GPS Pilot Project

PHASE FOUR: FINAL REPORT

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Contractor – STV

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Project Overview: Phase Four

In June 2007, the New York Metropolitan Transportation Council (NYMTC) sponsored a "proof-of-concept" study to determine whether incorporating Global Positioning Systems (GPS) technologies into the upcoming NYMTC Household Travel Survey would provide an alternate strategy for collecting person-based travel behavior data.

The first objective of the study was to ***determine the technical feasibility of using GPS technologies to collect "passive[1]" travel behavior data.*** The initial experiment used "off-the-shelf" GPS hardware and currently-available software to collect person-based travel data in New York City. The factors considered included: data accuracy and reliability; weight of person-based GPS unit; ease of use/respondent burden; cost; public response; advantages of implementing GPS for travel survey data collection; and major findings from previous GPS survey studies. Rapid technological improvements in the GPS equipment market led the research team to base the decision of final equipment selection on performance characteristics rather than a particular make or model (*see Phase One Report for details*).

After conducting a series of controlled experiments in the study area, the research team found that although an urban canyon effect[2] was detected, it would not pose a serious problem for certain uses of the data. For example, distortions of 25 meters (82 ft) could impact the analysis of a walking trip on a particular sidewalk but would not be a concern for an application in a Traffic Analysis Zone (TAZ). The field experiments demonstrated that among the person-based GPS loggers that were tested, the i-Blue unit produced the preferred array of data fields.

The second objective of the study was to ***determine the feasibility of collecting data for "mixed mode" travel*** in New York City. Key factors taken into account during this phase of the study included the costs associated with any upgrades to the GPS devices, software programming and/or GIS data to support integration into NYMTC's Best Practices Model (BPM).

The research team conducted a second field test where two models of GPS units, the i-Blue and the GlobalSat, were tested extensively using different travel modes in New York City. Both GPS loggers worked well on buses, elevated trains, bridges, and ferries. Although the i-Blue and GlobalSat loggers were not able to receive satellite signals underground in the subway, on average they both were able to detect satellite signals within 39 seconds after re-emerging above ground. The accuracy tests from the second field test would have been better if the GIS subway file used in the calculation was as accurate as the GIS street file. Comparing the two GPS units, the GlobalSat is slightly more accurate than the i-Blue. However, the i-Blue consistently recorded more location points and produced a larger array of data fields than the GlobalSat. These additional variables were an essential part of the "cleaning" process and contributed to a higher quality of data for analysis.

The third objective of the study was to ***determine the feasibility of collecting data for "misreported" trips*** from the 1997/98 Regional Travel Household Interview Survey (RT-HIS), particularly those trips that included transit segments. The research team conducted an analysis of the 1997/98 HIS dataset and found that the population demographic groups most likely to misreport transit trips had one or more of the following characteristics: being male; being between 36 to 55 years old; having a full-time job; having a driver's license; working in the financial industry; or being Asian. It is expected that implementation of a GPS survey would improve the accuracy of the data for these groups.

[1]"Passive" data is generated and collected automatically using an equipment/software interface.
[2]In a dense, high-rise urban environment, the GPS signal can be lost or distorted, causing an "urban canyon effect".

To reduce the risk of misreported transit trips, the research team developed a post-processing technique designed to define multi-modal and linked trips. Riding in elevated trains, buses, cars, or taxis, and walking or waiting in the Manhattan street environment appear to not substantially deteriorate the quality of GPS data. With some simple data manipulation, the data generated by the GPS units could provide trip origin and destination (OD) information, including the location and time of each individual modal segment. This process would make it possible to identify the "lost segment" of trips by subway using the unique locations of subway entrances and exits. If the GPS data is processed and superimposed on high resolution imagery such as Google Earth or "snapped" to GIS shapefiles, it may be possible to accurately identify all relevant origins, destinations, and modes.

The research team developed a simple analysis focusing on the computed cumulative distance as a function of time and modified by intermittent speed and heading information. With this analysis, it was possible to identify trip OD time and location of modal segments, even in the presence of the errors caused by the urban canyon environment. Further development of the simple algorithm developed for this objective could provide an automated means of reducing the voluminous GPS data to information on fundamental modal segments: mode, start time, start location, end time, and end location. However, determining the accuracy of this approach will be crucial when applying this research method to actual practice.

The final objective of the study was to ***determine the feasibility of incorporating GPS data in future household travel survey efforts with a sample population*** based on the ease of use and acceptability of the technology by specific users. This demonstration of moving from *research to practice* is critical to the evaluation of a realistic deployment strategy.

To accomplish this objective, the research team worked with NYMTC Technical Group's Travel Survey Unit (TSU) to recruit volunteers. To simulate an actual agency-initiated deployment, the research team prepared the survey instruments and equipment, and the TSU members were responsible for delivering the instructions and equipment, and tracking the responses from the volunteers. In addition, a presentation was given to potential volunteers to better inform them about the study (*see Appendix A*). Thirty-five volunteers agreed to participate, with 32 participants' records used for analysis.

According to the research experimental design, the volunteers were randomly divided into two groups. Each group member received a "welcome" letter and instructions for using the GPS unit. The first group received a traditional paper survey and a GPS unit while the second group received instructions for a web-based survey and a GPS unit (*see Appendix B for deployment details*). After carrying a GPS unit and completing the assigned type of supplementary survey, the volunteers were asked to complete a second web-based survey to evaluate their experience, describe any problems, and provide overall feedback.

Section One: Early Lessons Learned

The primary purpose of the GPS Pilot Study was to conduct a "real-world" survey to enable the research team to evaluate the technical effectiveness of the GPS equipment, evaluate the quality of the data, and better understand the reactions and responses to the use of GPS by a representative sample of volunteers. This section describes the results of the GPS Pilot Study with respect to technical performance; ease of use and level of respondent burden; willingness to participate in a Household Travel Survey using GPS; reported trip purposes and destinations; use of GPS to improve transit trip reporting; and other current GPS deployments worldwide.

Technical Evaluation

The research team reviewed the GPS data immediately after it was received and noted any issues or problems. The data from 15 units were designated complete, with an additional 13 units found to have recorded data after the volunteer arrived at their home location at the end of their travel day. Presumably, these units remained active only because the volunteers had not yet turned them off. No data quality issues were associated with these data streams. Two of the units, however, failed to record the "hour" in the output in ".csv" format, but this field was recorded in the output in ".kml" format. Although this is a concern, the data was not permanently damaged since the variable was at least captured in the ".kml" format. In addition, two other units had data recording issues. One unit was accidentally deployed without being adequately prepared, which made it impossible to capture new data. This type of problem will require a second quality assurance checking process where every piece of equipment is verified as "ready" prior to issuance to a survey participant.

Of the 28 participants in the follow-up survey (15 paper-based and 13 web-based), 96% thought the GPS instructions were easy to understand. There was no difference between the two groups with respect to understanding the instructions for the survey ($\chi^2 = 1.257$, 1, $p > .05$). Eighty-two percent thought the GPS unit was working on their first trip. In addition, there was no statistically significant difference between the two groups with respect to the ease of completing their survey instrument ($\chi^2 = 0.039$, 1, $p > .05$).

Ease of Use and Level of Burden

Information on the reactions and responses to the GPS equipment by survey participants includes a range of positive and negative perceptions. The follow-up survey allowed survey participants to share this information with the research team (*see Appendix C*). Regarding the use of the GPS equipment, the overwhelming response was positive. Of the 17 comments regarding the ease of use, most commented on how easy it was to use the equipment. There was a suggestion for having a belt hook on the GPS unit and some concern about having to transfer the unit from one purse to another throughout the day. Statements about the burden of use included concerns that the equipment was accidentally turned off and concerns about whether the signal was sufficient.

Participants were asked to comment on their response to using a supplemental survey instrument (either paper or web-based). With respect to the paper survey, there were several positive comments regarding the ease of use, but most comments referred to the burden. Some of these negative comments included: too many questions; confusion about trip description; inability to remember details of travel; and inability to note time of arrivals. Comments regarding the web survey were similar, with several positive comments, but the majority of comments were descriptions of the burden. These comments included:

limited choices provided on the form; confusion over how to fill out the form; problem with recall; and other concerns about incomplete information.

Overall, the majority of the comments focused on ***the burden of attempting to record travel movements and the pressure to remember or recall these details while trying to fill out either the paper survey or the web-based survey***. This burden appears to be far greater than any burden described regarding the use of the GPS unit. Even for deployments that use a prompted recall on the phone, this burden to record precise details would remain. It is very clear that the burden of retention and recall looms large for the survey participants.

The comments regarding issues with the switches and accidentally turning off the GPS unit could be rectified by changes in the equipment design. Along these lines, Swanson and Stopher (2008) used a focus group strategy to gather user feedback from their GPS experiments. They found differing responses to the operational characteristics of the GPS units and used this information to recommend equipment design changes. For example, to reduce loss of data due to power issues, the revised devices now give a verbal warning, "low power", to alert the user to recharge the battery as soon as possible. In response to user comments, the authors also recommended a new slimmer device design. As the use of GPS in surveying grows, it would be very valuable to "debrief" users as an integral step in the deployment of any GPS survey to continue gaining a better understanding of how to reduce user burden and improve data quality.

Bricka (2008) compared levels of respondent burden by counting tasks associated with different types of travel surveys: traditional survey, traditional with GPS, traditional with GPS and prompted recall, GPS and prompted recall, and GPS only. She concluded that the highest burden score would be associated with a traditional survey with a GPS component and followed by a prompted recall. However, these scores were not weighted with respect to the difficulty of each type of task undertaken. It might be more realistic to provide a metric of burden by type of task (e.g., having to participate in a lengthy phone call to relate all of the activities for each member of the household would be far more burdensome than each member carrying a small piece of equipment).

Bothe and Maat (2008) looked at reported burden related to GPS and found very little concern. Neither carrying the GPS device nor charging the device seemed to burden the survey participants very much, as indicated in *Table 1*. Although not measured directly, the comments recorded in the GPS Pilot Study show a similar pattern.

Table 1. Burden Reported By Respondents

	Very	**Somewhat**	**No**
Burden of carrying GPS device	1%	14%	85%
Burden of charging GPS device	5%	10%	86%

Adapted from Bohte and Maat (2008)

Willingness to Participate in Household Travel Surveys using GPS

Household travel surveys normally use a random sampling strategy to produce data that can be generalized to a larger population. In this research project, the GPS Pilot Survey was conducted with volunteers rather than a random sample of individuals. Although the preliminary analysis indicates that the volunteers were able to use the GPS equipment, there could be concerns about whether the upcoming household travel survey, using a random sample, would have similar outcomes. To explore possible differences between "convenience" samples and randomly sampled individuals, Potoglou and Kanaroglou

(2008) conducted a study with respondents chosen randomly and given the option of participating in a telephone or web-based survey, and compared these results to a second survey where respondents were invited to participate in a web-based survey through email lists, a website, and snowballing ("word of mouth"). Compared to conventional methods of data collection, they found that web-based surveys were easier to administer and had higher quality data outcomes. Web-based surveys were faster to deploy, cost less, provided privacy, were more likely free of interviewer bias and had fewer measurement errors because the data is electronically assembled. The disadvantages included concerns about a bias towards more computer-experienced individuals (e.g., young, more educated, higher income). When they examined the differences between convenience sampling and probability sampling, the response speed was far greater in the convenience sample and the costs to administer the survey were much lower. *Table 2* reports their findings.

Table 2. Comparison of Web-based Surveys

	Convenience Sample	**Probability Sampling**
Response Speed	High	Very Low
Response Rates	Not Applicable	Very Low
Labor/Cost Requirements	Very Low	Low
Expertise to Construct	High	High
Measurement Error	Low	Low
Coverage Error	High	Medium
Non-Response Error	High	Medium

Adapted from Potoglou, D and Pavlos Kanaroglou. 2008. Comparison of Phone and Web-based Survey for Collecting Household Background Information. Paper presented at the 8th International Conference on Survey Methods in Transport, France, May 26-31, 2008.

There is a possibility that convenience sampling may also be more productive for GPS deployments, particularly if combined with a web-based survey. Although traditional household travel surveys use a probability sampling strategy, it might be more productive to consider a "voluntary" convenience sample, provided there is adequate demographic data to deal with bias issues.

To date, most GPS samples have been a subset of a random sample designated for the surveying effort. GPS is often offered to this subset as an option ("opt-in"), producing a form of "voluntary" participation (with presumably the same issues associated with the general use of volunteers). To combat this problem, the Washington DC/Baltimore Regional Household Travel Survey effort introduced a strategy of designating a particular set of their sample to be the GPS participants and not asking for "volunteers", an "opt-out" policy (Bricka 2008). The survey included a subsample of 1,600 households with a GPS component, of which 850 participated. Households on the original list were randomly assigned to a GPS or non-GPS condition. Those designated as GPS were recruited with reference to a GPS study, but non-GPS households were never offered the opportunity to "opt-in". The GPS sample showed improvement in the proportion of larger households and proportions of children and young adults as compared to the general population. Bricka (2008) speculates that this reflects key technology appeal for young adults. Given that better results are expected from an "opt-out" strategy, considerations need to be made for asking general households, as opposed to voluntary households, to use GPS.

For guidance on the acceptability of a GPS component in a large scale survey, Marchal et al. included a question in the French National Travel Survey regarding the willingness to use GPS. The authors point out that in small applications of GPS, interviewers are able to choose those who are willing to cooperate, leading to a higher rate of participation than in a large random sampling strategy. They assembled individual characteristics and mobility characteristics and used these statistics in conjunction with the household characteristics to calculate the probability of an individual's willingness to participate in a GPS-based survey. They found increasing acceptance with higher household incomes, presence of computers in the home, and higher levels of education, and declining participation with age and poor health. Willingness to participate in a GPS survey was also found to be positively associated with greater mobility and higher access to cars.

Analysis of Reported Trip Purposes and Destinations

When comparing the means of the percentages of the two groups (paper or web-based survey responses) who provided trip purpose as an item for each trip reported on the survey instrument, very little difference was found. In addition, no difference was found in the quality of the provided address information that was needed for geocoding responses. This suggests that either survey instrument, paper or web-based, provides comparable data on trip purpose and address locations.

Upon preliminary review of the data, as expected, there were a large number of transit trips and a variety of purposes for this transit travel. Twenty-two of the survey participants had one or more transit trips within their daily travel record. This makes the accuracy and correct interpretation of the reported transit trips particularly important. Large numbers of transit trips in the New York City region should not come as a surprise. According to Erlbaum (2007), the share of transit for work trips within a 5-mile radius of Manhattan is 60%, 58% for the area within a 10-mile radius, 46% within a 25-mile radius, 39% within a 50-mile radius, and 35% within a 100-mile radius. In a dense urban environment, it can be expected that transit is also used for a number of trip purposes, such as doctor appointments, meals, shopping, etc.

