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Atlanta Commute Vehicle Soak and Start Distributions and Engine Starts per Day

Impact on Mobile Source Emission Rates

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Atlanta Commute Vehicle Soak and Start Distributions and Engine Starts per Day: Impact on Mobile Source Emission Rates

by

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ABSTRACT

The Georgia Institute of Technology (Georgia Tech) School of Civil and Environmental Engineering research team analyzed the 2004 second-by-second vehicle activity data obtained from vehicles in the Atlanta Commuter Choice Value Pricing Initiative, otherwise known as Commute Atlanta. The onboard monitoring equipment installed in each participating Commute Atlanta vehicle records each second of vehicle activity. Hence, each engine event (engine on, engine off) is time-stamped to provide the start and end times of each vehicle trip. The times of each trip end can be used to directly quantify the number of engine starts per day, the start times for each trip, and the durations of soak times between trips. (The soak time affects exhaust start and exhaust running emissions. A vehicle is considered to be soaking if its engine is not running. Soak time is the length of time between the engine turn off time and engine start time. Cold soak time in MOBILE6 determines the percentage of vehicles that have been soaking for a given amount of time prior to an engine start, for each hour of the day. The hot soak time distributions represent the proportion of vehicles experiencing a hot soak of a given duration at each hour of the day.) For the purposes of the analyses presented in this report, the research team followed the same criteria U.S. Environmental Protection Agency (EPA) used to develop soak and start time distributions and engine starts per day in the MOBILE6.2 emission rate model (U.S. EPA, 2001; U.S. EPA, 2003).

The objective of research efforts reported herein is to develop gasoline vehicle soak and start time distributions and engine starts per day for EPA light-duty vehicle (LDV) and light-duty truck (LDT combining LDT1, LDT2, LDT3, and LDT4) classes using vehicle trip data collected in the 13-county Atlanta metropolitan area during the calendar year 2004. Given the equipment and methods used in the Commute Atlanta vehicle activity data can be linked back to general household demographic parameters (household income, household size, and vehicle ownership) and vehicle characteristics (vehicle type and model year). Approximately 80-85% of the vehicles in the study are not shared, meaning that most vehicle activity can also be linked back to individual driver characteristics (age and gender).

The research team developed weekday and weekend soak and start time distributions and engine starts per day by demographic and vehicle characteristics parameters, using the same hour of day intervals and soak time groups employed in the MOBILE6.2 (U.S. EPA, 2001; U.S. EPA, 2003). After developing the soak and start time distributions and engine starts per day from Commute Atlanta trip data, the research team conducted MOBILE6.2 emission rate modeling to assess the potential impacts on the regional emission inventory for the 13-County Atlanta Metropolitan Area, GA. The research team also examined potential emissions benefits from changing soak and start time distributions by applying the Commute Atlanta MOBILE6.2 external data files to three other areas, including Gaston County, NC, Mecklenburg County, NC, and York County, SC. The research team found that the start and soak distributions observed in Atlanta were significantly different from the default distributions currently used in the MOBILE6.2 emission rate model, and that the use of the observed Atlanta distributions has a significant impact upon predicted emission rates and inventories generated using these emission rates. By applying Commute Atlanta soak and start time distributions and engine starts per day in MOBILE6.2 emission rate modeling, engine start VOC emission rates are predicted to be 17.4% lower and hot soak VOC emission rates are predicted to be 27.3% lower. These significant reductions can account for an 8.3% reduction in predicted onroad VOC emissions in the 13-county Atlanta metropolitan area.

FOREWORD

The U.S. Environmental Protection Agency (EPA) is charged by Congress with protecting the Nation's land, air, and water resources. Under a mandate of national environmental laws, the agency strives to formulate and implement actions leading to a compatible balance between human activities and the ability of natural systems to support and nurture life. To meet this mandate, EPA's research program is providing data and technical support for solving environmental problems today and building a science knowledge base necessary to manage our ecological resources wisely, understand how pollutants affect our health, and prevent or reduce environmental risks in the future.

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This publication has been produced as part of the laboratory's strategic long-term research plan. It is published and made available by EPA's Office of Research and Development to assist the user community and to link researchers with their clients.

Sally Gutierrez, Director
National Risk Management Research Laboratory

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ATL	unweighted Commute Atlanta data
CPU	central processing unit
GDNR	Georgia Department of Natural Resources
GPRS/GSM	General Packet Radio Service/ Global Systems for Mobile Communications
GPS	global positioning system
GT-TDC	Georgia Tech-Trip Data Collector
I/M	inspection/maintenance
LDT	light duty truck
LDT1	light duty truck 1
LDT2	light duty truck 2
LDT3	light duty truck 3
LDT4	light duty truck 4
LDV	light duty vehicle
MARTA	Metropolitan Atlanta Rapid Transit Authority
Min/Max	minimum/maximum
MySQL	open-source database
NC	North Carolina
OBD	on-board diagnostic
QA/QC	quality assurance/quality control
RVP	Reid Vapor Pressure
SC	South Carolina
SIP	state implementation plan
SiRFstarII	a global positioning system chipset technology
SMS	short message service
SUVs	sport utility vehicles
TDMA	time division multiple access
U.S. EPA	U.S. Environmental Protection Agency
VOC	volatile organic compounds
WATL	weighted Commute Atlanta data

Overview

The Georgia Institute of Technology (Georgia Tech) School of Civil and Environmental Engineering research team analyzed the 2004 second-by-second vehicle activity data obtained from vehicles in the Atlanta Commuter Choice Value Pricing Initiative, otherwise known as Commute Atlanta. The onboard monitoring equipment installed in each participating Commute Atlanta vehicle records each second of vehicle activity. Hence, each engine event (engine on, engine off) is time-stamped to provide the start and end times of each vehicle trip. The times of each trip end can be used to directly quantify the number of engine starts per day, the start times for each trip, and the durations of soak times between trips. (The soak time affects exhaust start and exhaust running emissions. A vehicle is considered to be soaking if its engine is not running. Soak time is the length of time between the engine turn off time and engine start time. Cold soak time in MOBILE6 determines the percentage of vehicles that have been soaking for a given amount of time prior to an engine start, for each hour of the day. The hot soak time distributions represent the proportion of vehicles experiencing a hot soak of a given duration at each hour of the day.) For the purposes of the analyses presented in this report, the research team followed the same criteria U.S. Environmental Protection Agency (EPA) used to develop soak and start time distributions and engine starts per day in the MOBILE6.2 emission rate model (U.S. EPA, 2001; U.S. EPA, 2003).

The objective of research efforts reported herein is to develop gasoline vehicle soak and start time distributions and engine starts per day for EPA light-duty vehicle (LDV) and light-duty truck (LDT combining LDT1, LDT2, LDT3, and LDT4) classes using vehicle trip data collected in the 13-county Atlanta metropolitan area during the calendar year 2004. Given the equipment and methods used in the Commute Atlanta vehicle activity data can be linked back to general household demographic parameters (household income, household size, and vehicle ownership) and vehicle characteristics (vehicle type and model year). Approximately 80-85% of the vehicles in the study are not shared, meaning that most vehicle activity can also be linked back to individual driver characteristics (age and gender).

The research team developed weekday and weekend soak and start time distributions and engine starts per day by demographic and vehicle characteristics parameters, using the same hour of day intervals and soak time groups employed in the MOBILE6.2 (U.S. EPA, 2001; U.S. EPA, 2003). After developing the soak and start time distributions and engine starts per day from Commute Atlanta trip data, the research team conducted MOBILE6.2 emission rate modeling to assess the potential impacts on the regional emission inventory for the 13-County Atlanta Metropolitan Area, GA. The research team also examined potential emissions benefits by applying the Commute Atlanta MOBILE6.2 external data files to three other areas, including Gaston County, NC, Mecklenburg County, NC, and York County, SC. The research team found that the start and soak distributions observed in Atlanta were significantly different from the default distributions currently used in the MOBILE6.2 emission rate model, and that the use of the observed Atlanta distributions has a significant impact upon predicted emission rates and inventories generated using these emission rates.

Commute Atlanta Data

The Georgia Tech research team has been collecting and managing second-by-second vehicle activity data from a fleet of private vehicles monitored in Atlanta since 2003. More than 270 households and 470 vehicles participated in the Phase I (2003 to 2005) data collection effort. To date, the monitoring program has tracked more than 1.3 million vehicle trips on a second-by-second basis. The research team selected vehicle trip data collected during the calendar year 2004 (1/1/2004 to 12/31/2004) for this research effort (614,276 vehicle trips).

Data Collection and Quality Assurance Process

Georgia Tech Trip Data Collectors (GT-TDC) used in the Commute Atlanta study are Linux-based 386 computers that include a CPU, power system, compact flash memory, GPS, cellular transceiver, and input/output lines (Figure 1).

