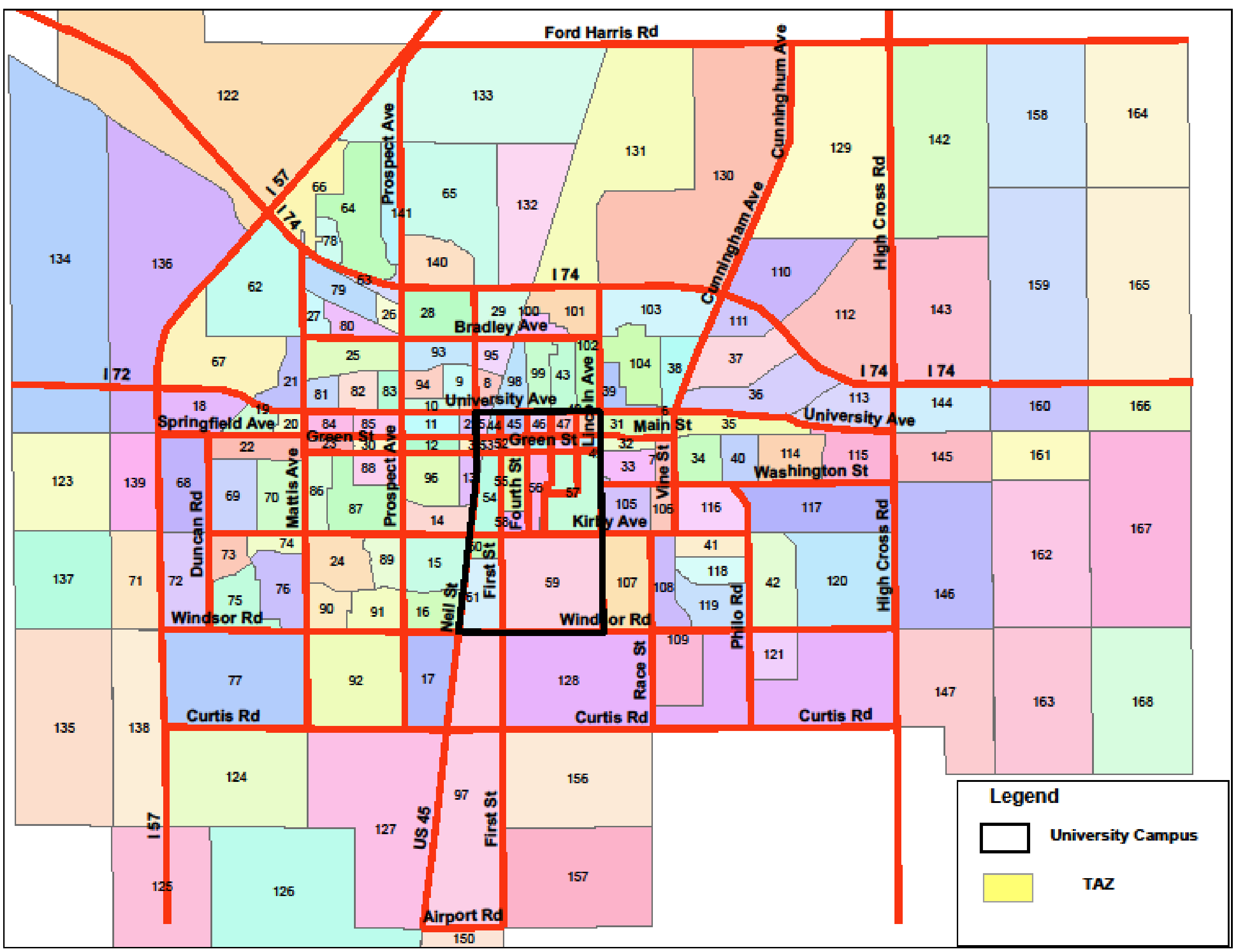


Table 8 shows the number of student residences (based on the survey response) within the campus district TAZs.