The next step in the preliminary analysis was the processing of the written descriptions in the paper and web-based survey instruments into GIS shapefiles, "cleaned[3]" GPS traces, and Trip Summary GPS data generated from the speed-based algorithm. A set of maps was produced for each individual participant, including enlargements of specific segments for closer review. To protect confidentiality, all of the actual location data were deleted as well as the underlying base-map spatial data prior to printing the maps.

Figure 1 illustrates the technique of combining the cleaned GPS traces, the GPS Trip Summary Points, the GPS Trip Summary Stationary Locations, and the reported locations for one particular paper survey. *Table 3* is a sample of the data reported on the paper survey by the survey participant, and *Table 4* is a sample of the information generated from the post-processing technique.

[3] The steps involved in "cleaning" the data include extracting the data logged during the survey period and determining valid GPS "fix" indicators (three or more satellites in the sky and a HDOP value less than 5).

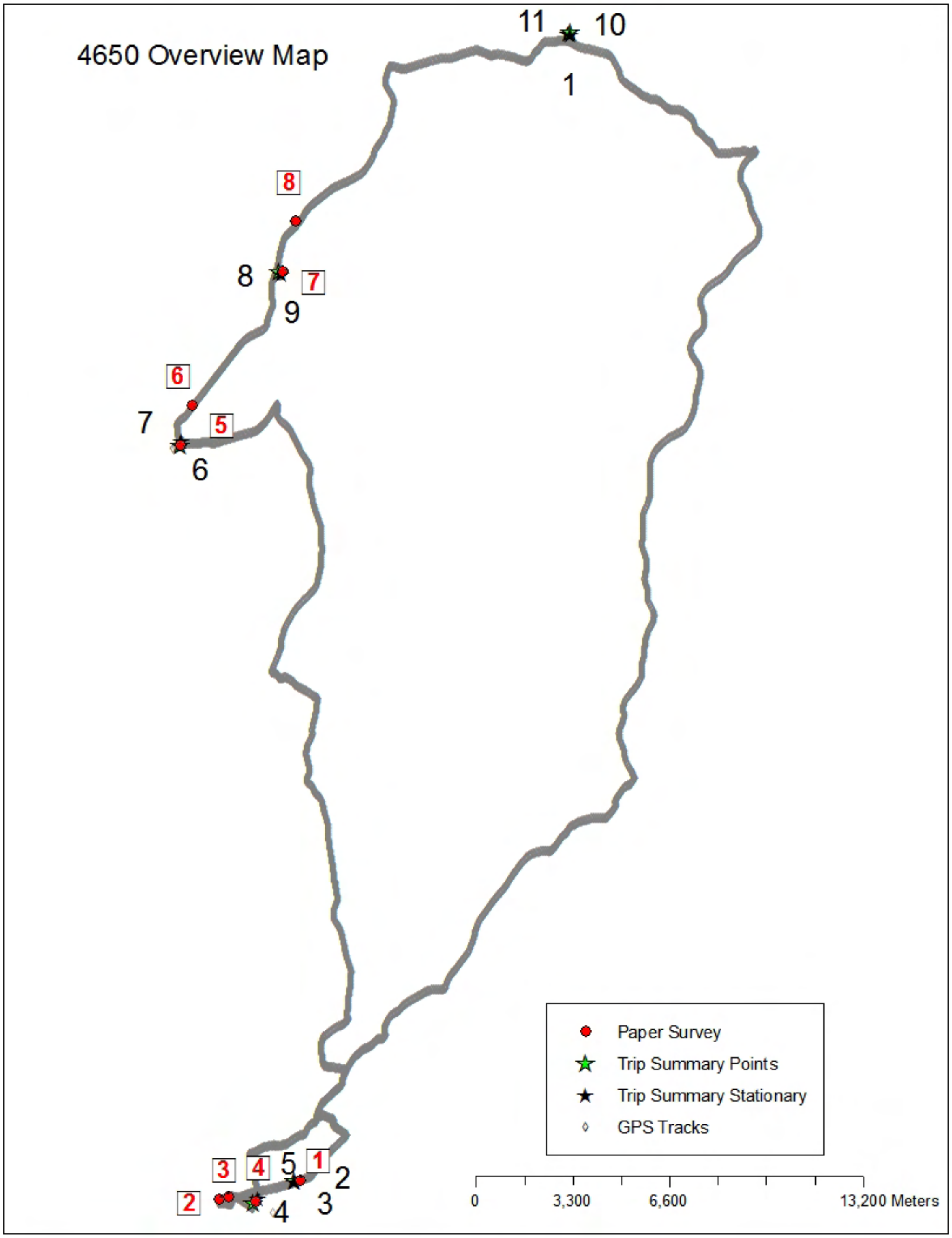


Figure 1: Sample map showing paper survey destinations, possible mode shifts, stationary points and the entire GPS trace.

Table 3. Paper Survey Details

Place	Location	Arrival AM/PM	Arrival hour	Arrival minutes	Travel Mode	Activity 1	Activity 2	Departure AM/PM	Departure hour	Departure minutes	Geocoded
0	my home					eat meal	sleep	AM	8	0	NO
1	new place	AM	8	40	car	shop		AM	8	45	YES
2	new place	AM	8	48	car	drop books		AM	8	48	YES
3	new place		8	50	car	bank ATM			8	52	YES
4	regular work	AM	8	56	car	work		PM	3	2	YES
5	new place	PM	3	43	car	shop	doctor	PM	3	48	YES
6	new place	PM	3	53	car	gas		PM	3	56	YES
7		PM	4	4	car	shop		PM	4	24	YES
8	new place	PM	4	29		ATM		PM	4	32	NO
9	my home	PM	4	50	car						NO

Table 4. Trip Summary Details

TripID	StartSecs	StartTime	EndSecs	EndTime	StartSpeed	EndSpeed	ElapsedMins	Distance	AvgSpeed	Mode
1	28170	7:49:30 AM	28890	8:01:30 AM	0.2	3.3	12	0.1	0.3	Stationary
2	28890	8:01:30 AM	31351	8:42:31 AM	3.3	0.4	41	39.9	58.3	Vehicle
3	31351	8:42:31 AM	31712	8:48:32 AM	0.4	2.4	6	0.1	0.6	Stationary
4	31712	8:48:32 AM	32314	8:58:34 AM	2.4	0.4	10	1.2	7.5	Vehicle
5	32314	8:58:34 AM	54273	3:04:33 PM	0.4	71.128	366	0.2	0.0	Stationary
6	54273	3:04:33 PM	56374	3:39:34 PM	71.1	2.0	35	25.8	44.3	Vehicle
7	56374	3:39:34 PM	57095	3:51:35 PM	2.0	18.9	12	0.1	0.7	Stationary
8	57095	3:51:35 PM	57877	4:04:37 PM	18.9	-	13	6.3	29.0	Vehicle
9	57877	4:04:37 PM	58898	4:21:38 PM	-	8.6	17	0.1	0.4	Stationary
10	58898	4:21:38 PM	60027	4:40:27 PM	8.6	0.6	19	11.0	35.2	Vehicle
11	60027	4:40:27 PM	89850	12:57:30 AM	0.6	-	497	-	-	Stationary

For this particular participant, the home location was either not available or was not sufficient to produce a latitude/longitude point based on the paper survey data. However, by combining the GPS Trip Summary Stationary point locations and the GPS traces, it is possible to utilize the entire dataset, with a rich illustration of trip chaining activities. This data can now be used to describe the trip segments by mode, trip purpose, travel time, time at location, and speed of travel. The GPS traces will also be useful for future modeling efforts in order to validate the trip assignment process.

Some research has been conducted with GPS data only. For example, Schuessler and Axhausen (2009) used a GPS-only dataset and developed a post-processing procedure to compensate for the lack of good data on the number of satellites in view or the satellites' positions. They also had no validation data from survey participants on their actual trip experiences to compare to their post-processing findings.

The experience with volunteers in the GPS Pilot Study was satisfactory with respect to their ability to deploy and control the equipment and the data during the experiment, the ability of the research team to process the GPS data into its general form (the GPS traces), and the application of a simple algorithm to help with the interpretation of the GPS data (although more work on the algorithm development is necessary to increase its value). At this time, the research team recommends using either a paper survey or a web-based survey to capture trip purpose and to cross-validate the GPS data. Research has been conducted on the possibility of determining trip purpose using only the GPS traces by implementing a post-processing technique (*see* Wolf 2000; Wolf et al. 2001; Wolf et al. 2004).

Advances with post-processing techniques, capable of seamlessly transforming raw GPS traces into analysis-ready metrics, hold great promise. The rich source of travel behavior data that can be produced with minimal effort by those carrying GPS units would make it possible to use this data with current transportation forecasting models and also contribute to the next generation of these models (*see Special Report 288, Transportation Research Board 2007*).

Use of GPS to Improve Transit Trip Data

As indicated in the third objective of this research project, analyzing the ability of GPS to reduce misreported transit trips is of key importance. As documented in the Phase Three Report, the research team conducted extensive analyses of misreported trips in the 1997/98 Regional Travel Household Interview Survey (RT-HIS). To simulate the circumstances for testing the usefulness of GPS, the research team explicitly incorporated transit trips into the possible modes used in the GPS Pilot Study experiment. However, only those volunteers using the paper survey were required to provide details on travel modes used, including sequencing, facility names, and facility locations. Detailed travel mode information could not be obtained from web-based survey participants due to technology limitations of the application used for the survey. Web-based survey participants were asked "*What was your primary mode of transportation? (a primary mode of transportation is a mode you spent the most time during your entire trip*)". Given this constraint, it is not possible to directly compare the data collected in the web-based survey regarding transit travel when more than one mode was used with the raw GPS data (the GPS traces) or the resulting trip summary data.

Reflecting on the problems with transit trips in the 1997/98 RT-HIS, *Table 5* illustrates the complexity of transit trip patterns reported by volunteers using paper surveys. Confirming the validity of these descriptions requires expert knowledge of the transit system. The descriptions need to be "snapped" to a database of possible combinations, times of service, and/or connectivity of modes. The burden of relating these complex modes, either in written or verbal form, is sizable. Previous research identified characteristics of individuals most likely to have problems reporting transit trips (*see Phase Three Report*).

The table reports the set of modes used to move from one location to the next, the type of transit used for each component of each transit trip, the location where this transit type was used, the final exit point for transit services, and the purpose of the trip.

Using GPS to clarify the trip-making patterns should reduce the time required to verify the accuracy of the reported data and reduce the risk of incorrectly interpreting actual travel patterns. It is unclear whether intensive phone interviewing techniques would improve the quality of the information provided by survey participants. This is particularly true for those individuals belonging to one or more of the demographic groups already found to be prone to misreporting (e.g., being male; being between 36 to 55 years old; having a full-time job; having a driver's license; working in the financial industry; or being Asian).

The Metropolitan Transportation Authority in New York (MTA) is currently conducting a phone and mail-in travel survey that includes the use of GIS-based software that geocodes a respondent's trip origins and destinations instantaneously (Seltzer 2009). The purpose of this enhancement is to allow the interviewers to identify any odd-looking trips and to reduce post-processing of the data. This methodology may still produce respondent burdens typical with traditional travel surveys, including the burden of trying to recall activity patterns. More details on the performance of the GIS-based software are expected at the conclusion of this effort.

Current Uses of GPS for Travel Survey Data Collection

To date, the advantages of using GPS have been frequently analyzed, yet just how best to gather data is still under investigation. Stopher (2008) indicates that GPS is being used in Australia for the TravelSmart[4] evaluations and for validation and analysis of traditional household travel surveys. The most recent use is the TravelSmart Evaluation of Households in the West, Adelaide (2005 – 2008). Using an improved GPS unit, a panel of 200 households, originally contacted by phone, was asked to carry a GPS unit for seven days once a year for three years (with a sub-sample required to carry the GPS for 15 days). The data is currently under review. The Long-term Monitoring of Travel Behaviour Change (2007 – 2013) is now underway in Australia. This effort recruited a 120-household panel by phone. They have been asked to carry a GPS unit for 15 days once a year for six annual waves.

Stopher's stated advantages of GPS include:

- Passive method requires very little of participants
- Records accurate data for routes used, distance traveled, time taken, and when and where a trip takes place
- Provides a means for collection of multi-day travel data
- Records distances for ALL modes of travel, allowing for inference of mode and capturing walking and biking trips
- Data can serve multiple uses, including travel speed by time-of-day and route, inputs for fuel consumption and emissions estimation, and measures of physical activity

[4] According to Richardson et al. (2005), TravelSmart is being used in Australia to reduce vehicle-kilometers of travel (VKT) through voluntary behavior change programs.

Table 5. Paper Survey Examples of Complex Transit Trip Details

MODES*	TRANSIT.1	LOCATION.1	TRANSIT.2	LOCATION.2	TRANSIT.3	LOCATION.3	TRANSIT.4	EXIT LOCATION	TRIP PURPOSES
walk, subway, walk	F subway	7th Ave	A subway	Jay St.		34th			eat meal, regular work
subway	Q67	62nd & 53rd Dr	7 subway	Hunters Point Ave	6 subway	Grand Central		Bleecker St.	attend training classes
bus, walk	5 subway	Morris Pk	6 subway	Lex. Ave & 196th St.	196 bus	Lex. Ave. & 125	96 St. Subway	1st Ave & 97th St.	regular work
transit, walk	NJ transit	Edison NJ	PATH	Newark					
walk, express bus, walk	BxM18								doctor
subway, walk	LIRR	Ronkonkoma	3 subway	Penn St.				Fulton St. & John St.	regular work
car, train, walk	PATH	Harrison	PATH	Journal Sq.					work at another place
train, walk	1 train	240 St.							eat meal
walk, transit, walk, car	PATH	WTC	NJ transit	Newark					drop off, eat meal, sleep
walk, subway, subway, walk	7 subway	Bliss St.	3 subway	Time Square				Fulton	shop
train, subway, walk	LIRR	Central Islip	2 subway	Penn Station					regular work
walk, subway, walk	F subway	Parsons Blvd	C subway	West 4th St.				Broadway/ Nassau	regular work
walk, subway, walk	2 subway	34th St.							regular work

* Note: MODES are representative of responses received from volunteers on their survey instruments as illustrations of what was reported

Table 5. Paper Survey Examples of Complex Transit Trip Details (continued)

MODES*	TRANSIT.1	LOCATION.1	TRANSIT.2	LOCATION.2	TRANSIT.3	LOCATION.3	TRANSIT.4	EXIT LOCATION	TRIP PURPOSES
walk, transit, walk, car	PATH	WTC	NJ transit	Newark					Drop off, eat meal, sleep
walk, subway, subway, walk	7 subway	Bliss St	3 subway	Time Square				Fulton	shop
train, subway, walk	LIRR	Central Islip	2 subway	Penn Station					regular work
walk, subway, walk	F subway	Parsons Blvd	C subway	West 4th St				Broadway/Nassau	regular work
walk, subway, walk	2 subway	34th St							regular work
walk, train, walk									regular work
walk, subway, bus	6 subway	E96th & Lex Ave	5 subway	E125 & Lex Ave				Morris Park	
walk, subway, train, car	3 subway	Fulton St	LIRR	Penn Station					visit friend
walk, subway, walk	E subway	WTC						Union Turnpike	shop
walk, subway, bus, walk	6 subway	Bleecker St	7 subway	Grand Central	Q67	63rd St & 53rd Dr			
subway, walk	F subway	Carroll St	A subway	Jay St				West 4th St	regular work
walk, subway, train, car	subway	Fulton St	LIRR	Penn Station				Ronkonkoma	vote
walk, train, train, bus	1 train	168th St	bus	231 St					work at another place , see client

* Note: MODES are representative of responses received from volunteers on their survey instruments as illustrations of what was reported

The Ohio Department of Transportation (ODOT) has commissioned Abt SRBI and PlanTrans to conduct the nation's first GPS-Based Household Travel Survey. This is a demonstration project intended to improve the accuracy of trip reporting compared to traditional paper diary efforts while reducing respondent burden (PRNewswire 2008). The survey design calls for the recruitment of households by phone and Internet, using an address-based sampling frame for the Greater Cincinnati region. GPS data will be collected for 4,000 households for a minimum of three days for all members of the household 13 years of age and older. An abbreviated paper diary will be kept for children 12 and under.