Figure 1: Configuration of the Georgia Tech Trip Data Collector

Optional connections include six on/off sensors (which can be used to monitor seat belts or brake lights) and two serial connections [one of which is used to monitor onboard diagnostic, (OBD), data]. The GT-TDC is connected to constant battery power as well as switched power (vehicle ignition). Hence, no human interaction is required for vehicle turn-on/off. These features make data collectors a practical option to monitor vehicle activities 24 hours per day over an extended period. Trip data recorded by the GT-TDC are wirelessly transferred through the digital cellular communication network. A digital cellular transceiver is capable of sending data through low cost short message service (SMS) or sending larger volume circuit switched data − time division multiple access (TDMA). The newest systems currently being deployed in 150 Atlanta vehicles are equipped with General Packet Radio Service/Global Systems for Mobile Communications (GPRS/GSM) cellular modules, providing the capability of real-time, interactive vehicle position monitoring.

The switched power connection to the GT-TDC triggers the data recording process each time the engine starts. The GT-TDC records each second of vehicle activity data to the compact flash memory in an encrypted form. Second-by-second data elements include: date, time, vehicle position (latitude and longitude), vehicle speed (phase differential speed calculated by the SiRFstarII GPS unit), and engine operating parameters (monitored for approximately 40% of the vehicles). When the driver turns off the engine, the GT-TDC writes a trip record summary and enters a sleep mode. Approximately once per week, the research team polls the unit and triggers a data upload to the main server system. The encrypted data pass to the server via cellular connection, where programs automatically decrypt and process data into storage arrays. A series of programs process each trip to route and summarize trip characteristics. For example, total trip time equals the trip record length (one-second per record). The trip distance calculation methods are proprietary, but they include a Kalman filter for vehicle speed, and shortest path infill distance from trip origin position (equal to destination of previous trip) to the point where the first viable satellite data point is collected.

A series of quality assurance/quality control (QA/QC) checks are performed for every trip to identify potential data integrity problems. These methods are outlined below:

- An automated system monitors the operating status of equipment and verifies garage location. By automating box reporting status commands and storing the results in a master MySQL table, the researchers can identify systems that need to be replaced and households that may have changed location. Automated e-mail messages alert the team to potential problems so that repairs can be scheduled, significantly decreasing equipment downtime. The team uses these data to determine when a unit has failed and to differentiate vehicle inactivity from failure to report trips. The automated systems cannot identify when a vehicle owner has temporarily disconnected a unit from the power source and then later reconnected that unit. Given the relative inaccessibility of the hardware, this is not likely to be a significant issue. The next generation equipment will automatically detect and report a power system disconnect.

- Data integrity checks and data consistency checks were undertaken when populating the MySQL database to ensure that the correct households, vehicles, and individuals are joined in applicable tables. This process included both an automated and visual check. In early 2006, the team manually audited all equipment install and uninstall paperwork and verified the database entries for each household and vehicle.

- The team developed a graphical user interface to help researchers interact with the MySQL database. Customized functions for updating the database use data entry forms to update multiple tables automatically. These features allow users to respond more readily to frequently occurring scenarios (e.g., sale of a vehicle, opt-out of a household). This helps maintain database integrity, improves data entry efficiency, and reduces the likelihood of data entry error.

- The research team has automated the comparison of trip summaries and processed trips, reported on separate communication channels (proprietary process). Using this technique, the team identified 11,087 trip files that appeared to have been generated by the data collection devices, but not processed by the server. More than 6,209 (56%) of the total missing files were not trips, but were files created every few seconds by corrupted onboard software aboard five vehicles. The remaining 4,878 (44%) missing trip files were distributed among 462 boxes (an average of approximately 10 trips/vehicle over an 18-month period). These files were either lost during data transmission, or overwritten by newer trip files when the vehicle communication system failed. The 4,874 dropped trips do not constitute a significant fraction (0.4%) of the total 1.2 million trips (from August 2003 to September 2005) and many of these trips are likely to have been zero mile trips based upon analysis of the size of the missing file. The data transfer issue causing these drops will be eliminated in the next generation of equipment when transmitted using a newer cellular technology (GPRS/GSM cellular modules).

- The research team also conducts a final visual review of all data. Using a database analysis coupled with a visual review of plotted data for confirmation purposes, the team determined that trip data were missing for 18 vehicles from November 24, 2004 through January 14, 2005. The loss occurred during the period of service disruption on the part of the cellular provider. We have re-coded the data for these vehicles, as if each unit failed on November 24 and was replaced on January 14. Thus, the zero-trip data from these 18 vehicles during this date range are excluded from the database from start and soak analyses.

- During September and October 2005, the research team performed an additional QA/QC pass through all vehicle-trip data to identify and correct any GPS time stamp-errors. A small fraction of units exhibited these errors due to an internal clock failure. Such errors are readily identified in the start and soak time distributions by examining outliers, identifying trip time overlaps (two trips occurring within the same time interval), and identifying negative soak time increments. A new automated software feature identifies time stamp problems associated with GPS clock failure, excludes the data from analysis (trip data and monitored days are excluded, just as if the vehicle had left the program for that period), and flags the data for human follow-up.

The research team assembled all trip data collected in calendar year 2004. As described in the QA/QC procedures above, not every trip from every vehicle is available for analysis, due to potential equipment outages. For daily activity distributions, zero trip days are differentiated from days in which no data were collected. Hence, a zero value for trips per day is included in the database only when the research team has determined that the equipment was functional on that day.

During the initial stages of the travel variability analysis, the research team discovered that vehicles used part time for commercial purposes have a significant impact on household travel variability as well as total sample variability. Some of these vehicles make 10 to 20 trips per weekday − significantly more trips than the typical household. Vehicles identified by their owners as being used part time for business purposes made approximately 5% of the total vehicle trips. The effect was so significant that the research team now excludes these vehicles from vehicle activity analyses and excludes these households from household activity analyses. The team has determined that such vehicles and households need to be sampled and analyzed separately from other households in the region. In addition, vehicle trips made by diesel vehicles, Metropolitan Atlanta Rapid Transit Authority (MARTA) buses and Georgia Tech vans are excluded from the start and soak distribution analysis.

The start and soak time analyses in this report include all vehicle activity monitored in 2004. The research team has developed a series of routines to identify the intra-regional and inter-regional status for each trip in the 2004 database. Approximately 7.4% of all trips recorded in 2004 begin or end outside of the 13-county Atlanta metropolitan area. These trips are coded as extra-regional trips. The researchers are currently conducting analyses to compare the start and soak distributions for long-distance tours (travel departing the region, traveling outside of the region, and then returning to the region) and the purely intra-regional travel. The research team will prepare a separate manuscript for journal publication once the findings are complete.

Data Screening

The research team processed all trip data collected in the calendar year 2004 with each step of the data QA/QC process and used only the data that passed the QA/QC procedures for soak and start time distributions and engine start per day. During calendar year 2004, the research team monitored a total of 667,836 vehicle trips. From the collected total vehicle trips, the research team excluded vehicle trips generated by buses, Georgia Tech service vans, diesel vehicles, and commercial vehicles. The research team excluded trips generated from the small number of trip data collectors that had data recording problems, such as recording wrong starting or ending trip time, global positioning system (GPS) failures, etc. Recording problems that cause negative and zero soak intervals, zero travel duration, extremely long trip duration (greater than a 5-hour travel duration), high average speed [such as an average speed of 180 miles per hour (mph)], or combination of them have been excluded. In addition, the first trip of the year from each trip data collector was excluded because soak duration for the first trip cannot be calculated. After excluding these trips, the research team used 614,276 trips for soak and start time analysis. Table 1 shows the vehicle trips collected in the year 2004, excluded by the QA/QC process, and the data used in the start and soak analyses.

Table 1: Vehicle Trips Collected in the Year 2004, Excluded by the QA/QC process, and Used for Soak and Start Time Analysis.

Vehicle Trips		Vehicle Trips
Collected in the calendar year 2004		667,836
Excluded by the QA/QC process	Buses, Georgia Tech Vans, and Commercial Use Vehicles	52,227
	Minus and Zero Soak Time Vehicle Trips	402
	Zero Duration Trips	269
	Greater than 5-hour Duration Trips	102
	High Average Speed Trips	4
	First Vehicle Trips of the Year	556
Used for Soak and Start Time Analysis		614,276

Methodology

Development of Soak and Start Time Distributions

The research team developed weekday and weekend soak and start time distributions using the MOBILE6.2 soak time and hour intervals (U.S. EPA, 2001; U.S. EPA, 2003). All soak and start time distributions developed by the research team are directly comparable to weekday and weekend soak and start time distributions used in MOBILE6.2. The research team included the 2004 vehicle trip data and did not drop any vehicle trips once the data passed the QA/QC process. In these analyses, even a three-second vehicle trip is considered a unique vehicle trip. In addition, soak duration is assigned to engine start time because that is when start related emissions begin (i.e., g/mile and g/start). The Sunday to Monday soak is assigned to Monday. The Monday morning to afternoon soak is assigned to afternoon.

Soak Time Distributions by Vehicle Characteristics

In this research, the research team considered two vehicle types and four vehicle technology/model year groups. The two vehicle types included passenger cars (LDV) and light-duty trucks (LDT). Vehicle technology/model year groups included pre-1994, 1994-1995, 1996-1999, and post-1999. These vehicle technology/model year groups were derived from light-duty gasoline vehicle certification standards and vehicle technology development. Table 2 shows vehicle technology/model year groups.