Table 8: Number of Student Residences with in the Campus District

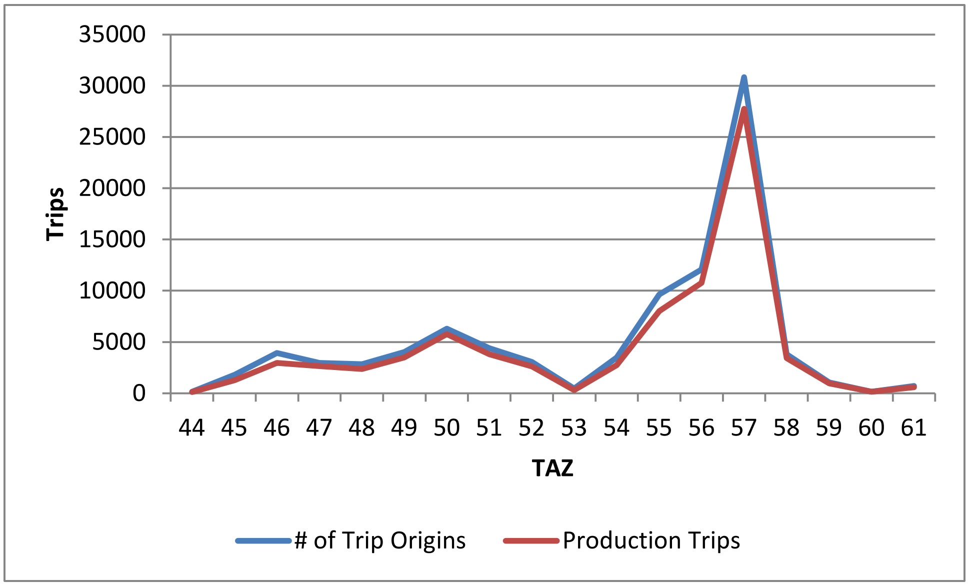
TDM TAZ	Students Residing						Total*
	Freshman	Sophomore	Junior	Senior	Masters	PhD	
44	0	0	1	2	0	1	63
45	0	3	8	15	8	10	919
46	0	3	19	20	34	27	1,840
47	0	1	0	0	2	4	83
48	0	4	14	18	15	29	1,430
49	9	13	8	8	8	14	1,138
50	0	0	1	3	2	4	178
51	0	1	10	7	3	3	543
52	0	11	18	23	11	4	1,578
53	0	0	2	1	1	3	114
54	1	13	23	14	15	3	1,526
55	83	56	44	26	6	6	4,910
56	18	23	26	20	12	2	2,299
57	211	123	54	22	7	12	9,138
58	36	24	19	11	3	3	2,104
59	0	0	0	0	0	0	0
60	0	0	0	0	1	0	17
61	0	0	0	2	4	2	151
Total	**358**	**275**	**247**	**192**	**133**	**129**	**28,032**

* calculated by using expansion factors shown in Table 6 in Section 3.6

Figure 16 shows the number of trip origins based on the travel survey (using the expansion factors) and the production trips (based on the updated trip generation equation of the TDM) comparisons for the campus area TAZs.

As can be seen in Figure 16, the maximum number of trips originated from TAZ 57. Major University of Illinois residence halls including Florida Avenue Residence Halls, Pennsylvania Avenue Residence Halls, Lincoln Avenue Residence Halls, and Illinois Street Residence Halls are located within this TAZ.

Figure 16: Home Based University Trip Origins



5.2 Trip Distribution

As identified in Section 5.1, TAZ 57 produced the maximum number of HBU trips. Figure 18 shows the distribution of trips produced in TAZ 57 among other campus area TAZs. As can be seen in Figure 17, there are a significant number of intra-zonal trips for TAZ 57, as several colleges and University facilities including the College of Business, Illini Union and the Main Library are located within this TAZ.

Figure 17: Intra-Zonal Home Based University Trips

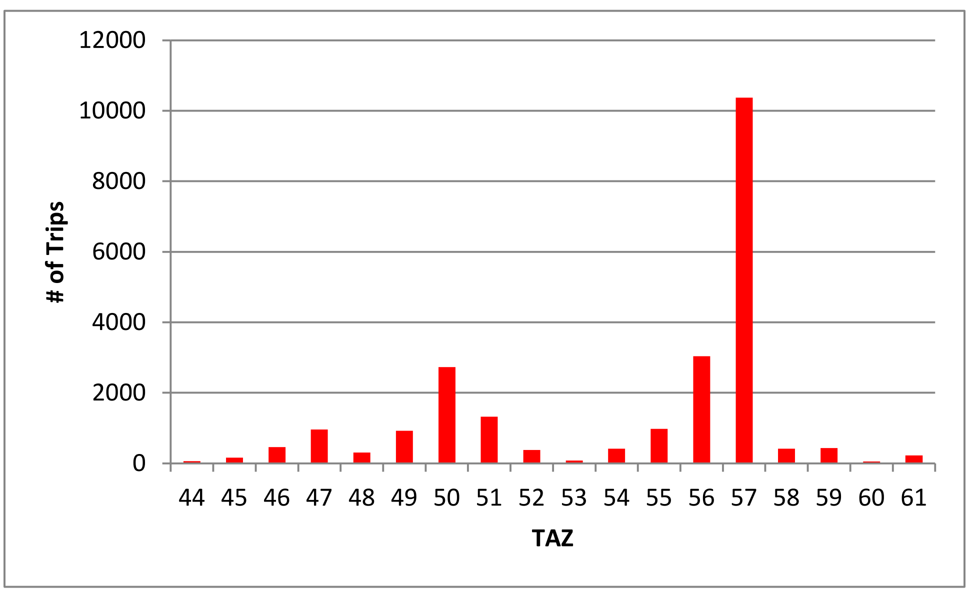
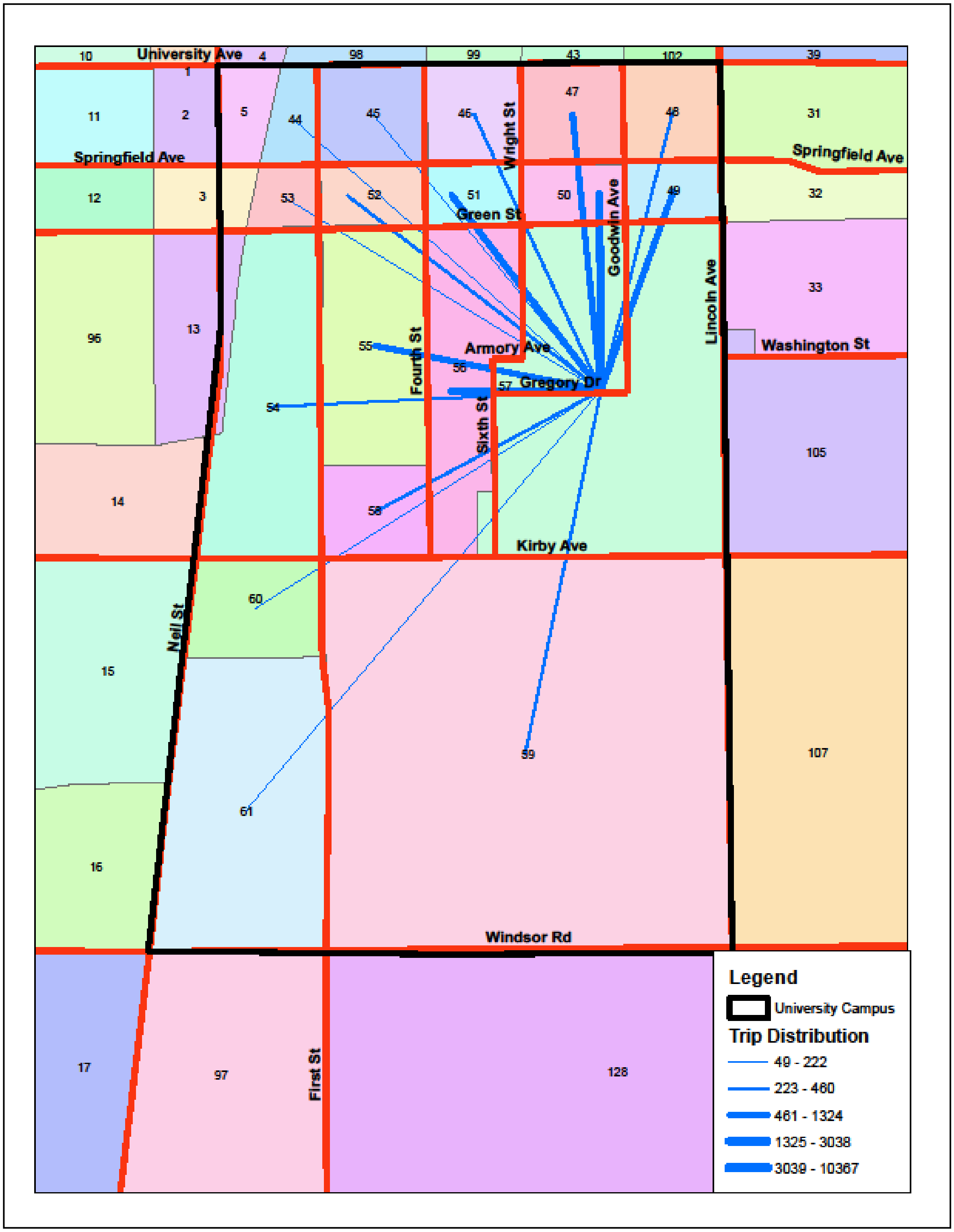