To validate the data, 1,500 respondents will also receive a follow-up Internet or mail survey to record their travel for one day. The follow-up survey will ask respondents to verify trips and stops and to provide information not directly collected from the GPS, including trip purpose and mode. PlanTrans also plans to develop an artificial intelligence (AI) program for this purpose. A schedule will be designed to maximize the distribution of the GPS units, with each household being assigned three full travel days. Census data will be used to expand the results of the survey to the entire region (Ohio Department of Transportation 2008).

At the 88th Annual Transportation Research Board Meetings in Washington, D.C., Vovsha et al. (2009) announced their upcoming GPS-only travel survey project in Jerusalem. This effort will include the use of a customized computer-assisted personal interviewing (CAPI) tool for both recruitment and data retrieval. The methodology includes an incentive for participation. The surveying effort is being designed to capture the travel behaviors of households with religious and ethnic differences. The pilot is scheduled for March 2009, with the full surveying effort expected to begin in October 2009. The planned sample size is 5000 households (Vovsha 2009). The research team hopes to minimize recording errors using GPS and plans to automatically conduct edit checks to identify joint activities and chained trips. They described an "in-home" data downloading procedure that would allow the survey participants to "audit" their own data using electronic geocoding with real-time respondent verification (Vovsha et al. 2009).

Section Two: Discussion

Issues Relating to Research

Should a person-based GPS survey be a part of the upcoming regional household travel survey?

There are a range of options for the upcoming Regional Household Travel Survey with respect to the use of GPS. The GPS Pilot Study has provided guidance on the type and quality of GPS equipment required to work in a dense urban region and has demonstrated that the GPS data is sufficiently robust for preliminary mode identification strategies. The following options can be considered:

- No use of GPS
    - High potential for misreported transit trips, even if extensive attempts are made to gather information from survey participants, as the task of recording and recalling all trip legs is quite onerous
    - No data to cross-check paper, web or phone interview information
    - No improvement in traditional data elements currently being used in models, with no potential for model improvements with speed data, routing data for validation, etc.
    - No risk of equipment loss and no additional training needed for deployment and data storage
    - No additional costs, but potential loss of future value

- Independent GPS survey
    - A small, rolling fleet of GPS units collecting data in conjunction with a modified paper or web survey
    - Strategy for data collection could include a panel and/or multi-day survey
    - Samples could be targeted geographically or by socio-demographic characteristics
    - Limited cost for equipment, staff time for distribution and retrieval, and data storage
    - Data will be available for current model validation and future model development

- GPS subsample of volunteers within upcoming sample
    - Replication of current practice with voluntary subsamples
    - Limited cost depending on number of GPS units and amount of data processing performed

- Targeted use of GPS
    - Using socio-demographic initial scan, determine groups most likely to misreport transit trips and offer GPS survey
    - Could reduce misreported trips, especially for young males
    - Limited costs, but depends on extent of use

- Randomly assign GPS units to households using “opt-out” strategy
    - Households collecting GPS data will provide wealth of information for current model and sufficiently high quality data for future model development
    - GPS units could be scheduled to maximize distribution and minimize costs

- GPS survey along with paper or web-based survey for trip purpose and verification of mode
    - Entire sample will contain high quality, next generation model-capable data, including speed, exact latitude/longitude, exact time of start and end of trips, exact travel time, etc.
    - Supplementary data from follow-up surveys can be appended and used for validation
    - Additional cost for GPS units, with some savings from strategic distribution and data collection scheduling
    - Opportunity to use GPS fleet for continuous program of data collection (similar to the strategy of American Community Survey)

With any of the options where GPS data is collected, the initial investment in time and processing could be extended over a longer budgeting cycle as long as preliminary data quality checks are conducted immediately. Such checks could use Google Earth for viewing .kml files. An archiving strategy would allow for future retrieval and analysis. Determination of trip segments and trip purposes for traditional modeling needs would require some additional algorithm development; however, this work is already underway in several research efforts (e.g., Stopher et al 2007; PRNewswire 2008; Wolf et al. 2001; Wolf et al. 2004). The long-term investment in the data could be preserved with sufficient maintenance and care by staff.

The GPS Pilot Study has demonstrated the feasibility of using GPS in the NYTMC region with relative ease and no extraordinary costs (other than the initial cost of the equipment). The data generated from GPS deployment would provide additional value as it would include more detailed information than any other methodology. This additional value is not necessarily needed, however, for current models.

It is worth noting that the ODOT is planning to use GPS for their upcoming household travel survey because of the higher quality data obtainable. They intend to gather a limited amount of supplementary information on trip purpose using either a paper survey or a web-based survey, similar to the data collected in the GPS Pilot Study. Their current direction indicates a forward-thinking strategy that should prepare them for the next generation of models. For this reason, *the research team recommends the inclusion of as many GPS samples as possible.* If another methodology can produce data of equivalent quality with the same low level of perceived burden by the survey respondents, it is then a question of cost alone. If an “opt-out” strategy is used for all potential participants, those NOT willing to use GPS could still participate using a more traditional methodology such as CATI, paper survey, or in-person interview (in extreme cases for a special population). *At a minimum, those households with a propensity to misreport transit trips should be offered GPS as a way to improve their data and reduce the amount of manual post-processing required to “fix” the data.*

While the MTA survey data collection is complete, the analysis has not been finished (Seltzer 2009). It could provide an opportunity to quantify the level of respondent burden by calculating the amount of time required to complete each call, assembling a time-in-processing metric for the coding and recoding as attempts are made to match the verbal descriptions of each respondent’s travel patterns with the software cues, and by counting the number of required callbacks for clarification. The respondent burden includes the stress of knowing the participant will be responsible for accurately recalling their daily activities as well as the actual task of reporting and re-reporting when their descriptions are not accurate enough for the geocoding process to be completed.

The comfort of knowing that the GPS is accurately capturing the location and time data may actually reduce the stress associated with complete dependence on human recall. This division of work between the use of technology and human contribution – a hybrid approach – may offer the most realistic approach at the present time, given the inability of the GPS to report trip purpose.

What would be the minimum recommended sample size of the person-based GPS component of the regional household travel survey?

The appropriate sample size is dependent on the future use of the data. Stopher et al. (2008) provide some guidance on sample size for GPS surveys. They strongly recommend the collection of multi-day data as it allows for the analysis of day-to-day travel behavior variation while reducing sample size and survey costs. In addition, the lack of trip purpose data with current GPS technology limits the possibility of selecting an entire sample of only GPS users. The rest of this section will offer guidance on how to determine the minimum sample size for these GPS-only population subsets.

Given the variable of interest, sample size calculation depends on two important elements: the variability over the population in the parameter to be measured and the degree of precision required for the parameter estimation. The size of population does not play an important role in general, unless the population size is very small.[5]

Suppose we are interested in estimating two key variables for young males: daily trip rate and percentage of transit users[6]. From the 1997/98 RT-HIS data, the mean daily trip rate for young males is 4 with a standard deviation of 2.28. The mean proportion of transit users for the young male population is 0.25 with a standard deviation of 0.43. For trip rate, suppose we have 95% confidence that the sampling error is no more than 5% of the sample means. Thus, the margin of error equals 0.2. The required sample size is: $N = (\frac{z_{\alpha/2} \times S_x}{E})^2 = (\frac{1.96 \times 2.28}{0.2})^2 = 100$. In other words, a sample size of 100 is required to allow us to have a trip rate estimate such that there is a 95% probability that the sampling error will be no more than 5% of the sample mean. The calculation for the share of transit users in the young male population is similar, except the estimate is now a proportion variable. Assume that we want the sampling error to be no greater than 5 percentage points. The required sample size is: $N = \hat{p}(1-\hat{p})(\frac{z_{\alpha/2}}{E})^2 = 0.25 \times (1-0.75) \times (\frac{1.96}{0.05})^2 = 288$. Therefore, a sample of 288 young males is required to estimate the proportion of transit users with a sampling error less than 5%.

The sample size calculation based on different variables of interest will result in different numbers. An easy solution is to select the maximum required sample size. However, in reality, this is often infeasible due to cost considerations. In actual surveys, compromises are often made. One can also conduct multiple-stage sample size calculations during the survey process, such that the precision level can be controlled in real time. In reality though, this strategy can pose some challenges, as it requires one to collect and analyze data simultaneously.

Another issue is that the above calculations are based on a simple random sampling strategy. If stratified sampling is used, as is often the case, the required sample size will be smaller than the one derived from the simple random sampling, unless the variation in the population is the same across strata.

Given ODOT's decision to exclusively use GPS for their upcoming household travel survey effort of 4000 households (and the survey in Jerusalem's choice of 5000 households), the sample size for GPS use could be as high as the total survey sample. If an "opt-out" strategy is used, then a GPS sample of approximately 30% of the original sample could be expected based on recent experiences with this methodology. If a stratified method is used during the initial contact to determine those households

[5] This contradicts the intuitive feeling that sample size is always expressed in percentage form.

[6] Here we use the same definition for transit user as before. A transit user is someone who uses any of the available public transit modes on the given survey day.

most likely to misreport transit trips, the number of needed samples would depend on the proportion of this target market segment expected to be necessary for future models. If the strategy for determining the sample is based on geography similarly to the “mode leadership” methodology used in the 1997/98 RT-HIS, it may be problematic as this methodology did not use a socio-demographic stratification methodology. In this case, the number of GPS samples will be completely dependent on the outcome of the random sampling strategy used and the characteristics of this population determined in an initial phone interview. However, all contacts could be “qualified” as GPS-based if they have those characteristics with a higher than normal propensity to misreport transit trips.

The minimum number of GPS samples will be dependent on the initial sampling strategy used and on how many of the sampled households contain individuals with a higher than normal propensity to misreport transit trips. As indicated by ODOT, it is possible to use GPS for the entire sample, and this strategy would provide data of the highest possible quality for all trips.

Even if an “opt-in” strategy is used, those agreeing to use the equipment will contribute higher quality data regardless. This data will also have additional value for future model improvements and travel behavior analysis provided that survey respondents agree to these additional data uses.

How could the person-based GPS survey be used to improve and/or enhance current travel survey processes that have been used in the NYMTC region?

The travel surveying process includes a number of tasks, including determination of the sampling frame, recruitment, data collection, and post-processing of the data after it is collected. Using GPS can be seen as a trade-off between using the traditional surveying processes, which has the risk of lower quality data due to misreporting, and the risk of trying a new technology that promises to provide better data but only if properly used and accepted for use by potential survey participants. There could be an additional benefit of improved survey participation if some groups currently not participating would find the use of the new technology intriguing enough to now consider responding to a recruitment offer.

GPS devices have become very popular and people might be intrigued (and perhaps honored), therefore choosing to participate in greater quantities. This might also apply to very busy people who cannot be bothered with participating in a traditional travel surveying effort. An additional cost saving associated with accurate data is the reduction in staff time to try and “fix” poorly collected and/or recorded data. However, refinements in the data-processing stage may be needed to confirm stopping behaviors. For example, there could be issues associated with the distinction between a purposeful stop and the appearance of a stop (e.g., at a bus stop or a traffic light).

During the initial inspection of the GPS Pilot Study data, several data issues were found, including:

- The GPS unit recorded points that ended several hours later than the reported time – presumably because survey participants did not turn off the GPS unit as soon as they arrived back at home
- The hour was recorded in the .kml file but not in the .csv file
- The respondent forgot to record their “work to home” trip in the web survey form
- The departure time for the first trip matches the time that the GPS was turned on, but the first “fix” point (and the first point in the Google Earth data review process) was not until one hour later
- One unit was inadvertently not erased before deployment and was unable to record data during the survey day
- The “minutes” information was not included for the first entry on the web survey
- The start and end times of GPS and reported records did not match

Although there is no loss of information when the GPS is not immediately turned off upon arrival at home, one concern for future endeavors is that more care needs to be taken to check the equipment prior to distribution (e.g., to check that the memory is empty) to ensure the best possible results.

Using GPS for detailed data elements will require high-quality data-handling techniques. The units will need to be tagged with unique identifiers, and the data will need to be downloaded, properly named, and stored for post-processing techniques. These skills are necessary for traditional survey work but will need to be electronically enhanced if GPS data is part of the survey.

How could the person-based GPS survey help in addressing non-reported trips in the travel diaries?

The GPS Pilot Study clearly illustrates that the effectiveness of using GPS to capture all trips is better than or equal to traditional surveying methods. A general response by the volunteers was that the burden of recording their own activities manually was onerous. The few periods of missing GPS data were explained by volunteers in their follow-up survey, with indications that they forgot to turn on the GPS unit or that it accidentally was turned off. To reduce the impact of these types of incidents, it is recommended that multiple days of data be recorded. This would increase the likelihood that at least one, if not all, of the days of data will be complete for all variables.

How could the person-based GPS survey help in addressing the rounding of travel times, imprecise departure and arrival times reported in the travel diaries, and bad recollection of O-D locations by respondents for geocoding purposes?