Table 2: Vehicle Technology/Model Year Groups

Vehicle Age Groups	Criterion
Pre-1994	Tier 0
1994 to 1995	Tier 1
1996 to 1999	Tier 1, phase-in of vehicles with enhanced evaporative controls
Post- 1999	Tier 1, addition of supplemental federal test procedure

The research team created soak time distributions across the combinations of four technology/model year groups, two vehicle types, for weekdays and weekends.

Soak Time Distributions by Demographic Parameters

The research team developed separate soak time distributions across five different demographic parameters: household income, household size, vehicle ownership, driver age, and driver gender (Guensler et al., 2004). Household income employed four clusters: $0-$30,000, $30,000 to $75,000, $75,000 to $100,000, and more than $100,000). Household size and vehicle ownership parameters were each divided into three groups: 1, 2, and 3+. Driver age groups were binned (grouped) by: 16-24, 25-34, 35-44, 45-54, 55-64, and 65+.

Households in the Commute Atlanta study were recruited in eight sampling strata, defined by household income, household size, and vehicle ownership (Ogle et al., 2005). The research team developed start and soak distributions for each of these sampling strata. Because equal numbers of households are not present in each sampling strata, and because each sampling strata represents a different fraction of regional households, the team developed weighting factors for the eight Commute Atlanta sampling strata so that regional distributions could be developed from the eight individual distributions. That is, to account for Commute Atlanta sample size effects (potential over- or under-sampling by demographic strata), weighting factors are applied to soak and start time distributions to develop weighted soak and start time distributions (see the section entitled "Demographic Weighting Factors").

Soak Time Distributions by Season

For soak time distributions by season, the research team separated vehicle trips into four seasons: winter (December to February), spring (March to May), summer (June to August), and fall (September to November). Soak time distributions were developed by vehicle type and technology/model year group for each season.

Emissions Impact Analysis

For the emissions impact analyses, the research team developed fifteen MOBILE6.2 modeling scenarios. The fifteen MOBILE6.2 modeling scenarios employ combinations of MOBILE6.2 default data, Commute Atlanta data, and Commute Atlanta data weighted by demographic parameters for the soak time distribution, start time distribution, and engine starts per day inputs. Table 3 shows the fifteen MOBILE6.2 modeling scenarios that result from the combinations of the input data files.

Table 3: MOBILE6.2 Modeling Scenarios for Emissions Impact Analysis

Scenarios	Emissions Rate Modeling Data Files		
	Soak Time Distribution	Start Time Distribution	Engine Starts per Day
1	EPA[1]	EPA	EPA
2	ATL[2]	EPA	EPA
3	EPA	ATL	EPA
4	EPA	EPA	ATL
5	ATL	ATL	EPA
6	ATL	EPA	ATL
7	EPA	ATL	ATL
8	ATL	ATL	ATL
8	ATL	ATL	ATL
9	ATL	ATL	WATL
10	ATL	WATL	ATL
11	WATL[3]	ATL	ATL
12	ATL	WATL	WATL
13	WATL	ATL	WATL
14	WATL	WATL	ATL
15	WATL	WATL	WATL

1) EPA: MOBILE6.2 default soak and start time distributions and engine starts per day

2) ATL: Commute Atlanta soak and start time distributions and engine starts per day

3) WATL: Weighted Commute Atlanta soak and start time distributions and engine starts per day

The research team conducted MOBILE6.2 emission rate modeling for each scenario using modeling control file developed for the Atlanta 13-county 1-hr ozone nonattainment area (GDNR, 2005). As examples of emissions impact analysis, the research team compared volatile hydrocarbon compounds (VOC) emissions rates across the scenarios.

The research team performed emissions impact analysis in regional or local emissions inventory development with MOBILE6.2 modeling control files for the 13-county Atlanta metropolitan area and three other regions (Gaston County, NC, Mecklenburg County, NC, and York County, SC). U.S. EPA staff provided modeling control files for these three other regions. This analysis provides not only emissions impact in Atlanta regional emissions inventory development, but also provides insights as to the potential effect in other regions, where different environmental parameters, inspection and maintenance (I/M) programs, fuels programs, registration distributions, etc., may exist.

Demographic Weighting Factors

In transportation planning and modeling, patterns of vehicle activity are noted across household income, vehicle ownership, household size, etc. Household demographics and lifestyle stage influence tripmaking, which in turn influences start and soak time distributions within a region. For instance, a large, high-income household owning multiple vehicles will tend to generate more trips (shorter average soak times) compared to smaller, low-income, single vehicle households.

The proportion of high-income households participating in the Commute Atlanta project is greater than actual proportion of high-income households in the 13-county region. The proportion of low-income households is lower than the actual proportion in 13-county region. The eight demographic strata used for recruitment (household income, vehicle ownership, and household size groups) represent different fractions of regional households. The research team created demographic strata weighting factors, based upon the relative contribution of each household stratum to the overall regional demographic composition. The percentage of households in each sampling stratum of the 2004 Commute Atlanta household data was compared to the percentage of 13-county Atlanta metropolitan households in each sampling stratum (derived from 2002 U.S. Census demographic data). Sampling strata ratios were used to adjust the contribution of each 2004 Commute Atlanta stratum to the metropolitan average. For instance, household portions of sampling stratum 1 in Table 4 (households with annual income of less than $30,000, owning one or more vehicles, of any household size) represented 19.85% of the 2002 U.S. Census data for the 13-county Atlanta metropolitan area, but only 6.29% of the 2004 Commute Atlanta data. Therefore, the weighting factor for this stratum is 3.1566 (0.1985 divided by 0.0629). Weighting factors for each stratum are applied to the Commute Atlanta data to estimate the weighted contributions of soak and start time distributions and engine starts per day to the regional average. Table 4 shows the weighting factors for each sampling stratum.

Table 4: Weighting Factors for each Sampling Stratum used in Calculating the Relative Contribution of each Stratum to Regional Average Distributions

Sampling Stratum	Household Income	Vehicle Ownership	Household Size	2002 U.S. CENSUS Atlanta Household	2004 Commute Atlanta Household	Weighting Factors
1	<30k	1+	Any	0.1985	0.0629	3.1566
2	30-75k	1+	1	0.1219	0.0882	1.3818
3	30-75k	1	2+	0.0734	0.0380	1.9326
4	30-75k	2+	2	0.1143	0.1305	0.8759
5	30-75k	2+	3+	0.1499	0.1589	0.9437
6	75k+	1+	1	0.0302	0.0116	2.6065
7	75k-100k	1+	2+	0.1305	0.1829	0.7138
8	>100k	1+	2+	0.1812	0.3271	0.5541
9	UNK	Any	Any	N/A	N/A	1.0000

Soak/Start Time Distributions and Engine Starts per Day

The research team prepared soak and start time distributions and engine starts per day using the 2004 Commute Atlanta trip data passing the QA/QC criteria described earlier in the "*Data Collection and Quality Assurance Process*" section.

Soak Time Distributions

The research team created thirteen soaks time intervals to present the general soak time distribution, with a maximum four day soak time duration. These thirteen soak time intervals include the sixty-eight soak codes (1 to 68) applied in the EPA MOBILE6.2 emission rate model. Figure 2 shows the overall soak time distribution. Two peaks are noted, one contributing 16.1% of soaks in the 0 to 5 minute soak time interval and another contributing 17.9% of all soak durations in the 8 to 24 hour soak time interval.