Figure 18 shows the trip distribution from TAZ 57 to other campus area TAZ centroids.

Figure 18: Home Based University Trips Distribution from TAZ 57



5.3 Mode Choice

The mode choice model received from the CUMTD miPlan project was updated to account for the changes made in the trip production and trip distribution steps. The University of Illinois campus area traffic zones data, mode choice model coefficients, shared ride time penalties, and mode costs parameters were reevaluated and adjusted accordingly.

Table 9 shows the travel mode share comparisons of the Home Based University trips based on the updated mode choice model output and the O-D travel survey.

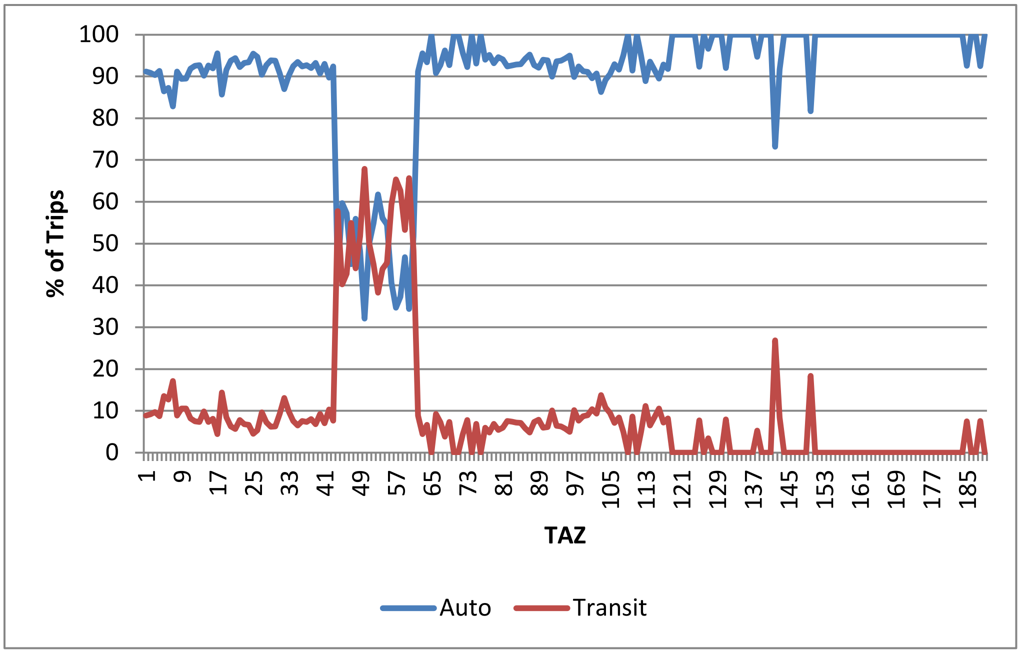
Table 9: Travel Mode Share Comparisons for HBU Trips

Travel Mode	% Based on Mode Choice Model	% Based on O-D Survey
Auto	13	9.5
Shared Ride	1.5	1.5
Transit	22	34
Bicycle	8	11
Walk	55.4	43
Total	**100**	**100**

As can be seen in Table 9, the mode choice model over-estimated walking trips and underestimated transit trips. Detailed review found that a significant percentage of intra-zonal trips were assigned as walk trips within the campus area by the mode-choice model.