Properly functioning GPS will always provide better data than traditional surveys with respect to exact travel times, exact departure and arrival times, and exact locations of activities. This was successfully demonstrated during the comparison between the paper survey and the GPS traces, and, in most cases, the comparison between the web-based survey and the GPS traces. (In the web-based survey, complex transit trips were truncated to include only the primary transit trip due to constraints of the web-based software. This could be rectified with additional web development.) Thus, every additional GPS unit will improve the quality of the data and avoid the loss of samples due to bad data reporting. The data handling procedures will also be crucial to this improvement.

Once the GPS data has been cleaned, the resulting latitudes and longitudes need to be saved in a database format. In this format, the data can be “added” as a table in GIS software and exported as X/Y coordinates to a GIS shapefile that can be projected appropriately (e.g., North American Datum 1983). The resulting shapefile of the GPS traces and Trip Summary GPS can be mapped and compared to a geocoded version of either a paper or web-based survey.

The paper or web-based survey can be geocoded by entering the provided address into Google Earth or other geocoding software, copying the latitude and longitude in degrees into dBase format, removing the degree symbol and following the same steps as above. The GPS data contains a time stamp that can then be compared to the times reported in either the paper or web-based survey.

Would the person-based GPS survey help to improve the response rate from low-response groups, such as young males?

The GPS Pilot Study did not confirm the ability of GPS to improve the response rate of low-response groups, such as young males, due to the nature of the sample frame and the limited research design. However, there are indications from a Washington, DC/Baltimore study that young adults would be more likely to participate in a survey that incorporated new technologies. The GPS Pilot Study found that none of the volunteers were unable to use the technology, with most responding positively to the idea of using this type of technology.

How could the person-based GPS help improve the BPM modeling process?

Our discussions with the BPM modeling staff indicated that they would be able to use the higher quality origin and destination data at this time. They would also be able to use the better quality time data for estimation purposes. The actual routing data may be useful for auditing and validating model assignment in the future. More research is needed to determine the most efficient and effective way to process the GPS data to accommodate the needs of the modeling community.

How would it be possible to track complex bus/subway transit rider paths in Manhattan?

The research completed by ALK Technologies used specific rules to identify mode profiles based solely on the speed of travel. Although this type of algorithm is very limited, it was useful in almost all cases where a volunteer was traveling by subway. The research team used the GPS traces and GPS Trip Summary latitude and longitude data from the ALK processing to produce GIS shapefiles. On the maps produced from the shapefiles, it is possible to "see" the travel patterns, and in some cases interpret the speed of travel from the visualizations or by referring to the GPS Trip Summaries containing the speed between stationary points. Subway trip patterns disappear at the entry to the system and reappear at the exit point. More work is needed to develop more complex rules and also to work with the data in a GIS environment. The use of GIS would allow for the ability to "snap" GPS data to shapefiles of transit stops, subway entrances, and other transit facility features.

How should "acquisition time" for GPS devices (the time necessary for devices to start registering latitude/longitude coordinates upon being turned on) be addressed, as well as related "no signal" and "inconsistent signal" issues related to being near tall buildings, being within structures, and cloudy days?

With regards to acquisition time, it takes between a few seconds and a few minutes for a GPS logger to start registering latitude/longitude coordinates after being turned on. It is very important to instruct the survey participants to stand still during the acquisition time and wait for a signal from the GPS logger (such as a blinking green light) that it has started registering coordinates. For reacquisition time, our second test shows that, on average, it takes approximately 39 seconds for a GPS logger to register coordinates after emerging from underground subways.

GPS loggers sometimes receive inconsistent signals near tall buildings. Inconsistent signals could be removed during data processing by using parameters such as horizontal dilution of precision (HDOP) and number of satellites used. Within structures such as buildings and bridges, GPS loggers receive signals on the street level or where the sky is visible (near windows, for example). GPS loggers cannot receive signals in underground subways, tunnels, or on the underground levels of structures. These "no signal" issues could be addressed with the help of GIS data (such as locations of subway lines and tunnels).

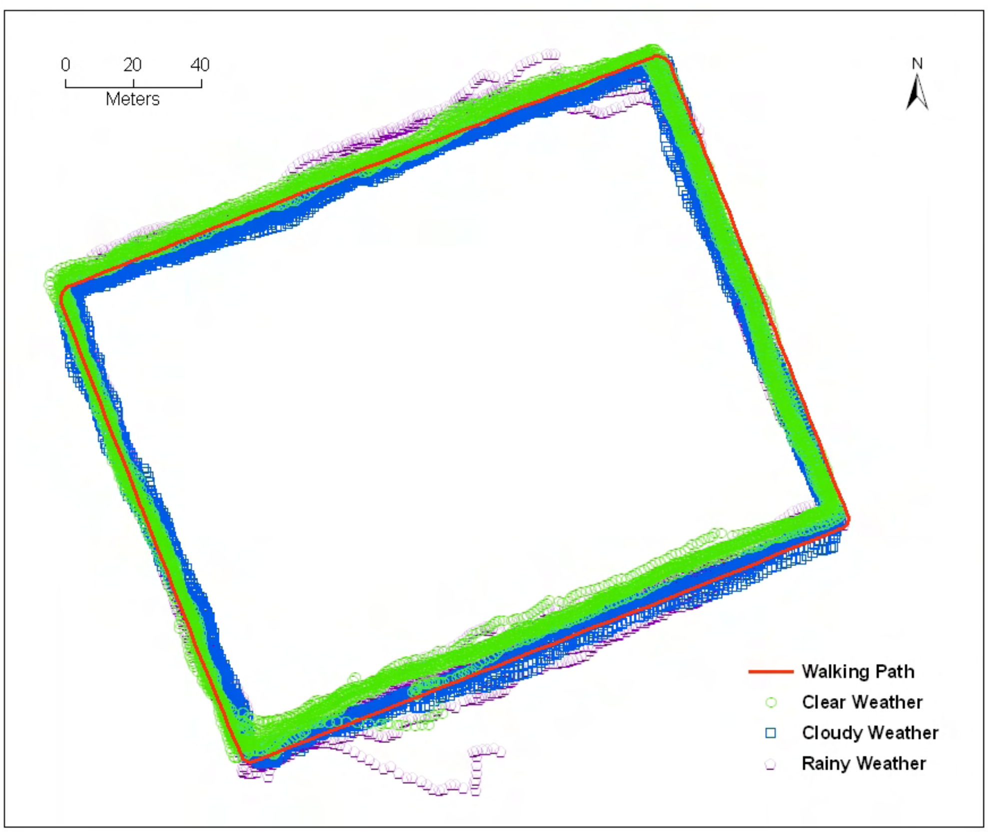
GPS loggers are able to receive sufficient signals on cloudy days. A test was conducted in late February and early March 2008 to compare the accuracy of the locations recorded by i-Blue on clear, cloudy, and rainy days (*Table 6*). Fourteen i-Blue loggers were carried during a walk around two blocks of single-detached houses in Queens (*Figure 2*). Areas with high-rise buildings, such as neighborhoods in

Manhattan, were purposely avoided to prevent the interference of the urban canyon effect with the potential effect of the weather.

Table 6. Deviation of the Recorded Locations under 3 Different Weather Conditions by i-Blue

Distance (meters)	Clear	Cloudy	Rainy
Mean	3.5263	2.6194	3.3896
# of loggers used	13	14	14
Count	5748	5359	5493
Sum	20269	14037	18619
Minimum	0.004875	0.000177	0.00143
Maximum	12.522947	9.783382	31.784459
Standard Deviation	2.5708	1.7689	2.6353

Figure 2: Locations recorded by i-Blue loggers under 3 different weather conditions



The i-Blue loggers recorded the fewest location points (*Table 6*) on the cloudy day but had the highest accuracy (only 2.6 meters away the walking path on average) and the lowest standard deviation (1.7689 meters). The standard deviation was the highest on the rainy day, as shown in both *Figure 2* and *Table 6* (2.6353 meters). The most location points were recorded on the clear day even though data from one of the 14 loggers were not downloadable and therefore were not included in the analysis. Overall, the weather has a much less of an effect than urban canyons on the performance of the i-Blue loggers and should not be a concern in the use of these loggers for travel surveys.

Conclusions

The GPS Pilot Study has been able to determine the technical feasibility of using GPS technologies to collect passive data on travel behavior. The GPS unit produced sufficient data for a variety of modes, including walking, transit, rail, and auto; subway use is captured at the entrance and exit of the system. The ability to produce high-quality data could mitigate the issue of misreported transit trips revealed in the 1997/98 RT-HIS efforts.

To determine the feasibility of incorporating GPS data in future household travel survey efforts, the research team worked with the NYMTC Travel Survey Unit (TSU) to recruit 35 volunteers as a representative sample of the public. In comparing the use of GPS to either traditional paper or web-based surveys, the burden on the participants of attempting to record travel movements and the pressure to recall the details was well described. Very little burden was mentioned with respect to the use of the GPS equipment. Several of the issues raised by participants are already being addressed by the manufacturers (e.g., solar powered units and fuzzy auto on/off systems).

The GPS Pilot Study confirmed the complexity of trip patterns for persons using transit, suggesting an increased respondent burden for transit riders and an increased possibility of misreporting trips. Post-processing techniques appear to offer a methodology for identifying the mode of travel based on computed cumulative distance traveled as a function of time, modified by intermittent information provided by speed and heading. In addition, the GPS Pilot Study provides sufficient evidence of the successful use of GPS units, as the experience of the volunteers was satisfactory with respect to their ability to deploy and control the equipment and the data during the survey.

The GPS Pilot Study demonstrated the feasibility of using GPS in the NYTMC region with relative ease and no extraordinary costs (other than the initial cost of the equipment). The data generated from a GPS deployment provides additional value as it includes more detailed information than with any other methodology. Therefore, GPS could be a complementary data collection method and could eventually be an alternate and substitute method for travel data collection.

While efforts are underway to improve travel forecasting models in order to make them more sensitive to policy and travel decisions facing households today and in the future, the need for high-quality, cost-effective household travel survey data is growing. Just as the Census Bureau has modernized its operations by implementing a continuous data collection effort (the American Community Survey), agencies relying upon traditional household travel surveying strategies now have an opportunity to consider new ways of collecting data, including new technologies, new deployment plans, and new ways of verifying and validating data. GPS is one of these new methods for collecting the necessary data.

Two efforts are underway to use GPS exclusively for upcoming household travel surveying efforts, suggesting that the age of passive data collection has arrived. The cost of a GPS deployment includes the purchase or lease of a fleet of equipment that could be used on an ongoing basis rather than only once a decade. This factor alone would allow follow-up or data enhancements if future analysis reveals the need for more targeted data from particular geographic or socio-demographic groups.

Advances in computer science will continue to add value to the GPS data streams as new algorithms and data-handling techniques are developed by various users, including person-based GPS, truck tracking for freight and operations, on-board GPS for vehicle tracking, etc. Improved stewardship practices of the collected GPS data will also ensure future benefits.

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Appendices: Phase Four

Appendix A: PowerPoint Presentation

Appendix B: Deployment Materials

1. **TSU Instructions**
2. **Group A Letter**
3. **Group B Letter**
4. **Travel Diary Memory Jogger**
5. **Web-based Diary**
6. **GPS Logger Instructions**
7. **Follow-up Questionnaire**

Appendix C: The GPS Pilot Study Experience

Appendix A: PowerPoint Presentation

Special Informational Session for the GPS Pilot Study

Project Team

- Consultants:
  - Dr. Catherine Lawson - University at Albany
  - Dr. Cynthia Chen – CCNY
  - Dr. Hongmian Gong – Hunter
  - Sowmya Karthikeyan –ALK
  - Jamie Cepler – University at Albany
- NYMTC
  - KuoAnn Chiao, Technical Group Director
  - Jorge Argote, Project Manager, Travel Surveys Unit (TSU)
  - Sal Mamone, Travel Surveys Unit
  - Tanya Rodriguez, Travel Surveys Unit

Purpose of the Project

- Project Title
  - GPS Pilot Study for the Regional Household Travel Survey
- Project Goal
  - To identify issues associated with using GPS in the upcoming Regional Household Travel Survey
  - To improve data quality and survey response rates

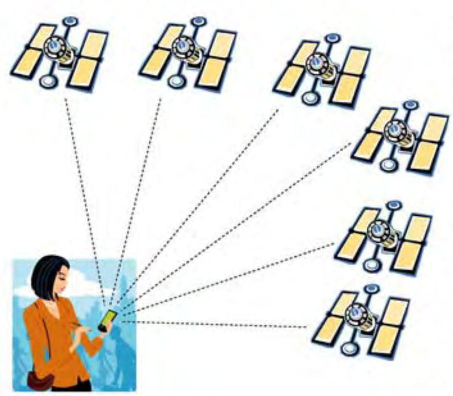
Benefits

- Better use of limited resources and funds to obtain the best available information on travel needs from the only major data collection effort, the Regional Household Travel Survey (RHTS) --collected every ten years
- The RHTS is the DATA that supports the NY Best Practice Model (developed from 1997 survey data)
- The RHTS is the first in a series of surveys, data collection and model updates, designed to provide the next ten-year cycle of state-of-the-art transportation planning practice

Issues that could be addressed using GPS

- Survey participants may forget to report portions of their travel (i.e., missed stops, missed short trips, illogical sequences, or large errors on reported travel times)
- Low response rates from certain participants (e.g., people with busy schedules)

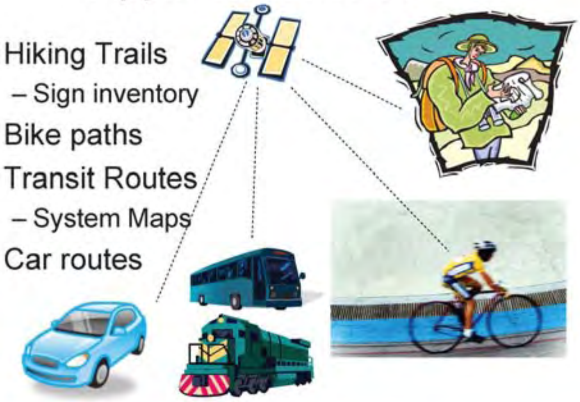
How does GPS Work?



- A series of satellites orbiting the earth send signals to receivers on the ground. The receiver uses the information from the satellites to find its approximate position
- They can report latitude, longitude, elevation, speed, heading, and much more.