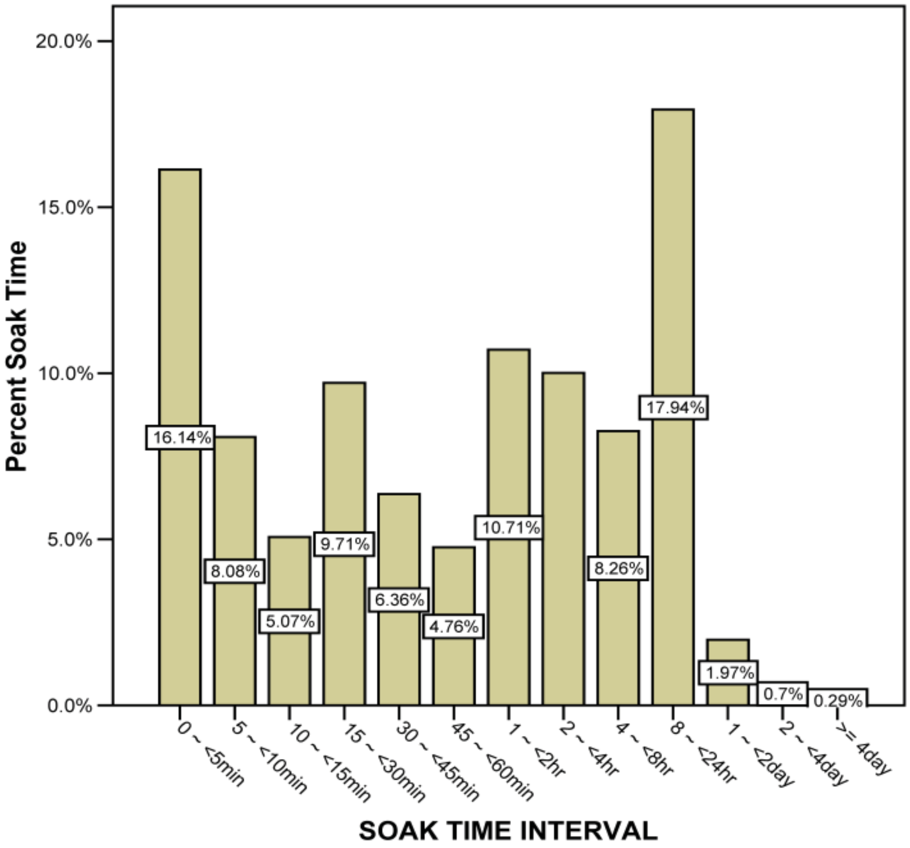

Figure 2: 2004 Commute Atlanta Soak Time Distributions

Using the thirteen soak time intervals, soak time distributions by day of week were also generated (Figure 3). Soak time distributions patterns across weekdays are similar (each day yields two high soak time durations in the 0 to 5-minute and 8-hour to 24-hour intervals). However, soak time distributions for Saturday and Sunday are significantly different. Weekend soak time distributions were significantly higher in the 10-minute to 4-hour soak time intervals. However, soak time durations for Saturday and Sunday were much lower than weekdays in the 4-hour to 24-hour soak time intervals. On Sunday and Monday, high soak time durations were observed in the 1-day to 2-day soak time intervals, which are associated with days that some vehicles were not used over the weekend).

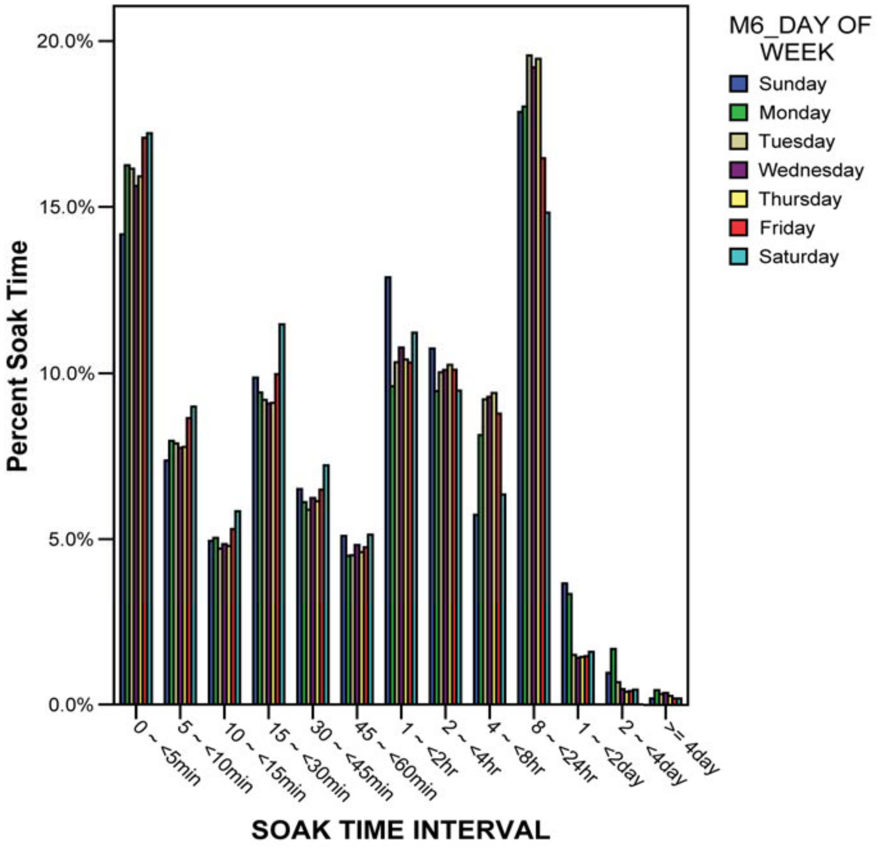

Figure 3: Soak Time Distributions by Day of Week

Figure 4 shows the 2004 soak time distributions for the four time periods used in Atlanta regional traffic analysis and for transportation planning purposes (ARC, 2002). The four time-periods include morning (6 a.m. to 10 a.m.), mid-day (10 a.m. to 3 p.m.), afternoon (3 p.m. to 7 p.m.), and night (7 p.m. to 6 a.m.). During the morning period, soak durations were elevated in the 0-minute to 5-minute bin (15% of soak time associated with short stops primarily along the commute) and in the 8-hour to 24-hour bin (48% of soak time associated with overnight parking). Soak time distributions for the mid-day and afternoon periods were very similar to each other. Soak time durations increase significantly at night, when soak time durations from 1-hour to 24-hour dominate the distribution.

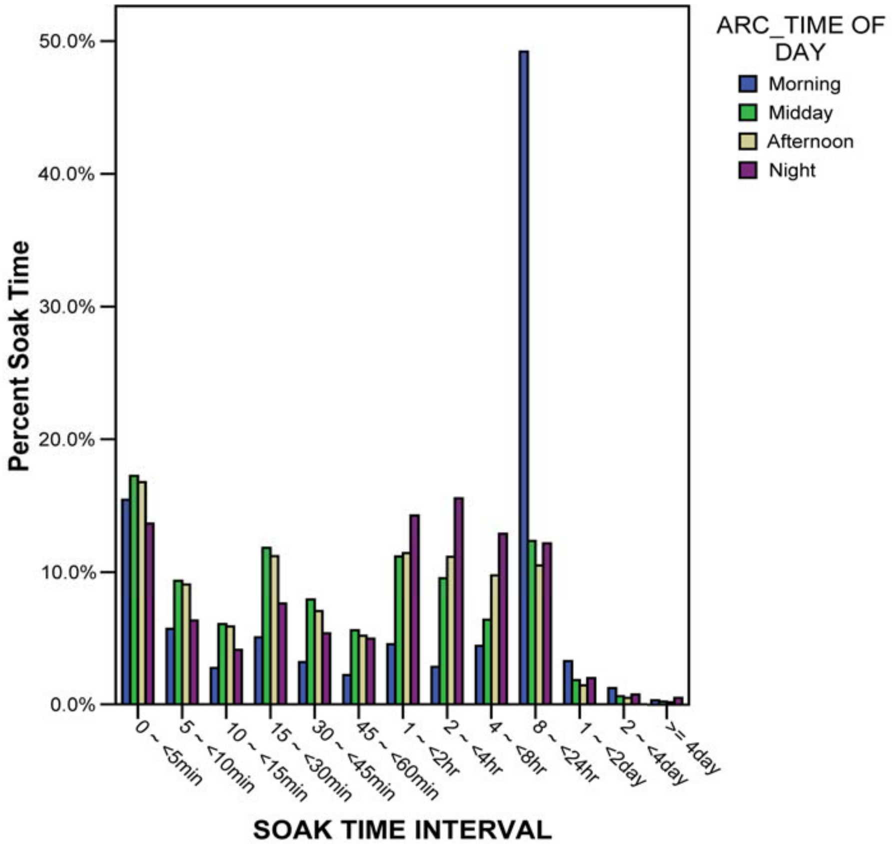

Figure 4: Soak Time Distributions for Time of Day

Soak Time Distributions for Weekday and Weekend

The research team developed soak time distributions using the sixty-eight MOBILE6.2 soak codes (soak time intervals) for weekdays and weekends. The sixty-eight MOBILE6.2 soak time intervals include: one category for soak durations less than 1 minute, 29 categories in 1-minute increment from 1 to 30 minutes, 15 categories in 2-minute increments from 31 to 60 minutes, 22 categories in 30-minute increments from 60 to 720 minutes, and one final category for soak durations greater than 720 minutes. For soak codes 69 ("Restart") and 70 ("Not Used"), the research team used MOBILE6.2 default values because appropriate values were not generated in the Commute Atlanta trip data. Appendix A1 contains the Commute Atlanta weekday soak time percentages by hour of day for the 68 MOBILE6.2 soak durations (except soak codes 69 and 70).

Figures 5 and 6 show MOBILE6.2 default weekday and weekend soak time distributions. MOBILE6.2 default soak time distributions are significantly different from Commute Atlanta soak time distributions (Figures 7 and 8). The Commute Atlanta distributions are markedly smoother (likely due to the large data set used to generate the distributions). The mid-day default distributions for MOBILE6.2 show significantly higher fractions of long and short soaks compared to the Commute Atlanta distributions.

From 3 a.m. to 11 a.m., the Commute Atlanta weekday soak time distributions exhibit high frequencies (greater than 0.1 for each hour) corresponding to soak time durations longer than 720 minutes. Three other high frequencies were observed at 7 p.m., 8 p.m., and 11 p.m. However, high soak time frequencies (greater than 0.1) from MOBILE6.2 weekday soak time distribution occurred during 6 a.m. to 10 a.m., which was a much narrower time window than the Commute Atlanta weekday soak time distribution. Appendix A1 shows the Commute Atlanta weekday soak time fractions for each hour of the day for the 68 MOBILE6.2 soak codes.