Figure 19 shows the distribution of auto and transit trips for different TAZs. As can be seen in Figure 19, for most of the TAZs within the campus area, the majority of the trips were transit trips.

Figure 19: Distribution of Auto and Transit Trips

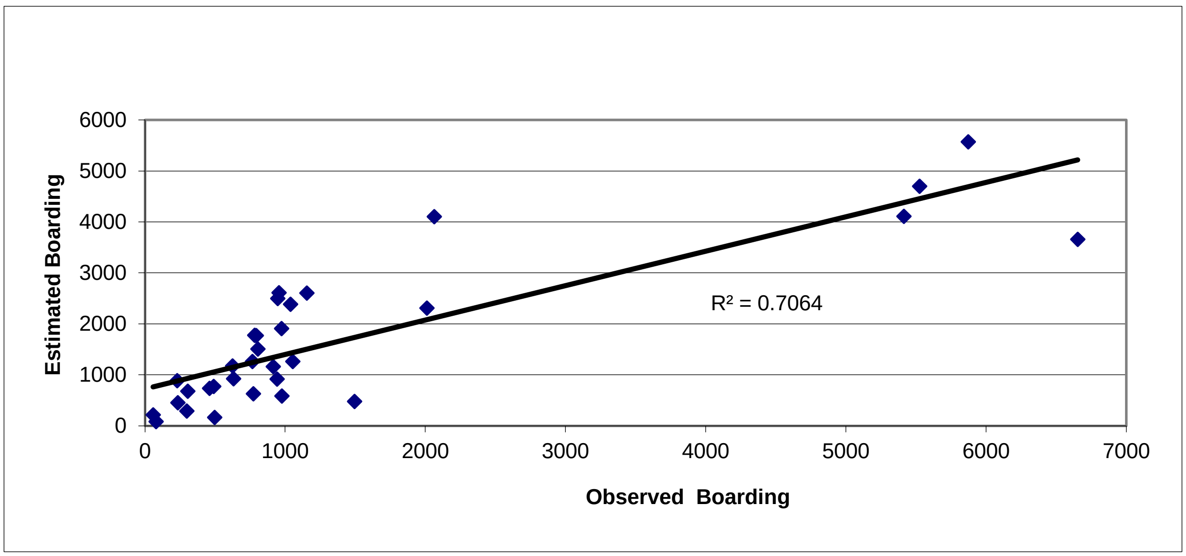


5.5 Trip Assignment

Trip assignment includes transit assignment and auto traffic assignment. This step allocates transit and auto trips from one zone to another through specific transit routes and roadway links respectively. Assigned transit data obtained through the updated TDM was compared with the observed average daily transit loading/unloading data between April 6 and April 10, 2009.

Figure 20 shows the comparisons of observed and estimated daily transit boarding for different bus routes within the urbanized area.

Figure 20: Observed and Estimated Daily Transit Boarding



As can be seen in Figure 20, there is a strong correlation between the observed and estimated boarding (R^2 = 0.71). This is a significant improvement from the observed and estimated boarding data plot shown in Figure 5 of Section 2.3, which was not based on the University of Illinois O-D travel survey.

Table 10 shows network-wide validation, comparing the updated model estimated volumes on freeways, major and minor arterials to field counts.

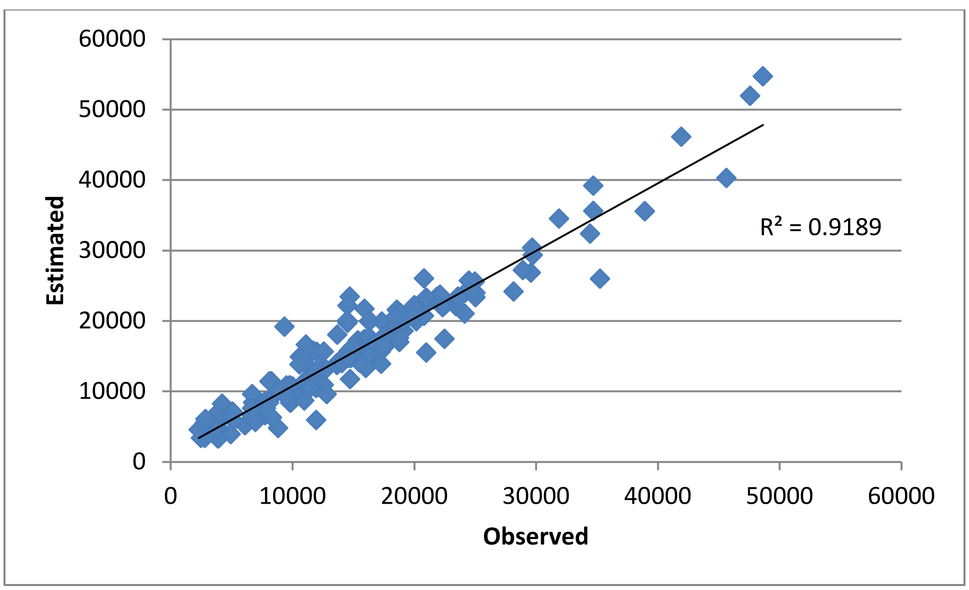
Table 10: Observed and Estimated Traffic Volume Comparisons