Applications of GPS

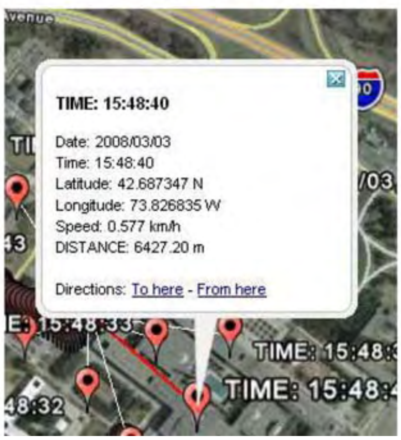
- Hiking Trails
  - Sign inventory
- Bike paths
- Transit Routes
  - System Maps
- Car routes



i-blue 747 GPS Data Logger

- MTK GPS chipset, with 51 channels.
- 25+ hrs operation time.
- 32Mb memory for saving up to 150,000 points.
- Also can be used for navigation via bluetooth
- 3 recording methods: by time, by distance or by speed
- Tracks can be shown in Google Earth or brought into GIS

What gets recorded



The GPS Experiment

- Using a combination of ways to collect the necessary information – paper surveys, web surveys and GPS
- Volunteers will receive instructions on how to fill out their survey and use the GPS unit
- Participate in a one-day “mock” survey
- Results will provide the Travel Survey Unit with possible ways to improve the RHTS using GPS

Procedure

- NYMTC Travel Survey Unit (TSU) will provide each volunteer with a unique ID for their data – no names will be associated with any of the processed data
- The team will use the “randomly generated keys” data to compare the performance of data collection techniques
- Volunteers will be asked to fill out a brief suggestion form after the “GPS survey date” to tell us your experience and provide your ideas for improvements
- The research team will provide recommendations for the upcoming RHTS

Special THANK-YOU for your willingness to participate!!

- We will provide you with instructions and samples to review
- We will ask everyone who participates to verify their thorough understanding of the one-day GPS pilot study with a consent form
- We truly want to thank you for your help!

Appendix B: Deployment Materials

TSU Instructions

Steps necessary to complete GPS Pilot Survey

Step 1: An invitation is made to any interested citizens to volunteer to participate in the GPS Pilot Study. They will be asked to contact staff at NYMTC Technical Group's Travel Surveys Unit (TSU). TSU staff will record their name, availability during the months of October and November, and their contact information at work/home.

Step 2: Once a sample of volunteers has been identified, the TSU will make arrangements for distributing the survey equipment and materials. TSU has developed a logistics spreadsheet to track the implementation of the pilot survey.

Step 3: Half of the volunteers (Group A) will receive a cover letter, a packet with a "memory jogger" diary, a GPS unit, and instructions for using the GPS unit. The remaining volunteers (Group B) will received a cover letter, the Survey Monkey website link, a GPS unit, and instructions for using the GPS unit. TSU staff will assign the packets using un unique ID for each volunteer.

Step 4: TSU will collect the completed diaries from GROUP A and the GPS units from both groups. TSU will then distribute a follow-up questionnaire to the volunteers asking them questions regarding what thoughts, experiences or problems they had. TSU will keep the original paper diary and send a scanned copy to the research team.

Step 5: TSU staff will bring the GPS units to the research team at Hunter College to download the data for analysis. The GPS units will be reset by the research team at Hunter College and returned TSU for redeployment.

Step 6: The research team members from Hunter College, City College and University at Albany, will retrieve the survey monkey data and provide TSU with an archive copy and provide the research team at ALK with an electronic copy.

Step 7: If there are questions to the volunteers (such as differences between the diary or Survey Monkey data and the GPS paths), the research team will provide TSU the questions with the volunteer ID, TSU will ask the questions and return the replies to the research team.

Step 8: The research team will conduct the analysis of the survey and the "lessons learned", its applicability, and recommendation to the Regional Household Travel Survey. This information will be documented in the final report for the project.

Group A Letter

(Group A)

October 29, 2008

Ref: Your ID Number is: XXXX
Your Survey Date is: XX/XX/XXXX

Dear Volunteer,

Thank you for agreeing to volunteer in our pilot research survey! With the increasing popularity of GPS units in the market, we have the opportunity to use these devices to collect additional data with a higher level of accuracy than could be achieved by traditional methods. However, little research exists in the application of GPS units in regional household travel surveys, and this is why we invited you to participate in this small-scale pilot research survey. Your participation will be an important contribution to the success of the upcoming household travel survey.

You will be asked to do the following activities:

- Carry a GPS unit with you on the survey day; enclosed find general instructions on how to use the GPS unit.
- Fill out the Survey Diary that will record the places you visit on the survey day and information associated with the trips to these places, including starting time and ending time, mode of transportation, trip purpose, etc. Please remember to record your ID number in the Survey Diary.
- Return the GPS unit and the completed Survey Diary to Jorge Argote on (Day).

Thank you again for your participation in this survey. If you have any questions or concerns about the survey, please call Jorge Argote at 212-383-2527.

Cordially,

Kuo Ann Chiao
Director Technical Group
New York Metropolitan Transportation Council
199 Water Street, New York, NY 10038
Tel: 212-383-7212

Group B Letter

(Group B)

October 29, 2008

Ref: Your ID Number is: XXXX
Your Survey Date is: XX/XX/XXXX

Dear Volunteer,

Thank you for agreeing to volunteer in our pilot research survey! With the increasing popularity of GPS units in the market, we have the opportunity to use these devices to collect additional data with a higher level of accuracy than could be achieved by traditional methods. However, little research exists in the application of GPS units in regional household travel surveys, and this is why we invited you to participate in this small-scale pilot research survey. Your participation will be an important contribution to the success of the upcoming household travel survey.

You will be asked to do the following activities:

- carry a GPS unit with you on the survey day;
- fill out a web-survey questionnaire that will record the places you visit on the survey day and information associated with the trips to these places, including starting and ending time, mode of transportation, trip purpose, etc.; The link to the web-survey questionnaire is: http://www.surveymonkey.com/s.aspx?sm=F14pZwbbCC6AZeR3ESOVHA_3d_3d
  Please remember to record your ID number in the web survey form.
- Return the GPS unit to Tanya Rodriguez on (Day).

Thank you again for your time and participation in this study, and if you should have any questions or concerns about the survey, please call Jorge Argote at 212-383-2527.

Cordially,

Kuo Ann Chiao
Director Technical Group
New York Metropolitan Transportation Council
199 Water Street, New York, NY 10038
Tel: 212-383-7212

Travel Diary Memory Jogger

Thank you for helping the GPS Pilot Survey Study Team!

This is your personal diary.

Each volunteer needs to complete a 24 hour diary of PLACES visited (what and where these places are) and TRIPS made (when and how you make your trips). We also ask what ACTIVITIES you do in each PLACE because people travel more or less depending on their activities at different places. When we put all the information together, we will have a complete picture of travel patterns and transportation needs for our pilot test.

In summary, the main items you need to keep track of are:

- PLACES you go to, by name and/or address as exact as possible.
- TIMES you leave from and arrive at these places, to the minute, if possible.
- ACTIVITIES you do at each place; and

List of Activities:

☐ drop off/pick up someone	☐ visit friends/relatives
☐ eat meals	☐ social/recreation/entertainment
☐ shop	☐ doctor/dentist/other professional
☐ other family or personal business	☐ religious
☐ work at home (job related)	☐ work at regular jobsite
☐ work at other place	☐ school at regular location
☐ school activities at other places	☐ sleep
☐ other activities at home	☐ other activities not at home

- MODES or each method of travel you use to go from place to place in order, such as *walk* to bus stop, take *bus* to subway, take *subway* to midtown, *walk* from subway station to office.

List of Transportation Modes:

☐ walk	☐ auto driver
☐ auto passenger	☐ group ride (car pool)
☐ school bus	☐ local bus
☐ express bus	☐ NYC subway
☐ Path	☐ Newark city subway
☐ Commuter rail (LIRR, Metro North, NJT)	☐ For hire van/jitney
☐ shuttle bus/van	☐ ferry
☐ taxi	☐ car service
☐ charter bus	☐ bike
☐ intercity travel (Amtrak, airline, greyhound)	☐ in-line skate

After you complete your diary, please return it to Jorge Argote.

Please note that the specific and exact details are very important.

Place # 1

START HERE

For this diary, your day begins at 3:00 am. Most people are home asleep at 3:00 am. If this is the case, then check "My Home," make note of the exact time you left home for the first time on your diary day, and check all the activities you did before leaving home.

(Complete the information below if you have not already provided it)

❑ My Home
❑ My Regular Workplace
❑ My School
❑ Another Place →

WHAT did you do here? *(Check all that apply)*

❑ Drop-off/ pick-up someone
❑ Visit friends/ relatives
❑ Eat meals
❑ Social/recreational/entertainment
❑ Shop
❑ Doctor/dentist/other professional
❑ Other family or personal business
❑ Religious or civic
❑ Other activities not-at-home (Specify): ____________
❑ Work at home (job related)
❑ Work at regular jobsite
❑ Work activity at other place
❑ School at regular place
❑ School activity at other place
❑ Sleep
❑ Other activities at home

From Place #1, did you go to another place during your 24-hour day?

NO- You stayed in one place all 24 hours. Check here: ❑ **DONE**

YES- At what time did you leave Place #1 to go to Place #2? : am/pm

NEXT PLACE #2

Place # 2

WHAT is Place #2?

❑ My Home
❑ My Regular Workplace
❑ My School
❑ Other Place (address already provided)
❑ A New Place →

(Complete the information below if you have not already provided it)

At WHAT TIME did you ARRIVE at Place #2? : am/pm

HOW did you get from Place #1 to Place #2?

Show ALL the methods of travel you used to make this trip. 1st → 2nd → 3rd → 4th → 5th

If you used TRANSIT Bus, Rail, Subway, Ferry, Other

	Line #/ Service		Station Name (if Rail or Subway)
First board:	________	at:	________
1st transfer:	________	at:	________
2nd transfer:	________	at:	________
Last Station		at:	________

WHAT did you do at Place # 2? *(Check all that apply)*

❑ Drop-off/ pick-up someone
❑ Visit friends/ relatives
❑ Eat meals
❑ Social/recreational/entertainment
❑ Shop
❑ Doctor/dentist/other professional
❑ Other family or personal business
❑ Religious or civic
❑ Other activities not-at-home (Specify): ____________
❑ Work at home (job related)
❑ Work at regular jobsite
❑ Work activity at other place
❑ School at regular place
❑ School activity at other place
❑ Sleep
❑ Other activities at home

From Place #2 did you go to another place during your 24-hour day?

NO- This was your LAST place for the 24-hour day. Check here: ❑ **DONE**

YES- At what time did you leave Place #2 to go to Place #3? : am/pm

NEXT PLACE #3

Place # 3

WHAT is Place #3?

❑ My Home
❑ My Regular Workplace
❑ My School
❑ Other Place (address already provided)
❑ A New Place →

(Complete the information below if you have not already provided it)

At WHAT TIME did you ARRIVE at Place #3? : am/pm

HOW did you get from Place #2 to Place #3?

Show ALL the methods of travel you used to make this trip. 1st → 2nd → 3rd → 4th → 5th

If you used TRANSIT Bus, Rail, Subway, Ferry, Other

	Line #/ Service		Station Name (if Rail or Subway)
First board:	________	at:	________
1st transfer:	________	at:	________
2nd transfer:	________	at:	________
Last Station		at:	________

WHAT did you do at Place # 3? *(Check all that apply)*

❑ Drop-off/ pick-up someone
❑ Visit friends/ relatives
❑ Eat meals
❑ Social/recreational/entertainment
❑ Shop
❑ Doctor/dentist/other professional
❑ Other family or personal business
❑ Religious or civic
❑ Other activities not-at-home (Specify): ____________
❑ Work at home (job related)
❑ Work at regular jobsite
❑ Work activity at other place
❑ School at regular place
❑ School activity at other place
❑ Sleep
❑ Other activities at home

From Place #3 did you go to another place during your 24-hour day?

NO- This was your LAST place for the 24-hour day. Check here: ❑ **DONE**

YES- At what time did you leave Place #3 to go to Place #4? : am/pm

NEXT PLACE #4

Place # 4

WHAT is Place #4?

❑ My Home
❑ My Regular Workplace
❑ My School
❑ Other Place (address already provided)
❑ A New Place →

(Complete the information below if you have not already provided it)

At WHAT TIME did you ARRIVE at Place #4? : am/pm

HOW did you get from Place #3 to Place #4?

Show ALL the methods of travel you used to make this trip. 1st → 2nd → 3rd → 4th → 5th

If you used TRANSIT Bus, Rail, Subway, Ferry, Other

	Line #/ Service		Station Name (if Rail or Subway)
First board:	________	at:	________
1st transfer:	________	at:	________
2nd transfer:	________	at:	________
Last Station		at:	________

WHAT did you do at Place # 4? *(Check all that apply)*

❑ Drop-off/ pick-up someone
❑ Visit friends/ relatives
❑ Eat meals
❑ Social/recreational/entertainment
❑ Shop
❑ Doctor/dentist/other professional
❑ Other family or personal business
❑ Religious or civic
❑ Other activities not-at-home (Specify): ____________
❑ Work at home (job related)
❑ Work at regular jobsite
❑ Work activity at other place
❑ School at regular place
❑ School activity at other place
❑ Sleep
❑ Other activities at home

From Place #4 did you go to another place during your 24-hour day?

NO- This was your LAST place for the 24-hour day. Check here: ❑ **DONE**

YES- At what time did you leave Place #4 to go to Place #5? : am/pm

NEXT PLACE #5

Place # 5

WHAT is Place #5?

❑ My Home
❑ My Regular Workplace
❑ My School
❑ Other Place (address already provided)
❑ A New Place →

(Complete the information below if you have not already provided it)

At WHAT TIME did you ARRIVE at Place #5? : am/pm

HOW did you get from Place #4 to Place #5?

Show ALL the methods of travel you used to make this trip. 1st → 2nd → 3rd → 4th → 5th

If you used TRANSIT Bus, Rail, Subway, Ferry, Other

	Line #/ Service		Station Name (if Rail or Subway)
First board:	________	at:	________
1st transfer:	________	at:	________
2nd transfer:	________	at:	________
Last Station		at:	________

WHAT did you do at Place # 5? *(Check all that apply)*

❑ Drop-off/ pick-up someone
❑ Visit friends/ relatives
❑ Eat meals
❑ Social/recreational/entertainment
❑ Shop
❑ Doctor/dentist/other professional
❑ Other family or personal business
❑ Religious or civic
❑ Other activities not-at-home (Specify): ____________
❑ Work at home (job related)
❑ Work at regular jobsite
❑ Work activity at other place
❑ School at regular place
❑ School activity at other place
❑ Sleep
❑ Other activities at home

From Place #5 did you go to another place during your 24-hour day?

NO- This was your LAST place for the 24-hour day. Check here: ❑ **DONE**

YES- At what time did you leave Place #5 to go to Place #6? : am/pm

NEXT PLACE #6

Place # 6

WHAT is Place #6?

❑ My Home
❑ My Regular Workplace
❑ My School
❑ Other Place (address already provided)
❑ A New Place →

(Complete the information below if you have not already provided it)

At WHAT TIME did you ARRIVE at Place #6? : am/pm

HOW did you get from Place #5 to Place #6?