The Commute Atlanta weekend soak time distribution is similar to the MOBILE6.2 default weekend soak time distribution, but the hour window for high frequencies is different. The Commute Atlanta weekend soak time distributions show high frequencies (greater than 0.10) corresponding to soak durations greater than 720 minutes from 4 a.m. to 2 p.m. Whereas, the MOBILE6.2 default weekend soak time distribution shows high frequencies corresponding to soak durations greater than 720 minutes from 6 a.m. to 2 p.m. Appendix A2 shows the Commute Atlanta weekend soak time fractions for each hour of day for the 68 MOBILE6.2 soak codes.

The research team also developed regional soak time distributions weighted by demographic parameters (with weightings applied to each demographic sampling strata to account for the fact that the Commute Atlanta household distributions differ from the metropolitan area demographic distributions). Figures 9 and 10 show the weighted Commute Atlanta weekday and weekend soak time distributions, respectively. The weighted Commute Atlanta soak time distributions were almost identical to the unweighted distributions. Hence, the demographic weighting process is not necessary for the development of regional soak and start time distributions with 2004 Commute Atlanta trip data. Appendices A3 and A4 show the demographic-parameter-weighted Commute Atlanta weekday and weekend soak time fractions for each hour of day for 68 MOBILE6.2 soak codes, respectively.

The Commute Atlanta weekday and weekend soak time distributions can be substituted for MOBILE6.2 default weekday and weekend soak time distributions in emission rate modeling for use in Atlanta metropolitan area regional emissions inventory development. The section entitled “Impacts on MOBILE6.2 Modeling and Implications on Emissions Inventory Development” explores the impacts on emission rates and regional emissions inventories when Commute Atlanta soak time distributions replace the MOBILE6.2 default distributions in the modeling runs.