Roadway Functional Class	No. of Segments	Traffic Volume		% Difference	FHWA Recommended Limit	%RMSE
		Observed	Estimated			
Freeway	11	400,840	393,393	-1.9	(+/-)7%	9.7
Major Arterials	79	1,282,887	1,228,602	-4.2	(+/-)10%	15.9
Minor Arterial	75	957,058	932,565	-2.6	(+/-)15%	20.3

As can be seen in Table 10, the percent difference between the observed and estimated traffic volumes for different functional class were well within the recommended FHWA guidelines. Moreover, Percent Root Mean Square Error (%RMSE) values were relatively low (less than 25%) as some states (e.g., Oregon) recommends %RMSE values less than 30%[5].

Figure 21 shows a scatterplot of observed and estimated traffic volumes for the roadway segments within the urbanized area network.

Figure 21: Observed and Estimated Traffic Volume Comparisons



As shown in Figure 21, there is a strong correlation between the observed and estimated traffic volumes with a coefficient of determination, R^2 value of 0.92. Moreover, the scatterplot also revealed that the amount of error in estimated volumes are not proportional to the observed traffic counts.

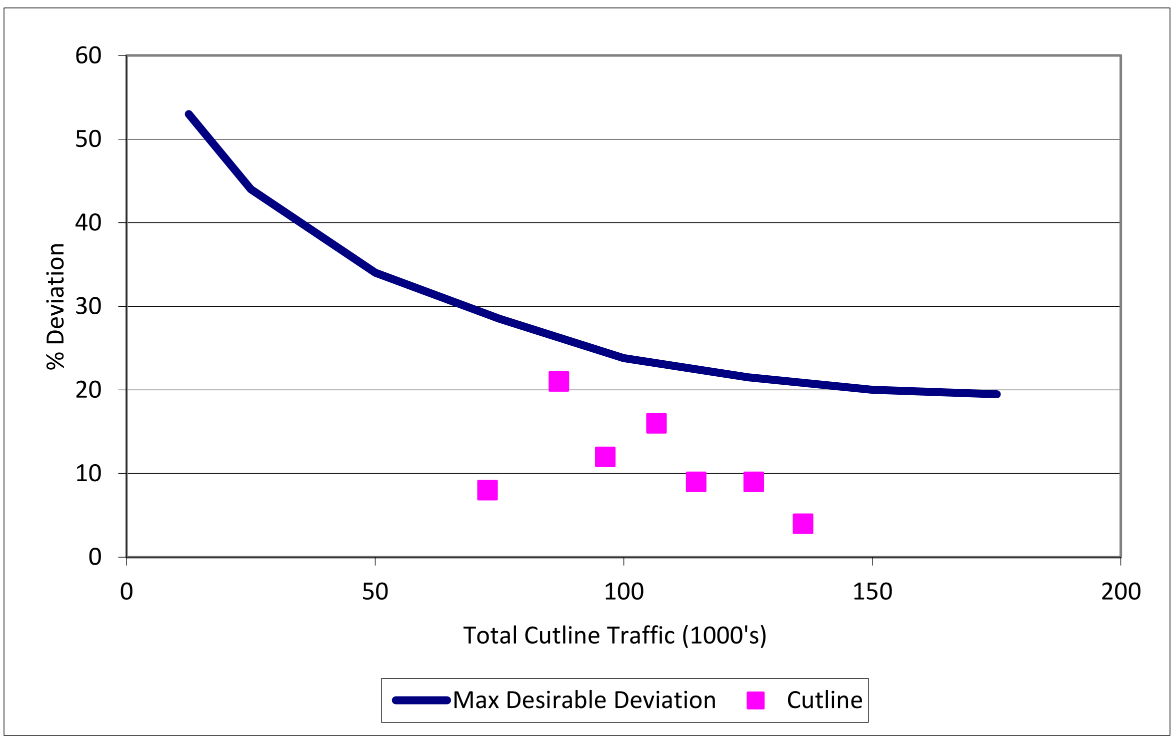
Cutline analysis for the regional network was performed and summarized in Table 11. Cutlines were shown in Figure 3.

Table 11: Cutline Analysis

Cutlilne	Volumes		Difference	% Deviation
	Estimated	Observed		
1	69,500	87,514	18,014	21
2	89,498	106,657	17,159	16
3	107,575	96,309	11,266	12
4	78,322	72,612	5,710	8
5	137,104	126,228	10,876	9
6	130,056	136,137	6,081	4
7	105,650	114,654	9,004	8

Figure 22 shows the relative positions of cutline volumes with respect to FHWA's recommended maximum desirable deviation line.