Show ALL the methods of travel you used to make this trip. 1st → 2nd → 3rd → 4th → 5th

If you used TRANSIT Bus, Rail, Subway, Ferry, Other

	Line #/ Service		Station Name (if Rail or Subway)
First board:	________	at:	________
1st transfer:	________	at:	________
2nd transfer:	________	at:	________
Last Station		at:	________

WHAT did you do at Place # 6? *(Check all that apply)*

❑ Drop-off/ pick-up someone
❑ Visit friends/ relatives
❑ Eat meals
❑ Social/recreational/entertainment
❑ Shop
❑ Doctor/dentist/other professional
❑ Other family or personal business
❑ Religious or civic
❑ Other activities not-at-home (Specify): ____________
❑ Work at home (job related)
❑ Work at regular jobsite
❑ Work activity at other place
❑ School at regular place
❑ School activity at other place
❑ Sleep
❑ Other activities at home

From Place #6 did you go to another place during your 24-hour day?

NO- This was your LAST place for the 24-hour day. Check here: ❑ **DONE**

YES- At what time did you leave Place #6 to go to Place #7? : am/pm

NEXT PLACE #7

Place # 7

WHAT is Place #7?

❑ My Home
❑ My Regular Workplace
❑ My School
❑ Other Place (address already provided)
❑ A New Place →

(Complete the information below if you have not already provided it)

At WHAT TIME did you ARRIVE at Place #7? : am/pm

HOW did you get from Place #6 to Place #7?

Show ALL the methods of travel you used to make this trip. 1st → 2nd → 3rd → 4th → 5th

If you used TRANSIT Bus, Rail, Subway, Ferry, Other

	Line #/ Service		Station Name (if Rail or Subway)
First board:	________	at:	________
1st transfer:	________	at:	________
2nd transfer:	________	at:	________
Last Station		at:	________

WHAT did you do at Place # 7? *(Check all that apply)*

❑ Drop-off/ pick-up someone
❑ Visit friends/ relatives
❑ Eat meals
❑ Social/recreational/entertainment
❑ Shop
❑ Doctor/dentist/other professional
❑ Other family or personal business
❑ Religious or civic
❑ Other activities not-at-home (Specify): ____________
❑ Work at home (job related)
❑ Work at regular jobsite
❑ Work activity at other place
❑ School at regular place
❑ School activity at other place
❑ Sleep
❑ Other activities at home

From Place #3 did you go to another place during your 24-hour day?

NO- This was your LAST place for the 24-hour day. Check here: ❑ **DONE**

YES- At what time did you leave Place #7 to go to Place #8? : am/pm

NEXT PLACE #8

Place # 8

WHAT is Place #8?

❑ My Home
❑ My Regular Workplace
❑ My School
❑ Other Place (address already provided)
❑ A New Place →

(Complete the information below if you have not already provided it)

At WHAT TIME did you ARRIVE at Place #8? : am/pm

HOW did you get from Place #7 to Place #8?

Show ALL the methods of travel you used to make this trip. 1st → 2nd → 3rd → 4th → 5th

If you used TRANSIT Bus, Rail, Subway, Ferry, Other

	Line #/ Service		Station Name (if Rail or Subway)
First board:	________	at:	________
1st transfer:	________	at:	________
2nd transfer:	________	at:	________
Last Station		at:	________

WHAT did you do at Place # 8? *(Check all that apply)*

❑ Drop-off/ pick-up someone
❑ Visit friends/ relatives
❑ Eat meals
❑ Social/recreational/entertainment
❑ Shop
❑ Doctor/dentist/other professional
❑ Other family or personal business
❑ Religious or civic
❑ Other activities not-at-home (Specify): ____________
❑ Work at home (job related)
❑ Work at regular jobsite
❑ Work activity at other place
❑ School at regular place
❑ School activity at other place
❑ Sleep
❑ Other activities at home

From Place #4 did you go to another place during your 24-hour day?

NO- This was your LAST place for the 24-hour day. Check here: ❑ **DONE**

YES- At what time did you leave Place #8 to go to Place #9? : am/pm

NEXT PLACE #9

Place #
9

WHAT is Place #9?

- ❑ My Home
- ❑ My Regular Workplace
- ❑ My School
- ❑ Other Place (address already provided)
- ❑ A New Place →

(Complete the information below if you have not already provided it)

At WHAT TIME did you ARRIVE at Place #9?

: am/pm

HOW did you get from Place #8 to Place #9?

Show ALL the methods of travel you used to make this trip.

1st → 2nd → 3rd → 4th → 5th

If you used TRANSIT Bus, Rail, Subway, Ferry, Other

	Line #/ Service		Station Name (if Rail or Subway)
First board:		at:	
1st transfer:		at:	
2nd transfer:		at:	
Last Station		at:	

WHAT did you do at Place # 9? *(Check all that apply)*

- ❑ Drop-off/ pick-up someone
- ❑ Visit friends/ relatives
- ❑ Eat meals
- ❑ Social/recreational/entertainment
- ❑ Shop
- ❑ Doctor/dentist/other professional
- ❑ Other family or personal business
- ❑ Religious or civic
- ❑ Other activities not-at-home (Specify):________
- ❑ Work at home (job related)
- ❑ Work at regular jobsite
- ❑ Work activity at other place
- ❑ School at regular place
- ❑ School activity at other place
- ❑ Sleep
- ❑ Other activities at home

From Place #5 did you go to another place during your 24-hour day?

NO- This was your LAST place for the 24-hour day. Check here: ❑ **DONE**

YES- At what time did you leave Place #9 to go to Place #10? : am/pm

NEXT PLACE #10

Place #
10

WHAT is Place #10?

- ❑ My Home
- ❑ My Regular Workplace
- ❑ My School
- ❑ Other Place (address already provided)
- ❑ A New Place →

(Complete the information below if you have not already provided it)

At WHAT TIME did you ARRIVE at Place #10?

: am/pm

HOW did you get from Place #9 to Place #10?

Show ALL the methods of travel you used to make this trip.

1st → 2nd → 3rd → 4th → 5th

If you used TRANSIT Bus, Rail, Subway, Ferry, Other

	Line #/ Service		Station Name (if Rail or Subway)
First board:		at:	
1st transfer:		at:	
2nd transfer:		at:	
Last Station		at:	

WHAT did you do at Place # 10? *(Check all that apply)*

- ❑ Drop-off/ pick-up someone
- ❑ Visit friends/ relatives
- ❑ Eat meals
- ❑ Social/recreational/entertainment
- ❑ Shop
- ❑ Doctor/dentist/other professional
- ❑ Other family or personal business
- ❑ Religious or civic
- ❑ Other activities not-at-home (Specify):________
- ❑ Work at home (job related)
- ❑ Work at regular jobsite
- ❑ Work activity at other place
- ❑ School at regular place
- ❑ School activity at other place
- ❑ Sleep
- ❑ Other activities at home

From Place #6 did you go to another place during your 24-hour day?

NO- This was your LAST place for the 24-hour day. Check here: ❑ **DONE**

YES- At what time did you leave Place #10 to go to Place #11? : am/pm

NEXT PLACE #11

Place #
11

WHAT is Place #11?

- ❑ My Home
- ❑ My Regular Workplace
- ❑ My School
- ❑ Other Place (address already provided)
- ❑ A New Place →

(Complete the information below if you have not already provided it)

At WHAT TIME did you ARRIVE at Place #11?

: am/pm

HOW did you get from Place #10 to Place #11?

Show ALL the methods of travel you used to make this trip.

1st → 2nd → 3rd → 4th → 5th

If you used TRANSIT Bus, Rail, Subway, Ferry, Other

	Line #/ Service		Station Name (if Rail or Subway)
First board:		at:	
1st transfer:		at:	
2nd transfer:		at:	
Last Station		at:	

WHAT did you do at Place # 11? *(Check all that apply)*

- ❑ Drop-off/ pick-up someone
- ❑ Visit friends/ relatives
- ❑ Eat meals
- ❑ Social/recreational/entertainment
- ❑ Shop
- ❑ Doctor/dentist/other professional
- ❑ Other family or personal business
- ❑ Religious or civic
- ❑ Other activities not-at-home (Specify):________
- ❑ Work at home (job related)
- ❑ Work at regular jobsite
- ❑ Work activity at other place
- ❑ School at regular place
- ❑ School activity at other place
- ❑ Sleep
- ❑ Other activities at home

From Place #3 did you go to another place during your 24-hour day?

NO- This was your LAST place for the 24-hour day. Check here: ❑ **DONE**

YES- At what time did you leave Place #11 to go to Place #12? : am/pm

NEXT PLACE #12

Place #
12

WHAT is Place #12?

- ❑ My Home
- ❑ My Regular Workplace
- ❑ My School
- ❑ Other Place (address already provided)
- ❑ A New Place →

(Complete the information below if you have not already provided it)

At WHAT TIME did you ARRIVE at Place #12?

: am/pm

HOW did you get from Place #11 to Place #12?

Show ALL the methods of travel you used to make this trip.

1st → 2nd → 3rd → 4th → 5th

If you used TRANSIT Bus, Rail, Subway, Ferry, Other

	Line #/ Service		Station Name (if Rail or Subway)
First board:		at:	
1st transfer:		at:	
2nd transfer:		at:	
Last Station		at:	

WHAT did you do at Place # 12? *(Check all that apply)*

- ❑ Drop-off/ pick-up someone
- ❑ Visit friends/ relatives
- ❑ Eat meals
- ❑ Social/recreational/entertainment
- ❑ Shop
- ❑ Doctor/dentist/other professional
- ❑ Other family or personal business
- ❑ Religious or civic
- ❑ Other activities not-at-home (Specify):________
- ❑ Work at home (job related)
- ❑ Work at regular jobsite
- ❑ Work activity at other place
- ❑ School at regular place
- ❑ School activity at other place
- ❑ Sleep
- ❑ Other activities at home

From Place #4 did you go to another place during your 24-hour day?

NO- This was your LAST place for the 24-hour day. Check here: ❑ **DONE**

YES- At what time did you leave Place #12 to go to Place #13? : am/pm

NEXT PLACE #13

GPS Logger Instructions

INSTRUCTIONS FOR OPERATING THE GPS LOGGER

1. On the survey day, after you walk outside of your residence and can see the sky, follow the instructions below to turn on the GPS logger:

Switch the Mode Switch on the side from "OFF" to "LOG".

(OFF mode) (NAV mode, incorrect) (LOG mode, correct)

Stand still for a few minutes until the orange light on the GPS logger starts blinking, which indicates that it is receiving signals from satellites.

If the orange light does not blink even after 5 minutes, move to a more open space nearby and stand still to wait for the orange light to start blinking.

2. When the orange light on the GPS logger is blinking, you can start your first trip of the day.

You could leave the GPS in your bag or pocket. The orange light on the GPS logger should be blinking most of the day, except in tunnels or underground subways when satellite signals are not available.

3. When you arrive home at the end of the day and do not plan to go out again, turn off the GPS logger by switching the Mode Switch on the GPS logger's side from "LOG" to "OFF".

4. If you turn on the GPS logger to see how it works before the survey day, do not leave it on for more than an hour to conserve the battery and memory for the survey day.

5. If you have any questions about the GPS logger on the survey day, please call Jorge Argote at 212-383-2527.

Follow-up Questionnaire

Default Section

0. What is your survey ID?

00. Did you complete an online or a paper survey?

- Online survey
- paper survey

1. Were the instructions to operate the GPS unit easy to understand?

- Yes
- No

Question 2

2. Were the instructions for the survey questionnaire easy to understand?

- Yes
- No

question 1 post

1a. What problems did you have?

Question 3

3. Were you able to carry the GPS unit to every place you went, whenever you left home, and on whatever mode you used to travel?

- Yes
- No

Question 4

4. Were you confident that the GPS unit was operating properly when you started your first trip?

- Yes
- No

Question 5

5. Were you able to easily complete the survey questionnaire?

- Yes
- No

question 2 post

2a. What problems did you have?

Question 3 post

3a. What problems did you have?

Question 4 post

4a. What problems did you have?

Question 5 post

5a. What problems did you have?

Question 6, 7, and 8

6. Please describe your experience with the use of the GPS unit, both positive and negative.

7. Please describe your experience with the survey questionnaire, both positive and negative.

8. Please comment on your overall survey experience.

Web-based Diary

1. Socio-demographics and Place #1

Each person needs to complete a 24 hour travel diary of the places visited (what and where they are) and trips made to reach those places (when and how you made those trips). We will ask about the main activity you did in each place.

This diary will have two parts. In the first part, we will ask you information about yourself and your household. In the second part, we will ask you about each place you visited on your survey day. Associated with each place, we will ask you the travel mode you used, the purpose of the trip, the time you departed, the time you arrived, the location and the type of place. Your survey day was assigned to you during our briefing last week.

Your first location will be the place you were at 3 A.M. on the survey day. For example, say your trip pattern on the survey day is described as follows:

a. walk to local deli from home to get a cup of coffee
b. walk back home and watch news for a couple of minutes
c. go to work at NYMTC by driving to metro-north station first, taking metro-north, taking the subway, and walking to the office
d. you purchased a donut and a newspaper from two different street vendors on your way to work
e. go back home from NYMTC by walking to the subway, taking the subway, transferring to metro-north, and driving home

In the above described trip sequence, you should enter five locations in sequence:
a. home
b. other (local coffee shop)
c. home
d. work (nymtc)
e. home

To protect your private information such as name and address, we assign each participant a survey ID. This survey ID was given to you during our briefing conducted last week.

Thank you for participating in this survey.