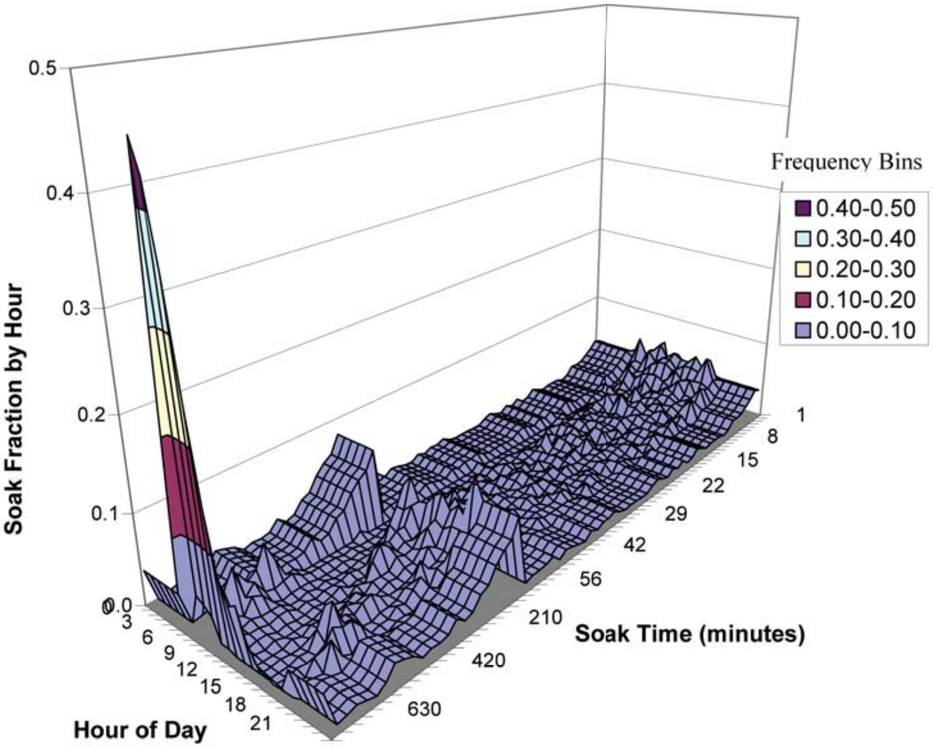

Figure 5: MOBILE6.2 Default Weekday Soak Time Distribution

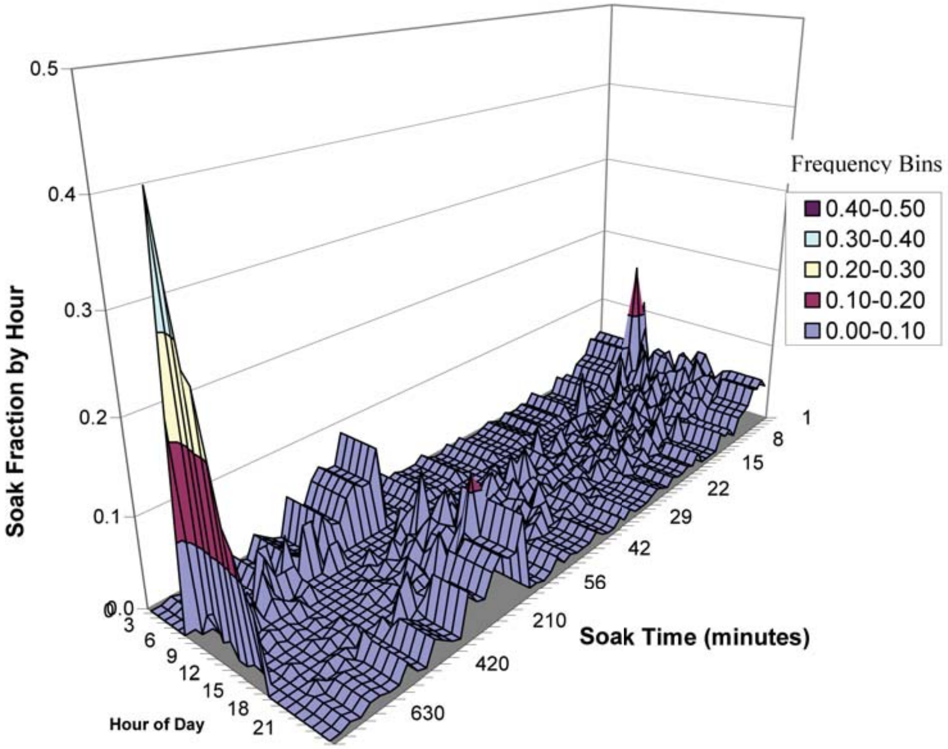

Figure 6: MOBILE6.2 Default Weekend Soak Time Distribution

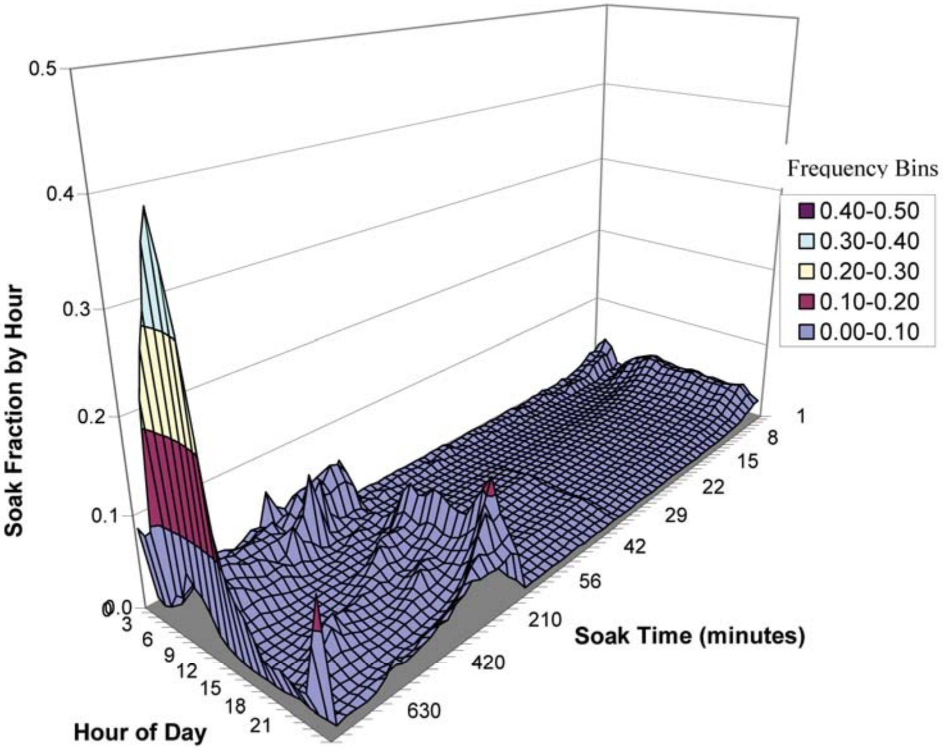

Figure 7: Commute Atlanta Weekday Soak Time Distribution

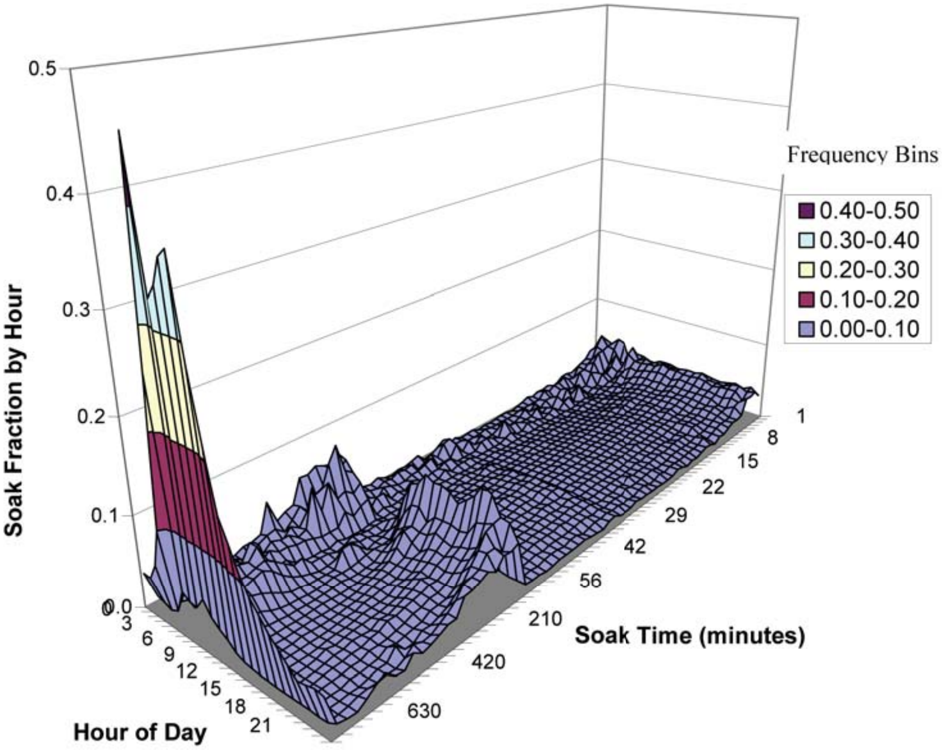

Figure 8: Commute Atlanta Weekend Soak Time Distribution

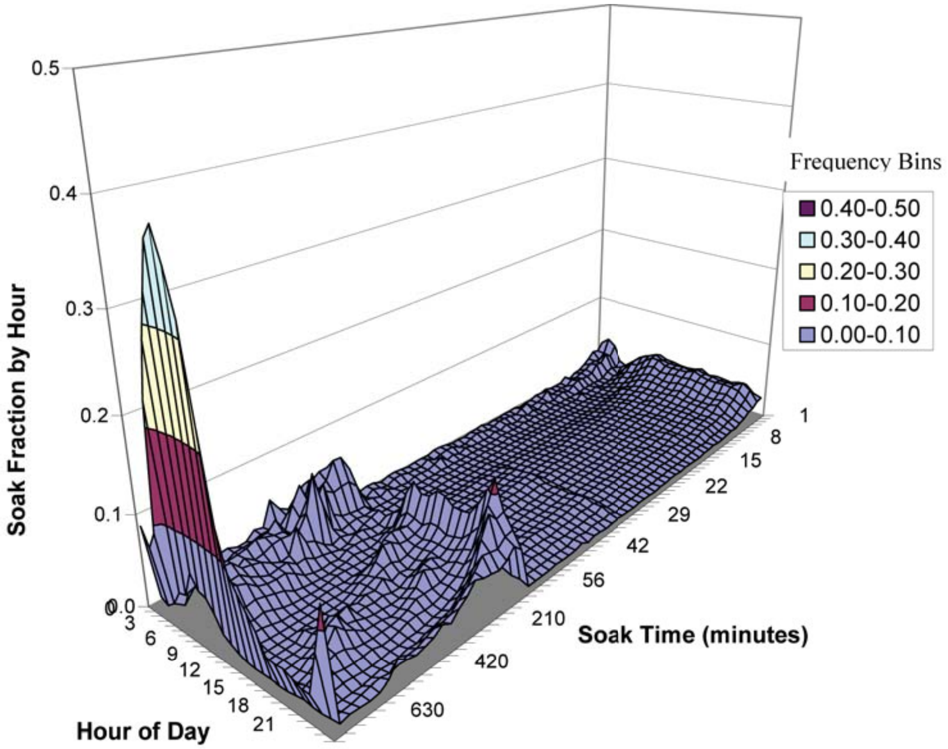

Figure 9: Commute Atlanta Weekday Soak Time Distribution (Weighted)

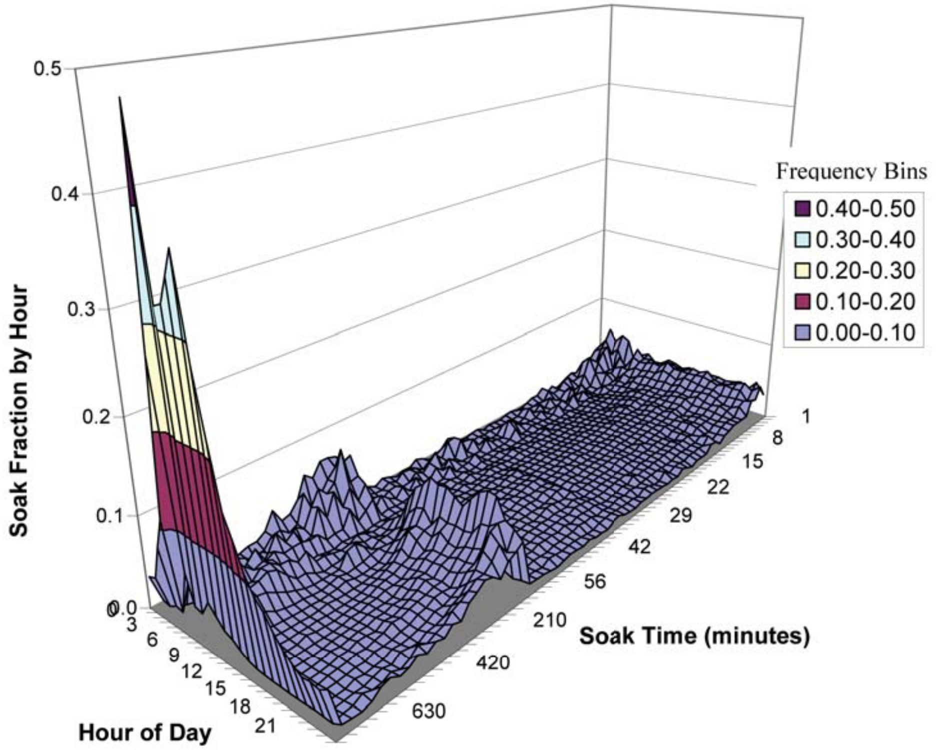

Figure 10: Commute Atlanta Weekend Soak Time Distribution (Weighted)

Distributions of Soak Time Durations by Day and by Vehicle Characteristics

Distributions of soak time durations (in seconds) by day of week were developed for vehicle characteristics, including vehicle model year/technology group and vehicle type. Vehicle model year/technology groups are grouped by model year: pre-1994, 1994-1995, 1996-1999, and post-1999. Younger vehicles exhibit shorter soak time durations (more frequent use), and soak time durations generally decreased from Sunday through weekdays to Saturday. Soak time durations for all vehicle model year groups were the longest on Monday and shortest on Saturday (more vehicle inactivity occurs on Saturdays and Sundays, leading to the longer soak time for starts on Sundays and Mondays). Newer vehicles appear to be driven more on the weekends, as evidenced by shorter soak times, indicating that newer vehicles may be preferred when multiple vehicles are available. Older vehicles (pre-1994 and 1994-1999 groups) tend to have longer soak times than the newer vehicle groups. However, it is important to keep in mind that this study only instrumented vehicles that owners report are used more than 3,000 miles per year. Hence, the mean and confidence bounds for the oldest vehicle set may be representative for active vehicles, but is probably not representative for the older inactive vehicles present in the regional vehicle registration database. Figure 11 shows the distributions of soak time durations by day of week for each vehicle model year group.

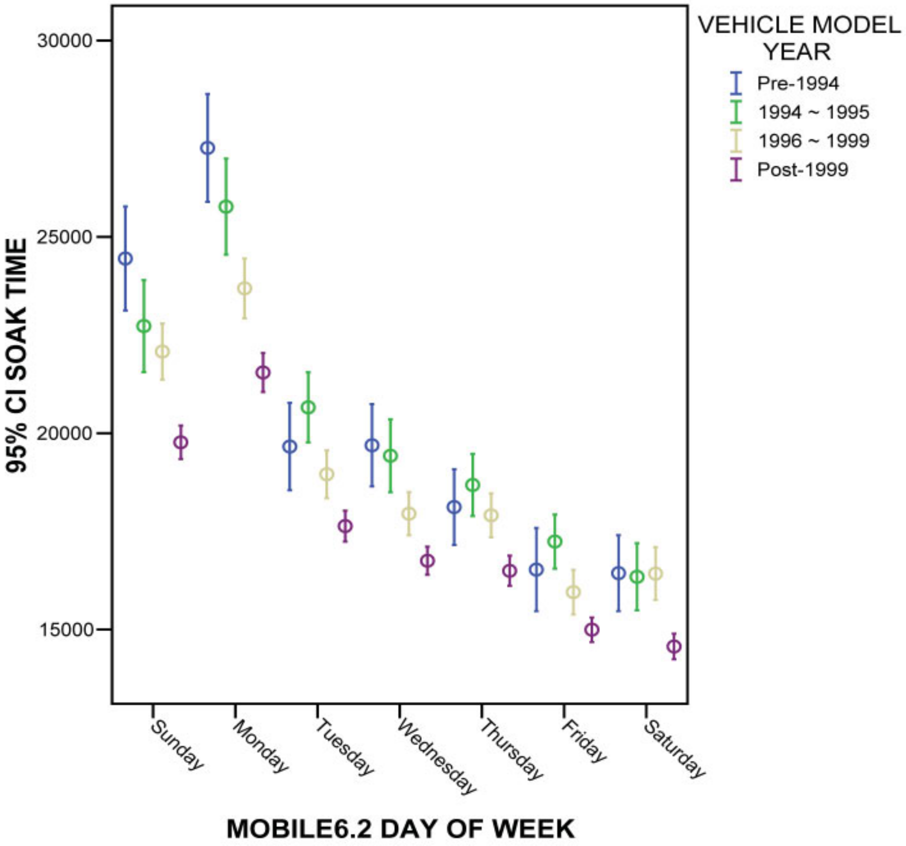

Figure 11: Average Soak Time Duration (Seconds) by Day of Week, by Vehicle Model Year Group