Figure 22: Cutline Volumes and FHWA Recommended Maximum Desired Deviation Line



6.0 Conclusions and Future Work

The University of Illinois Origin-Destination travel survey results were successfully utilized to update the CUUATS Travel Demand Model steps. The University of Illinois is the chief traffic generator for the Champaign-Urbana Urbanized Area. The traditional approach for estimating trips for the university campus was found inefficient and lacked desired sensitivity and reliability. This report described the detailed steps involved in updating the TDM with the travel survey results. Moreover, appropriate validation tests for every TDM steps were performed to check the reliability of the model. The validation steps provided satisfactory results as the model reliably replicated base year travel behavior for the Champaign-Urbana Urbanized Area.

6.1 Future Work

The updated CUUATS TDM will be an essential tool for the transportation planning purposes for this region. This tool would play an important role in integrating land use and transportation planning and evaluating different sustainability concepts. The updated model will be utilized for forecasting different alternative scenarios for the long-range transportation planning purposes, corridor studies, impacts of transportation policy and cost changes, evaluation of mode shift techniques etc. Moreover, the findings and tools developed through this study would be valuable tools for similar regions with university campuses within their transportation planning boundaries.

REFERENCES

1. Beimborn, E.A. – A Transportation Modeling Primer, Center for Urban Transportation Studies, University of Wisconsin-Milwaukee, May 1995, updated June 2006.

2. Travel Model Improvement Program – Model Validation and Reasonableness Checking Manual, prepared by Barton-Aschman Associates, Inc. and Cambridge Systematics, Inc. for Federal Highway Administration, 1997.

3. Transportation Research Board – NCHRP Report 255: Highway Traffic Data for Urbanized Area Project Planning and Design, Transportation Research Board, TRB, Washington DC, 1982.

4. City of Bloomington Metropolitan Planning Organization – Bloomington Area Year 2020 Transportation Plan, Technical Memorandum 3: Indiana University Travel Demand Survey Data Summary, Prepared by Bernardin, Lochmueller & Associates, Inc., 1998

Appendix

Default Question Block

1. How would you describe your primary role on campus?

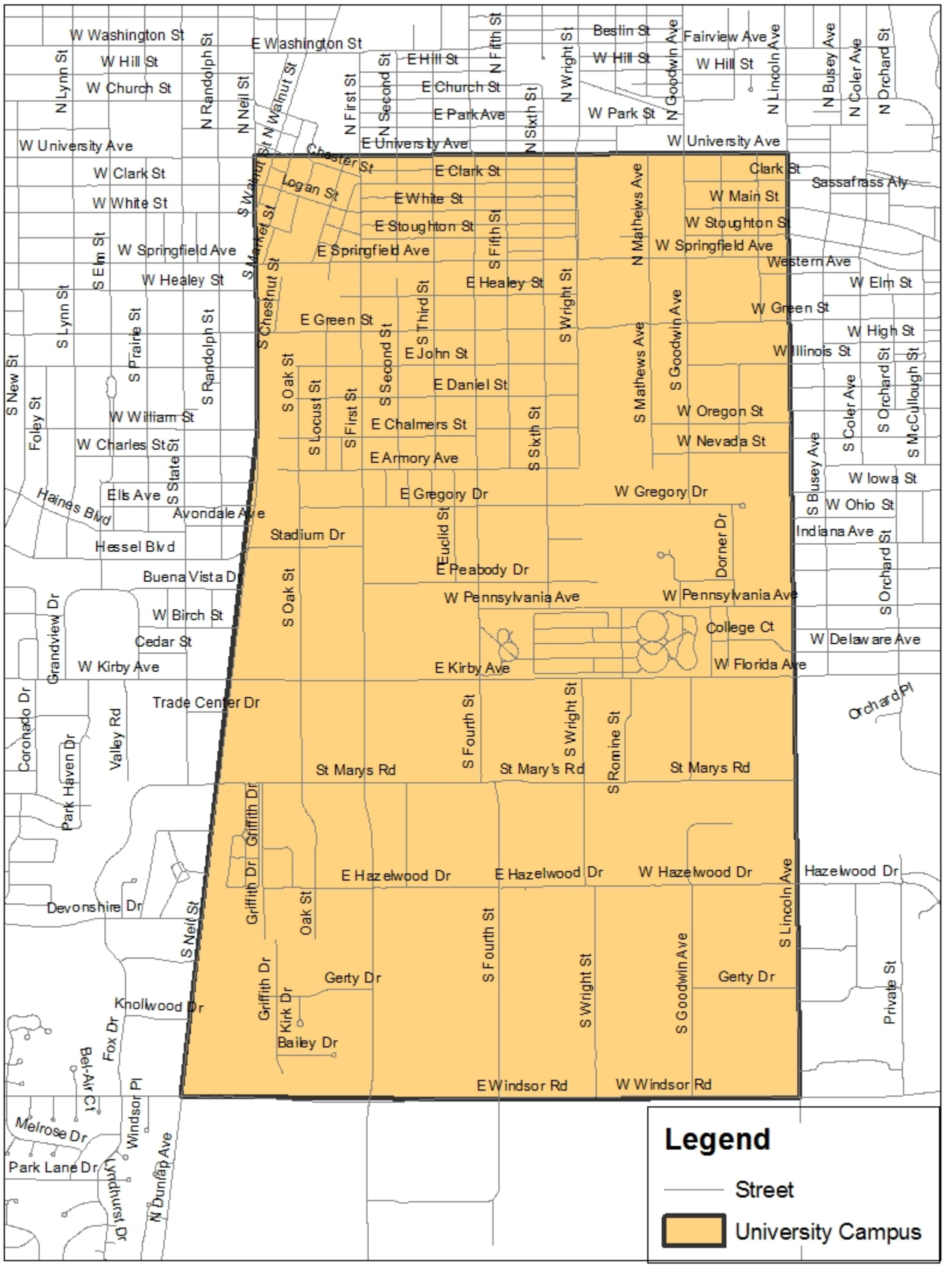
- Faculty
- Staff/Academic Professional
- Student