1. What is your survey ID?

2. Are you:

- Male
- Female

3. Are you:

- 25 years or younger
- between 26 and 35 years old
- between 36 and 45 years old
- between 46 and 55 years old
- between 56 and 65 years old
- above 65 years old

4. What was your highest educational attainment level?

- Non-high school graduate
- High school
- College
- Graduate school

5. Including yourself, how many people are living in your household?

	1	2	3	4	5	6	7	8	9	10 or more
Number of people										

6. Among them, how many (including yourself) are:

	Number of People
0-5 years old	
6-12 years old	
13-18 years old	
19-30 years old	
31-54 years old	
55-64 years old	
65 or older	

7. How many vehicles are there in your household?

- 0 vehicle
- 1 vehicle
- 2 vehicles
- 3 vehicles
- >3 vehicles

8. Do you have a land lined phone in the household?

- Yes
- No

9. Enter the address of your home location.

Address:
Address 2:
City/Town:
State:
ZIP:

10. Enter the address of your work location

Address:
Address 2:
City/Town:
State:
ZIP:

11. Where were you at 3 A.M. on the survey day?

- Home, go to Q.13 directly
- Work, go to Q.13 directly
- Other location

12. If other, please enter the address of this other place

Address:
Address 2:
City/Town:
State:
ZIP:

13. Did you go to another place on the survey day?

- Yes
- No

2. Place #2

14. What time did you leave for this place?

	AM/PM	Hour	Minutes
Time			

15. What was the primary purpose of your trip?

- Drop off/pick up someone
- Visit friends/relatives
- Eat meals
- Social/recreation/entertainment
- Shop
- Doctor/dentist/other professional
- Other family or personal business
- Religious
- Work at home (job related)
- Work at regular jobsite
- Work at other place
- School at regular site
- School at other place
- Sleep
- Other activities at home
- Other activities not at home

16. What was your primary mode of transportation? (a primary mode of transportation is a mode you spent the most time during your entire trip)

- ◯ Walk
- ◯ Auto as driver
- ◯ Auto as passenger
- ◯ Group ride (carpool)
- ◯ School bus
- ◯ Local bus
- ◯ Express bus
- ◯ NYC subway
- ◯ Path
- ◯ Newark subway
- ◯ Commuter rail (LIRR, Metro North, New Jersey Transit)
- ◯ For hire van/jitney
- ◯ Shuttle bus/van
- ◯ Ferry or Water taxi
- ◯ Taxi
- ◯ Car service
- ◯ Charter bus/private bus operator
- ◯ Bike
- ◯ In-line skates/roller skates
- ◯ Intercity travel (Amtrak, Airline, Greyhound)
- ◯ Other

17. What time did you arrive at this place?

	AM/PM	Hour	Minutes
Time			

18. Which place did you arrive at?

- ◯ Home, go to Q.20 directly
- ◯ Work, go to Q.20 directly
- ◯ Other

19. If other, please enter the address of this other place

Address:

Address 2:

City/Town:

State:

ZIP:

20. Did you go to another place on the survey day?

- ◯ Yes
- ◯ No

3. Place #3

21. What time did you leave for this place?

	AM/PM	Hour	Minutes
Time			

22. What was the primary purpose of your trip?

- ◯ Drop off/pick up someone
- ◯ Visit friends/relatives
- ◯ Eat meals
- ◯ Social/recreation/entertainment
- ◯ Shop
- ◯ Doctor/dentist/other professional
- ◯ Other family or personal business
- ◯ Religious
- ◯ Work at home (job related)
- ◯ Work at regular jobsite
- ◯ Work at other place
- ◯ School at regular site
- ◯ School at other place
- ◯ Sleep
- ◯ Other activities at home
- ◯ Other activities not at home

23. What was your primary mode of transportation? (a primary mode of transportation is a mode you spent the most time during your entire trip)

- ◯ Walk
- ◯ Auto as driver
- ◯ Auto as passenger
- ◯ Group ride (carpool)
- ◯ School bus
- ◯ Local bus
- ◯ Express bus
- ◯ NYC subway
- ◯ Path
- ◯ Newark subway
- ◯ Commuter rail (LIRR, metro north, NJT)
- ◯ For hire van/jitney
- ◯ Shuttle bus/van
- ◯ Ferry or water taxi
- ◯ Taxi
- ◯ Car service
- ◯ Charter bus/private bus operator
- ◯ Bike
- ◯ In-line skates/roller skates
- ◯ Intercity travel (Amtrak, Airline, Greyhound)
- ◯ Other

24. What time did you arrive at this place?

	AM/PM	Hour	Minutes
Time			

25. Which place did you arrive at?

- ◯ Home, go to Q.27 directly
- ◯ Work, go to Q.27 directly
- ◯ Other

26. If other, please enter the address of this other place

Address:
Address 2:
City/Town:
State:
ZIP:

27. Did you go to another place on the survey day?

- Yes
- No

4. Place #4

28. What time did you leave for this place?

	AM/PM	Hour	Minutes
Time			

29. What was the primary purpose of your trip?

- Drop off/pick up someone
- Visit friends/relatives
- Eat meals
- Social/recreation/entertainment
- Shop
- Doctor/dentist/other professional
- Other family or personal business
- Religious
- Work at home (job related)
- Work at regular jobsite
- Work at other place
- School at regular site
- School at other place
- Sleep
- Other activities at home
- Other activities not at home

30. What was your primary mode of transportation? (a primary mode of transportation is a mode you spent the most time during your entire trip)

- Walk
- Auto as driver
- Auto as passenger
- Group ride (carpool)
- School bus
- Local bus
- Express bus
- NYC subway
- Path
- Newark subway
- Commuter rail (LIRR, metro north, NJT)
- For hire van/jitney
- Shuttle bus/van
- Ferry or water taxi
- Taxi
- Car service
- Charter bus/private bus operator
- Bike
- In-line skates/roller skates
- Intercity travel (Amtrak, Airline, Greyhound)
- Other

31. What time did you arrive at this place?

	AM/PM	Hour	Minutes
Time			

32. Which place did you arrive at?

- Home, go to Q.34 directly
- Work, go to Q.34 directly
- Other

33. If other, please enter the address of this other place

Address:
Address 2:
City/Town:
State:
ZIP:

34. Did you go to another place on the survey day?

- Yes
- No

5. Place #5

35. What time did you leave for this place?

	AM/PM	Hour	Minutes
Time			

36. What was the primary purpose of your trip?

- Drop off/pick up someone
- Visit friends/relatives
- Eat meals
- Social/recreation/entertainment
- Shop
- Doctor/dentist/other professional
- Other family or personal business
- Religious
- Work at home (job related)
- Work at regular jobsite
- Work at other place
- School at regular site
- School at other place
- Sleep
- Other activities at home
- Other activities not at home

37. What was your primary mode of transportation? (a primary mode of transportation is a mode you spent the most time during your entire trip)

- Walk
- Auto as driver
- Auto as passenger
- Group ride (carpool)
- School bus
- Local bus
- Express bus
- NYC subway
- Path
- Newark subway
- Commuter rail (LIRR, metro north, NJT)
- For hire van/jitney
- Shuttle bus/van
- Ferry or water taxi
- Taxi
- Car service
- Charter bus/private bus operator
- Bike
- In-line skates/roller skates
- Intercity travel (Amtrak, Airline, Greyhound)
- Other

38. What time did you arrive at this place?

	AM/PM	Hour	Minutes
Time			

39. Which place did you arrive at?

- Home, go to Q.41 directly
- Work, go to Q.41 directly
- Other

40. If other, please enter the address of this other place

Address:
Address 2:
City/Town:
State:
ZIP:

41. Did you go to another place on the survey day?

- Yes
- No

6. Place #6

42. What time did you leave for this place?

	AM/PM	Hour	Minutes
Time			

43. What was the primary purpose of your trip?

- Drop off/pick up someone
- Visit friends/relatives
- Eat meals
- Social/recreation/entertainment
- Shop
- Doctor/dentist/other professional
- Other family or personal business
- Religious
- Work at home (job related)
- Work at regular jobsite
- Work at other place
- School at regular site
- School at other place
- Sleep
- Other activities at home
- Other activities not at home

44. What was your primary mode of transportation? (a primary mode of transportation is a mode you spent the most time during your entire trip)

- ◯ Walk
- ◯ Auto as driver
- ◯ Auto as passenger
- ◯ Group ride (carpool)
- ◯ School bus
- ◯ Local bus
- ◯ Express bus
- ◯ NYC subway
- ◯ Path
- ◯ Newark subway
- ◯ Commuter rail (LIRR, metro north, NJT)
- ◯ For hire van/jitney
- ◯ Shuttle bus/van
- ◯ Ferry or water taxi
- ◯ Taxi
- ◯ Car service
- ◯ Charter bus/private bus operator
- ◯ Bike
- ◯ In-line skates/roller skates
- ◯ Intercity travel (Amtrak, Airline, Greyhound)
- ◯ Other

45. What time did you arrive at this place?

	AM/PM	Hour	Minutes
Time			

46. Which place did you arrive at?

- ◯ Home, go to Q.48 directly
- ◯ Work, go to Q.48 directly
- ◯ Other

47. If other, please enter the address of this other place

Address:

Address 2:

City/Town:

State:

ZIP:

48. Did you go to another place on the survey day?

- ◯ Yes
- ◯ No

7. Place #7

49. What time did you leave for this place?

	AM/PM	Hour	Minutes
Time			

50. What was the primary purpose of your trip?

- ◯ Drop off/pick up someone
- ◯ Visit friends/relatives
- ◯ Eat meals
- ◯ Social/recreation/entertainment
- ◯ Shop
- ◯ Doctor/dentist/other professional
- ◯ Other family or personal business
- ◯ Religious
- ◯ Work at home (job related)
- ◯ Work at regular jobsite
- ◯ Work at other place
- ◯ School at regular site
- ◯ School at other place
- ◯ Sleep
- ◯ Other activities at home
- ◯ Other activities not at home

51. What was your primary mode of transportation? (a primary mode of transportation is a mode you spent the most time during your entire trip)

- ◯ Walk
- ◯ Auto as driver
- ◯ Auto as passenger
- ◯ Group ride (carpool)
- ◯ School bus
- ◯ Local bus
- ◯ Express bus
- ◯ NYC subway
- ◯ Path
- ◯ Newark subway
- ◯ Commuter rail (LIRR, metro north, NJT)
- ◯ For hire van/jitney
- ◯ Shuttle bus/van
- ◯ Ferry or water taxi
- ◯ Taxi
- ◯ Car service
- ◯ Charter bus/private bus operator
- ◯ Bike
- ◯ In-line skates/roller skates
- ◯ Intercity travel (Amtrak, Airline, Greyhound)
- ◯ Other

52. What time did you arrive at this place?

	AM/PM	Hour	Minutes
Time			

53. Which place did you arrive at?

- ◯ Home, go to Q.55 directly
- ◯ Work, go to Q.55 directly
- ◯ Other

54. If other, please enter the address of this other place

Address:
Address 2:
City/Town:
State:
ZIP:

55. Did you go to another place on the survey day?

- Yes
- No

8. Place #8

56. What time did you leave for this place?

	AM/PM	Hour	Minutes
Time			

57. What was the primary purpose of your trip?

- Drop off/pick up someone
- Visit friends/relatives
- Eat meals
- Social/recreation/entertainment
- Shop
- Doctor/dentist/other professional
- Other family or personal business
- Religious
- Work at home (job related)
- Work at regular jobsite
- Work at other place
- School at regular site
- School at other place
- Sleep
- Other activities at home
- Other activities not at home

58. What was your primary mode of transportation? (a primary mode of transportation is a mode you spent the most time during your entire trip)

- Walk
- Auto as driver
- Auto as passenger
- Group ride (carpool)
- School bus
- Local bus
- Express bus
- NYC subway
- Path
- Newark subway
- Commuter rail (LIRR, metro north, NJT)
- For hire van/jitney
- Shuttle bus/van
- Ferry or water taxi
- Taxi
- Car service
- Charter bus/private bus operator
- Bike
- In-line skates/roller skates
- Intercity travel (Amtrak, Airline, Greyhound)
- Other

59. What time did you arrive at this place?

	AM/PM	Hour	Minutes
Time			

60. Which place did you arrive at?

- Home, go to Q.62 directly
- Work, go to Q.62 directly
- Other

61. If other, please enter the address of this other place

Address:
Address 2:
City/Town:
State:
ZIP:

62. Did you go to another place on the survey day?

- Yes
- No

9. Place #9

63. What time did you leave for this place?

	AM/PM	Hour	Minutes
Time			

64. What was the primary purpose of your trip?

- Drop off/pick up someone
- Visit friends/relatives
- Eat meals
- Social/recreation/entertainment
- Shop
- Doctor/dentist/other professional
- Other family or personal business
- Religious
- Work at home (job related)
- Work at regular jobsite
- Work at other place
- School at regular site
- School at other place
- Sleep
- Other activities at home
- Other activities not at home

65. What was your primary mode of transportation? (a primary mode of transportation is a mode you spent the most time during your entire trip)

- Walk
- Auto as driver
- Auto as passenger
- Group ride (carpool)
- School bus
- Local bus
- Express bus
- NYC subway
- Path
- Newark subway
- Commuter rail (LIRR, metro north, NJT)
- For hire van/jitney
- Shuttle bus/van
- Ferry or water taxi
- Taxi
- Car service
- Charter bus/private bus operator
- Bike
- In-line skates/roller skates
- Intercity travel (Amtrak, Airline, Greyhound)
- Other

66. What time did you arrive at this place?

	AM/PM	Hour	Minutes
Time			

67. Which place did you arrive at?

- Home, go to Q.69 directly
- Work, go to Q.69 directly
- Other

68. If other, please enter the address of this other place

Address:
Address 2:
City/Town:
State:
ZIP:

69. Did you go to another place on the survey day?

- Yes
- No

10. Place #10

70. What time did you leave for this place?

	AM/PM	Hour	Minutes
Time			

71. What was the primary purpose of your trip?

- Drop off/pick up someone
- Visit friends/relatives
- Eat meals
- Social/recreation/entertainment
- Shop
- Doctor/dentist/other professional
- Other family or personal business
- Religious
- Work at home (job related)
- Work at regular jobsite
- Work at other place
- School at regular site
- School at other place
- Sleep
- Other activities at home
- Other activities not at home

72. What was your primary mode of transportation? (a primary mode of transportation is a mode you spent the most time during your entire trip)

- ◯ Walk
- ◯ Auto as driver
- ◯ Auto as passenger
- ◯ Group ride (carpool)
- ◯ School bus
- ◯ Local bus
- ◯ Express bus
- ◯ NYC subway
- ◯ Path
- ◯ Newark subway
- ◯ Commuter rail (LIRR, metro north, NJT)
- ◯ For hire van/jitney
- ◯ Shuttle bus/van
- ◯ Ferry or water taxi
- ◯ Taxi
- ◯ Car service
- ◯ Charter bus/private bus operator
- ◯ Bike
- ◯ In-line skates/roller skates
- ◯ Intercity travel (Amtrak, Airline, Greyhound)
- ◯ Other

73. What time did you arrive at this place?

	AM/PM	Hour	Minutes
Time			

74. Which place did you arrive at?

- ◯ Home, go to Q.76 directly
- ◯ Work, go to Q.76 directly
- ◯ Other

75. If other, please enter the address of this other place

Address:

Address 2:

City/Town:

State:

ZIP:

76. Did you go to another place on the survey day?

- ◯ Yes
- ◯ No

11. Place #11

77. What time did you leave for this place?

	AM/PM	Hour	Minutes
Time			

78. What was the primary purpose of your trip?

- ◯ Drop off/pick up someone
- ◯ Visit friends/relatives
- ◯ Eat meals
- ◯ Social/recreation/entertainment
- ◯ Shop
- ◯ Doctor/dentist/other professional
- ◯ Other family or personal business
- ◯ Religious
- ◯ Work at home (job related)
- ◯ Work at regular jobsite
- ◯ Work at other place
- ◯ School at regular site
- ◯ School at other place
- ◯ Sleep
- ◯ Other activities at home
- ◯ Other activities not at home