Soak time distributions (in seconds) by day of week were developed for automobiles, vans, sport utility vehicles (SUVs), and pickup trucks. In general, soak time duration decreased from Sunday through the weekdays for both LDV and LDT. However, soak time durations for LDVs (automobiles) were generally longer than soak time durations for LDTs (vans, SUVs, and pickups), especially on Sundays and Mondays. This indicates more frequent LDT use on weekends. Figure 12 shows the distributions of soak time durations by day of week for LDVs and LDTs. Within the LDT category, the average soak time duration for pickup trucks was much longer on Sunday and Monday (indicating less weekend activity). The soak time durations for vans and SUVs were significantly shorter on Sundays and Mondays (indicating more weekend activity). The van and SUV effect dominates the LDT difference. Figure 13 shows the average soak time durations by day for LDVs and the three LDT types.

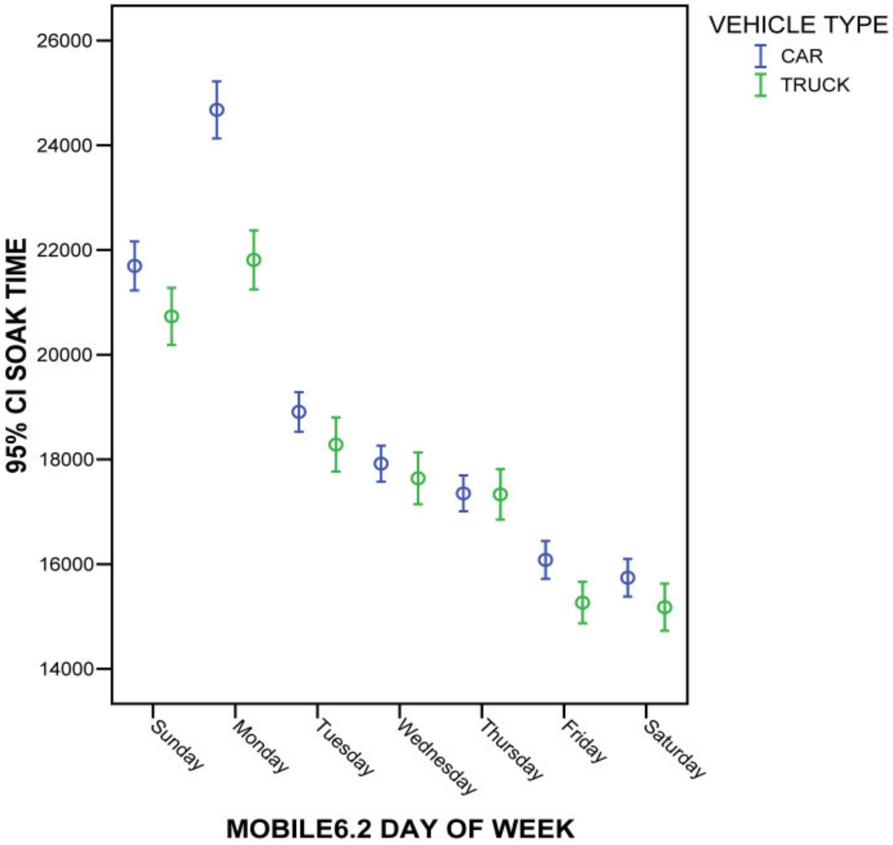

Figure 12: Average Soak Time (Seconds) by Day of Week, by Vehicle Type

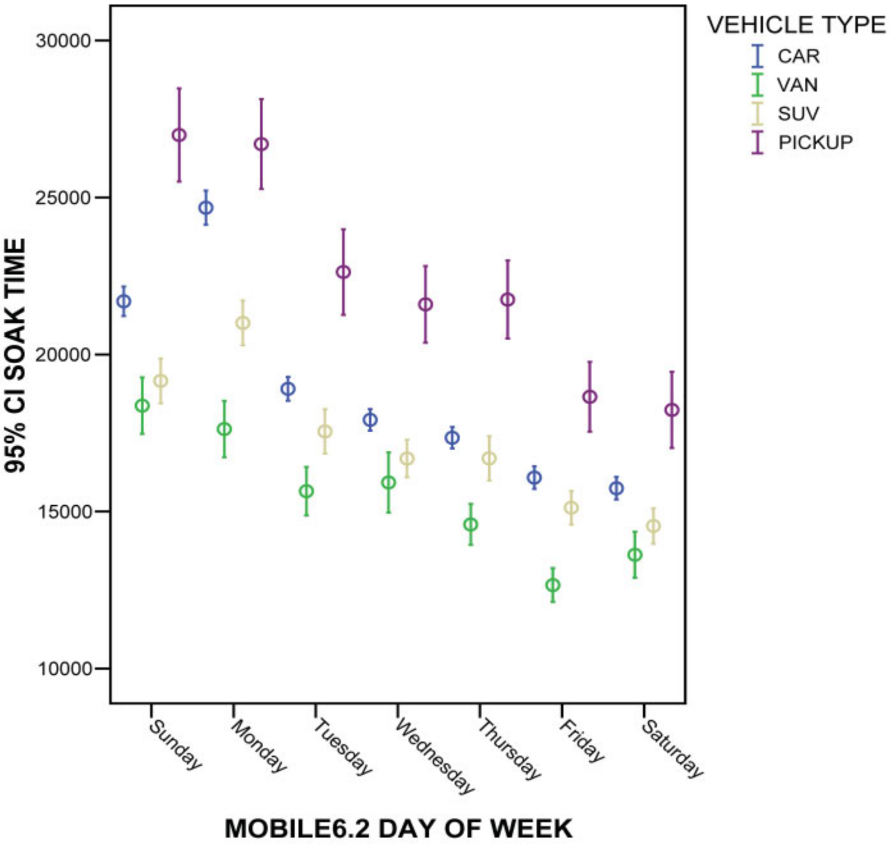

Figure 13: Average Soak Time Duration (Seconds) by Day of Week for LDVs and for Three LDT Types

Distributions of Soak Time Durations by Demographic Parameters

Average soak time durations (seconds) were developed across five demographic parameters including household size, household income, vehicle ownership, drive age, and driver gender.

Mean soak time durations for household sizes 1 and 2 were not significantly different, although the variance for household size 1 was slightly larger than for household size 2. Soak time duration for the 3+ household size group was significantly shorter than soak time durations for household sizes 1 and 2. Figure 14 shows the average soak time duration by household size.

Average soak time durations (seconds) were developed for the four household income groups (less than $30,000, $30,000 to $75,000, $75,000 to $100,000, and more than $100,000). Average soak time duration for the lowest income group (less than $30,000) was much longer than was noted for other household income groups, indicating lower tripmaking rates in the lowest income group). Average soak time duration for the $30,000 to $75,000 income group was the shortest. Except for the lowest income group, average soak time increases with income (higher income households tend to own more vehicles, which could reduce tripmaking per vehicle, but also tend to make even more trips per vehicle). Figure 15 shows average soak time durations by household income group.

Average soak time durations were all significantly different for 1, 2, and 3+ vehicle households. As household vehicle ownership increased, average soak time durations significantly increased. Figure 16 shows average soak time duration by vehicle ownership.

Average soak time durations (seconds) varied by driver age. Driver age groups 35 to 44 and 45 to 54 had the shortest soak time durations (i.e., they are more active with respect to making vehicle trips), while driver age groups 55 to 64 and 65+ had the longest soak time durations. Figure 17 shows the distributions of soak time durations by driver age group.

Distributions of soak time durations were significantly different across male and female drivers. The average soak time duration for male drivers was significantly longer than for female drivers. Figure 18 shows the distributions of soak time durations by driver gender.