2. If you are a student, could you please describe your student level?

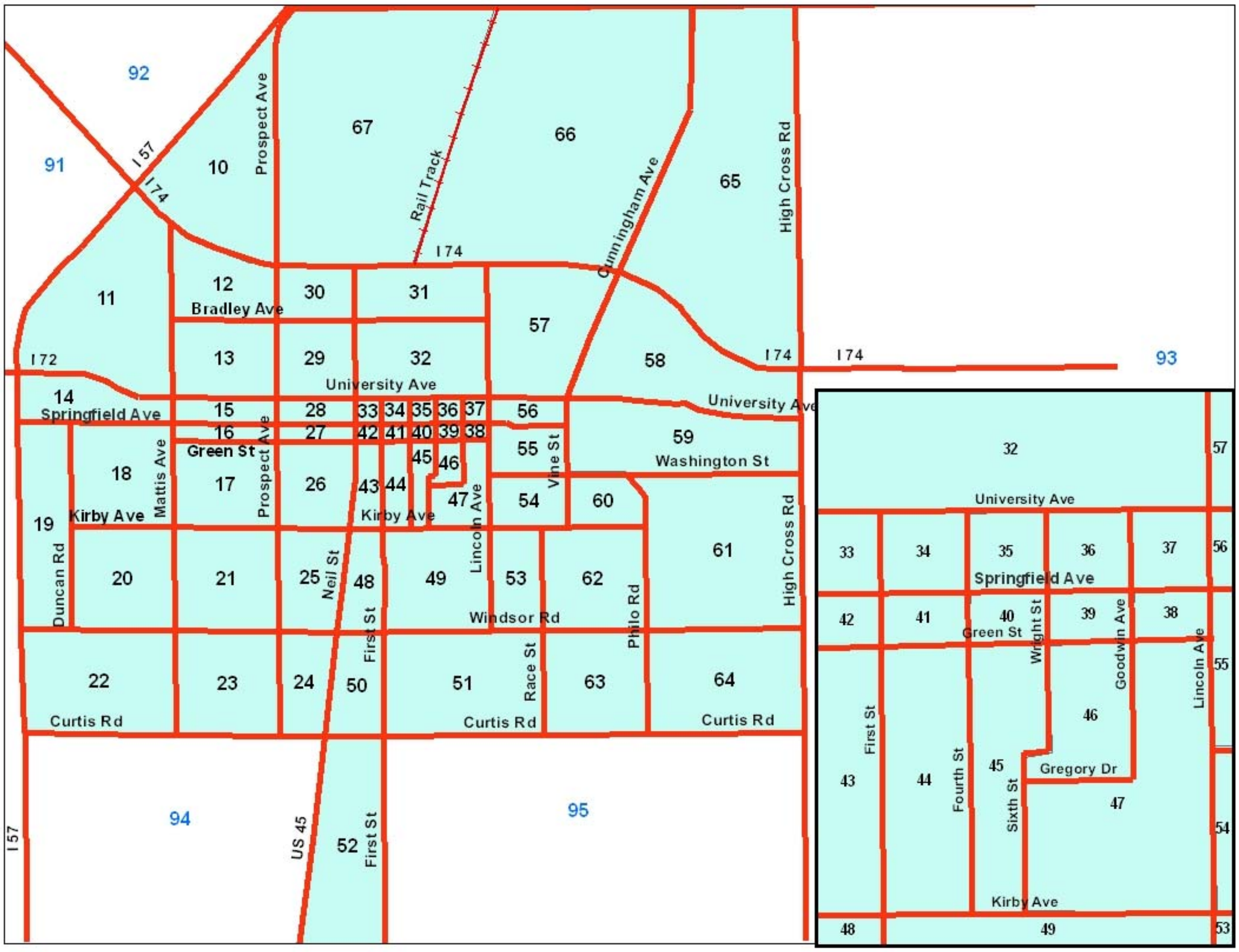
- Freshman
- Sophomore
- Junior
- Senior
- Master's
- PhD
- Other:

3. Where do you live?

- I live on campus (please see the campus map)
- I live elsewhere in City of Champaign
- I live elsewhere in City of Urbana
- I live elsewhere in Savoy
- I live elsewhere in Champaign County



4. Please write down the traffic zone number of your residence. Please see the **Traffic zone map**.



5. If you live on campus, what is the name and/or address of your campus residence (e.g., Bromley Hall, Newman Hall, etc.)?

6. What is your primary means of transportation from home to your first campus destination on a typical weekday?

- Walk
- Bicycle
- Bus
- Drive yourself (arrive/depart alone)
- Carpool/vanpool
- Get a ride (dropped off by someone who goes elsewhere... not in campus
- Other:

7. How many persons live in your household? Please do not report fellow residents in a dormitory, fraternity, sorority, or boarding house.