79. What was your primary mode of transportation? (a primary mode of transportation is a mode you spent the most time during your entire trip)

- ◯ Walk
- ◯ Auto as driver
- ◯ Auto as passenger
- ◯ Group ride (carpool)
- ◯ School bus
- ◯ Local bus
- ◯ Express bus
- ◯ NYC subway
- ◯ Path
- ◯ Newark subway
- ◯ Commuter rail (LIRR, metro north, NJT)
- ◯ For hire van/jitney
- ◯ Shuttle bus/van
- ◯ Ferry or water taxi
- ◯ Taxi
- ◯ Car service
- ◯ Charter bus/private bus operator
- ◯ Bike
- ◯ In-line skates/roller skates
- ◯ Intercity travel (Amtrak, Airline, Greyhound)
- ◯ Other

80. What time did you arrive at this place?

	AM/PM	Hour	Minutes
Time			

81. Which place did you arrive at?

- ◯ Home, go to Q.83 directly
- ◯ Work, go to Q.83 directly
- ◯ Other

82. If other, please enter the address of this other place

Address:

Address 2:

City/Town:

State:

ZIP:

83. Did you go to another place on the survey day?

- Yes
- No

12. Place #12

84. What time did you leave for this place?

	AM/PM	Hour	Minutes
Time			

85. What was the primary purpose of your trip?

- Drop off/pick up someone
- Visit friends/relatives
- Eat meals
- Social/recreation/entertainment
- Shop
- Doctor/dentist/other professional
- Other family or personal business
- Religious
- Work at home (job related)
- Work at regular jobsite
- Work at other place
- School at regular site
- School at other place
- Sleep
- Other activities at home
- Other activities not at home

86. What was your primary mode of transportation? (a primary mode of transportation is a mode you spent the most time during your entire trip)

- Walk
- Auto as driver
- Auto as passenger
- Group ride (carpool)
- School bus
- Local bus
- Express bus
- NYC subway
- Path
- Newark subway
- Commuter rail (LIRR, metro north, NJT)
- For hire van/jitney
- Shuttle bus/van
- Ferry or water taxi
- Taxi
- Car service
- Charter bus/private bus operator
- Bike
- In-line skates/roller skates
- Intercity travel (Amtrak, Airline, Greyhound)
- Other

87. What time did you arrive at this place?

	AM/PM	Hour	Minutes
Time			

88. Which place did you arrive at?

- Home, go to Q.90 directly
- Work, go to Q.90 directly
- Other

89. If other, please enter the address of this other place

Address:

Address 2:

City/Town:

State:

ZIP:

90. Did you go to another place on the survey day?

- Yes
- No

13. Place #13

91. What time did you leave for this place?

	AM/PM	Hour	Minutes
Time			

92. What was the primary purpose of your trip?

- Drop off/pick up someone
- Visit friends/relatives
- Eat meals
- Social/recreation/entertainment
- Shop
- Doctor/dentist/other professional
- Other family or personal business
- Religious
- Work at home (job related)
- Work at regular jobsite
- Work at other place
- School at regular site
- School at other place
- Sleep
- Other activities at home
- Other activities not at home

93. What was your primary mode of transportation? (a primary mode of transportation is a mode you spent the most time during your entire trip)

- Walk
- Auto as driver
- Auto as passenger
- Group ride (carpool)
- School bus
- Local bus
- Express bus
- NYC subway
- Path
- Newark subway
- Commuter rail (LIRR, metro north, NJT)
- For hire van/jitney
- Shuttle bus/van
- Ferry or water taxi
- Taxi
- Car service
- Charter bus/private bus operator
- Bike
- In-line skates/roller skates
- Intercity travel (Amtrak, Airline, Greyhound)
- Other

94. What time did you arrive at this place?

	AM/PM	Hour	Minutes
Time			

95. Which place did you arrive at?

- Home, go to Q.97 directly
- Work, go to Q.97 directly
- Other

96. If other, please enter the address of this other place

Address:
Address 2:
City/Town:
State:
ZIP:

97. Did you go to another place on the survey day?

- Yes
- No

14. Place #14

98. What time did you leave for this place?

	AM/PM	Hour	Minutes
Time			

99. What was the primary purpose of your trip?

- Drop off/pick up someone
- Visit friends/relatives
- Eat meals
- Social/recreation/entertainment
- Shop
- Doctor/dentist/other professional
- Other family or personal business
- Religious
- Work at home (job related)
- Work at regular jobsite
- Work at other place
- School at regular site
- School at other place
- Sleep
- Other activities at home
- Other activities not at home

100. What was your primary mode of transportation? (a primary mode of transportation is a mode you spent the most time during your entire trip)

- ◯ Walk
- ◯ Auto as driver
- ◯ Auto as passenger
- ◯ Group ride (carpool)
- ◯ School bus
- ◯ Local bus
- ◯ Express bus
- ◯ NYC subway
- ◯ Path
- ◯ Newark subway
- ◯ Commuter rail (LIRR, metro north, NJT)
- ◯ For hire van/jitney
- ◯ Shuttle bus/van
- ◯ Ferry or water taxi
- ◯ Taxi
- ◯ Car service
- ◯ Charter bus/private bus operator
- ◯ Bike
- ◯ In-line skates/roller skates
- ◯ Intercity travel (Amtrak, Airline, Greyhound)
- ◯ Other

101. What time did you arrive at this place?

	AM/PM	Hour	Minutes
Time			

102. Which place did you arrive at?

- ◯ Home, go to Q.104 directly
- ◯ Work, go to Q.104 directly
- ◯ Other

103. If other, please enter the address of this other place

Address:	
Address 2:	
City/Town:	
State:	
ZIP:	

104. Did you go to another place on the survey day?

- ◯ Yes
- ◯ No

15. Place #15

105. What time did you leave for this place?

	AM/PM	Hour	Minutes
Time			

106. What was the primary purpose of your trip?

- ◯ Drop off/pick up someone
- ◯ Visit friends/relatives
- ◯ Eat meals
- ◯ Social/recreation/entertainment
- ◯ Shop
- ◯ Doctor/dentist/other professional
- ◯ Other family or personal business
- ◯ Religious
- ◯ Work at home (job related)
- ◯ Work at regular jobsite
- ◯ Work at other place
- ◯ School at regular site
- ◯ School at other place
- ◯ Sleep
- ◯ Other activities at home
- ◯ Other activities not at home

107. What was your primary mode of transportation? (a primary mode of transportation is a mode you spent the most time during your entire trip)

- ◯ Walk
- ◯ Auto as driver
- ◯ Auto as passenger
- ◯ Group ride (carpool)
- ◯ School bus
- ◯ Local bus
- ◯ Express bus
- ◯ NYC subway
- ◯ Path
- ◯ Newark subway
- ◯ Commuter rail (LIRR, metro north, NJT)
- ◯ For hire van/jitney
- ◯ Shuttle bus/van
- ◯ Ferry or water taxi
- ◯ Taxi
- ◯ Car service
- ◯ Charter bus/private bus operator
- ◯ Bike
- ◯ In-line skates/roller skates
- ◯ Intercity travel (Amtrak, Airline, Greyhound)
- ◯ Other

108. What time did you arrive at this place?

	AM/PM	Hour	Minutes
Time			

109. Which place did you arrive at?

- ◯ Home, go to Q.111 directly
- ◯ Work, go to Q.111 directly
- ◯ Other

110. If other, please enter the address of this other place

Address:

Address 2:

City/Town:

State:

ZIP:

111. Did you go to another place on the survey day?

- Yes
- No

16. The End

Thank you for participating our survey!

Appendix C: The GPS Pilot Study Experience

The following comments were collected using the Survey Monkey Questionnaire offered to all the participants in the GPS Pilot Study.

THE GPS EQUIPMENT EXPERIENCE

Ease of use

- *"Easy to start."*
- *"I have no problem at all using the GPS unit. It operates right with the instructions"*
- *"The unit is fine, does not cause any inconvenience"*
- *"The unit was compact and easy to carry."*
- *"The problem with the GPS in the morning was minor; it worked without problems all day. I'm happy that I participated with my information."*
- *"It was simple to use. If the GPS has a clock built into it would be easier to record times."*
- *"Small and convenient device to carry – even in pocket on clothing."*
- *"It would take the unit a minute or two to start blinking again after exiting the subway and I think it might have gone off at one point when it was under my desk. At one point, as I was walking to the subway and doubled back and forth a few times, I didn't record each little stop. I know this is no excuse, but it felt like a bit much. Overall, I didn't find the experience to be too onerous, however and I enjoyed it."*
- *"It was fun – a little trouble getting started but otherwise good. I believe the device turned itself on in my bag – I don't know if it also turned itself off. A locking mechanism would be good."*
- *"I had no problems at all using the GPS, it acquired a satellite very quickly."*
- *"Experience was not necessarily positive or negative; rather, it was non-intrusive and easy to manage"*
- *"No negative experience"*
- *"It was very easy to use"*
- *"It was easy to carry in my purse, but I change purses throughout the day. It was a routine day, so I remembered to transfer the GPS to each purse. On a hectic day, I may not have remembered."*
- *"Would help to have a belt hook or something"*
- *"There was no special skill needed or once turned on was sufficient and it was working fine"*
- *"It wasn't what I had expected; I expected it to be a regular GPS unit. Not that that's a negative thing, it was just different"*

Burden of use

- *"Did not start GPS at home"*
- *"I forgot for several days to actually start the survey"*
- *"I forgot it in my purse when I got home and changed purses. I wrote my trips down in the diary but they will not be represented in the GPS."*
- *"I placed the unit in my pocket and when I checked it the button on the side had pushed into the off position"*
- *"When I left the house it was not working, so I turned off and on again and it worked properly."*
- *"Couldn't get a signal on the street so I had to go back upstairs to my apartment."*
- *"Turned off once in my purse one time, I was afraid that would continue happening, but it did not happen again."*

THE TRADITIONAL EXPERIENCE: PAPER SURVEYS

Ease of use

- *"I thought the survey was interesting. I had to complete it on paper and return it with my GPS however. I couldn't find our survey on the website."*
- *"Simple"*
- *"It was fine"*
- *"Positive"*
- *"I believe it is a good survey, the purpose is good. I see mostly positive side of it. I do not see a negative point on it".*
- *"Fairly straightforward to understand and complete"*
- *"Easy for me to fill out. However, I did have to estimate some times. If there was some sort of mini notebook I could write down notes about my trip that would have helped a lot."*

Burden of use

- *"Too many questions"*
- *"Would forget to notice time of arrivals"*
- *"I got confused because I thought it was one main trip from home to work, but I had to have in consideration the trips in between"*
- *"It's hard to remember what I did the day before, especially WHEN for every trip"*
- *"Needs more instruction. Once used it was easy and straightforward, but starting was a bit confusing"*
- *"Questionnaire printing was very light and some sections were a little hard to read. Other than that easy to fill out."*
- *"Had to remember to write down the times when you arrive at different places"*
- *"Seemed oddly formatted and has no dates"*
- *"As stated, needed something small to record arrival times"*
- *"I made bus and train rides destinations. To avoid this, an example could be given indicating that transportation is not a destination."*

THE WEB-BASED SURVEY EXPERIENCE

Ease of use

- *"Easy to complete, questions were concise enough to provide answers. Not a lot of time was needed to complete questionnaire. However, it must be stressed that individuals completing the on-line questionnaire one must keep a diary/log of trips so that he/she can accurately complete questionnaire"*
- *"It was easy to answer all the questions"*
- *"The online questionnaire was simple and convenient. It saved the information that I filled out half way through the day which made it easy to complete the survey accurately the next day (actually Monday morning)"*
- *"Found easy to fill"*
- *"It was kind of long, but at the end it was OK to fill it out"*

Burden of use

- *"I thought there could have been more options to answer or explanation [sp] about the categories (for example use shop when you buy lunch but bring back to work) – a few more choices or better explanations. Not terrible but could be better."*
- *"Again, some questions about definitions and need for explanation on answer options."*
- *"Not problems so much as easily completing information for each step in my day's journey could have been easier; in other words, I would retool the manner in which participants sequence their steps during the day so that the next question is "Where did you go next?"*

- *"It should say that you should keep track of certain things during the course of your travel day (especially departure and arrival times), because otherwise they are hard to remember very accurately when the survey is filled out. That wasn't clear in the instructions."*
- *"I wasn't sure if my first trip of the day should be from home to the store where I stop for coffee on the way to work or from home to work, I chose the former, I made my second trip from the store to work. I think there should be an example in the instructions."*
- *"I could not record all my trips which were part of my journey to work"*
- *"I would forget to write down the times I came and went. I'm not use to do this, so I would forget"*
- *"I lost the link; if I get another link, I will complete the survey"*
- *"Just that some of the response needed to be clarified. I also think it would be helpful to include a paper sheet – or upfront instructions to write everything down explicitly before starting"*
- *"The survey was easy to use, but some of the choices were too limited, if I made stops along the way of a main trip I was not sure how to record them and the purposes for the trips were very rigid and maybe not related to my trips"*
- *"Survey questionnaire, as mentioned earlier, could be better set up in terms of easily leading the participant to follow each step – i. e.,"where did you go next?" – and ending with "does this complete your journey for your commute – yes/no" – this way, if a participant forgot a side trip (say, picking up a pack of gum at a kiosk on the way to the subway), there is an opportunity to record it without having to redo the entire survey"*
- *"It was very easy to do – the instructions should just say to keep a note of a few trip details during the survey day to help remember for the questionnaire later"*
- *"It was easy to complete, but as I mentioned previously, I was unsure about my first trip"*
- *"The questionnaire did not give me a chance to record all my trips which were part of my journey to work and all different modes that I used to get to my destination*"

OVERALL COMMENTS

- *"Recording all the information throughout the day was challenging, there often wasn't time moving from one part of the day to the next to sit down with the questionnaire"*
- *"Good. I'd like to see the output data from the GPS device, like spatial information, also the analysis report indicating how the data are processed, what analysis is conducted, and what are the conclusions, etc."*
- *"I would participate again"*
- *"Generally as hassle free experience – biggest challenge was remembering to keep the daily diary/log"*
- *"It was fine, got a little hung up on some of the responses, not sure which category they fit under. Also, would have written everything down more completely had I known what was being asked for"*
- *"Generally good experience – does take a bit of time to complete the questionnaire"*
- *"I was happy to be a part of it. It did not inconvenience me. I hardly thought about the GPS device, until I changed bags"*
- *"I tried to be as honest as possible because I assume you want to know how people will actually use the GPS unit. In addition to asking whether or not equipment works, maybe you should also ask questions about how easy it was to use, incorporate into one's routine, etc."*