- 1
- 2
- 3
- 4
- 5 or more

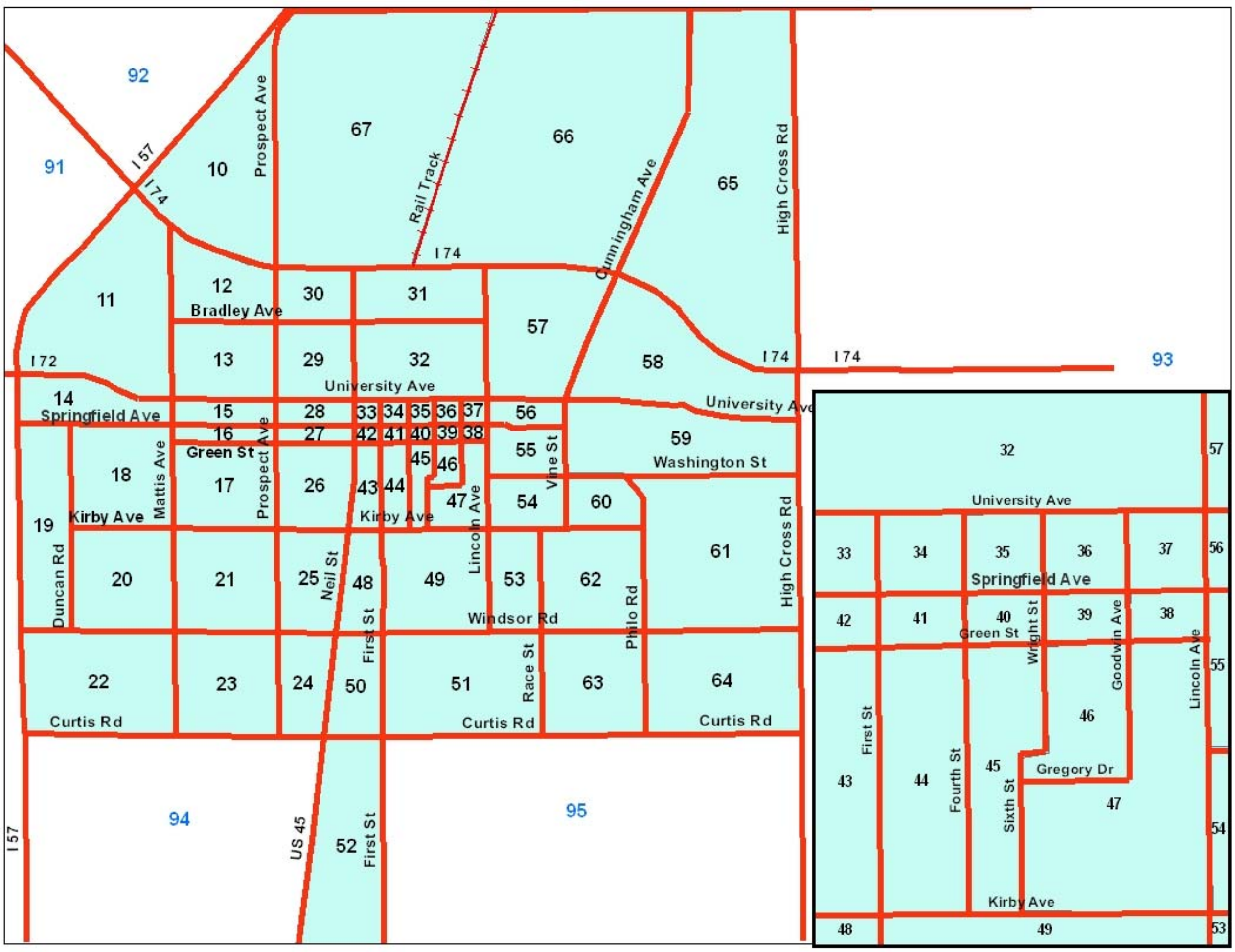
8. Do you happen to know how many licensed drivers live in your household?

- 0
- 1
- 2
- 3
- 4 or more

9. How many personal vehicles are normally used by members of your household on a daily basis?

- 0
- 1
- 2
- 3
- 4 or more

10. Please report the trips taken by you on a typical weekday/class day in the following table. For traffic zone information please look at the **Traffic Zone Map**.



Please report the traffic zone where you park your car or get off the bus, even if your final destination is in another traffic zone. Important roads are marked **red** in the map. Traffic zones inside the Champaign Urbana Urbanized area are shown in **black** font. Traffic zones outside the urbanized area boundary are shown in **blue** font. Campus area traffic zones are shown in the inset.

Trips to report:

- ¿ Trips taken by you.
- ¿ All trips by auto and transit (bus).
- ¿ All bicycle and/or walk trips between traffic zones

¿ All bicycle and walk trips within the same traffic zone.

	# of persons making trip	Primary mode: Auto = A; Transit = T, Bike = B; Walk = W	Traffic zone # at the start of trip (see map)	Traffic zone # at the end of trip (see map)	Trip purpose: Work = W; Class = C; Other = O
Trip #1					
Trip #2					
Trip #3					
Trip #4					
Trip #5					
Trip #6					
Trip #7					
Trip #8					
Trip # 9					
Trip #10					
Trip #11					
Trip #12					
Trip #13					
Trip #14					
Trip #15					

What is your email address? We will use this only to select winner(s) of the survey rewards.