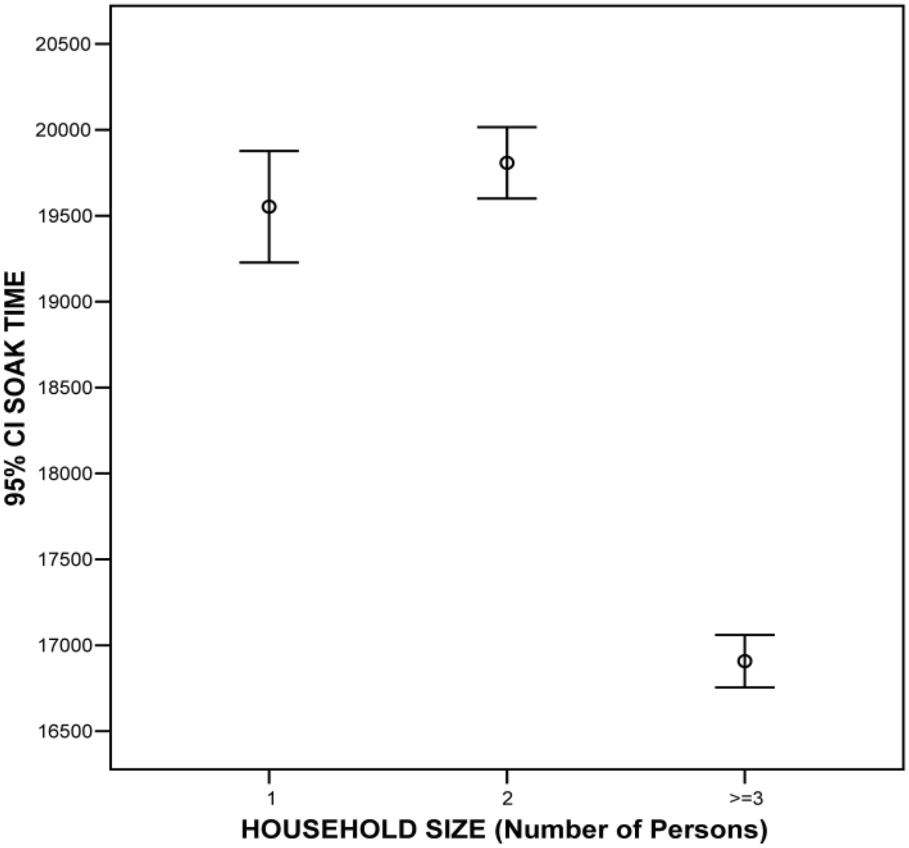

Figure 14: Average Soak Time Duration (Seconds) by Household Size

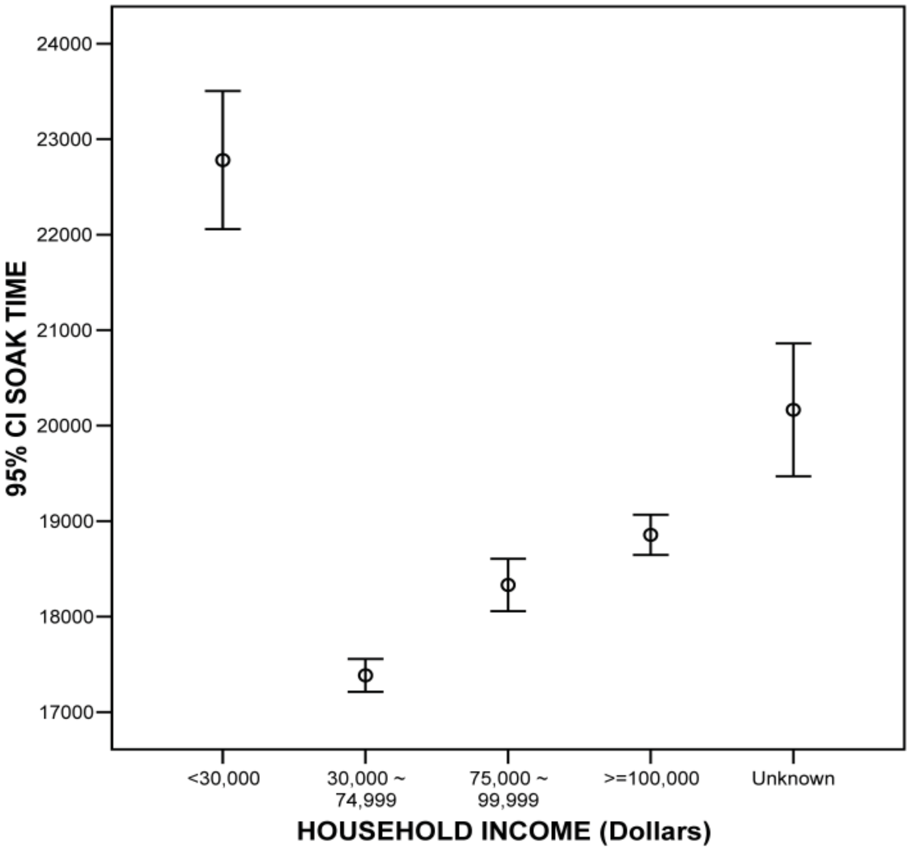

Figure 15: Average Soak Time Duration (Seconds) by Household Income Group

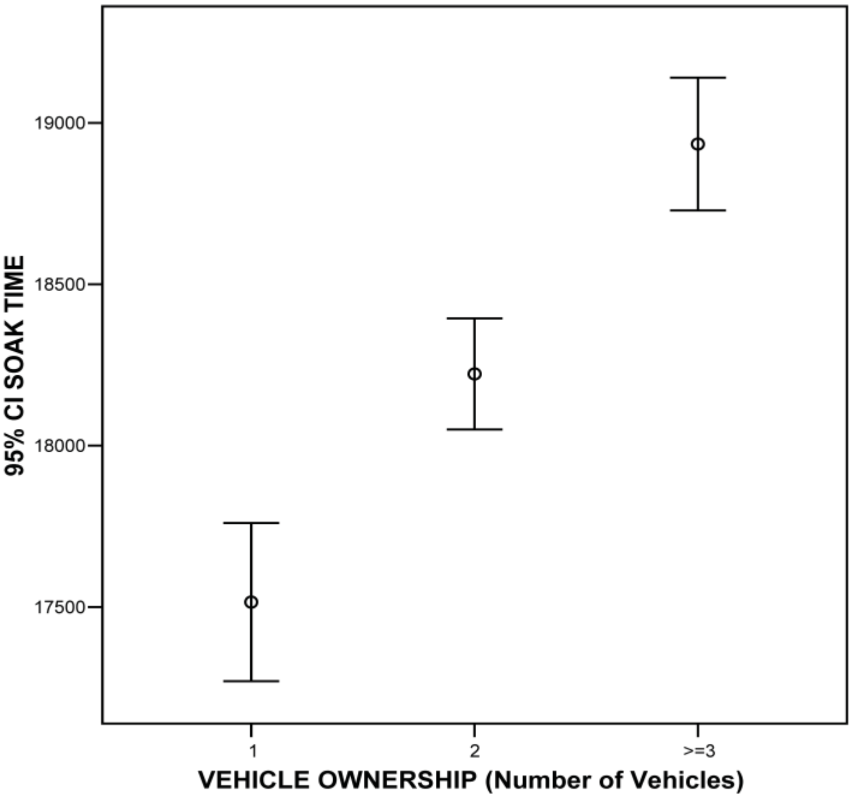

Figure 16: Average Soak Time Duration (Seconds) by Vehicle Ownership

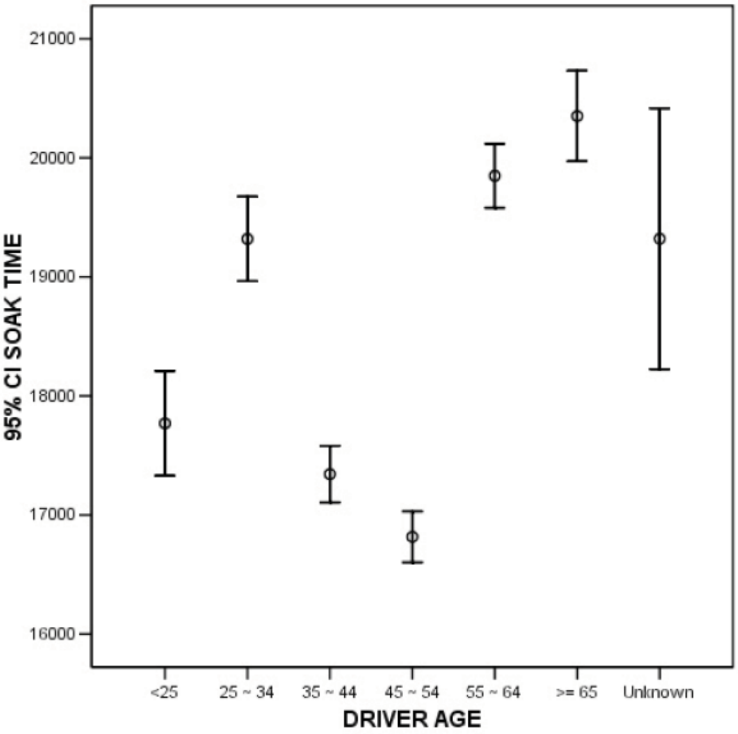

Figure 17: Average Soak Time Duration (Seconds) by Driver Age Group

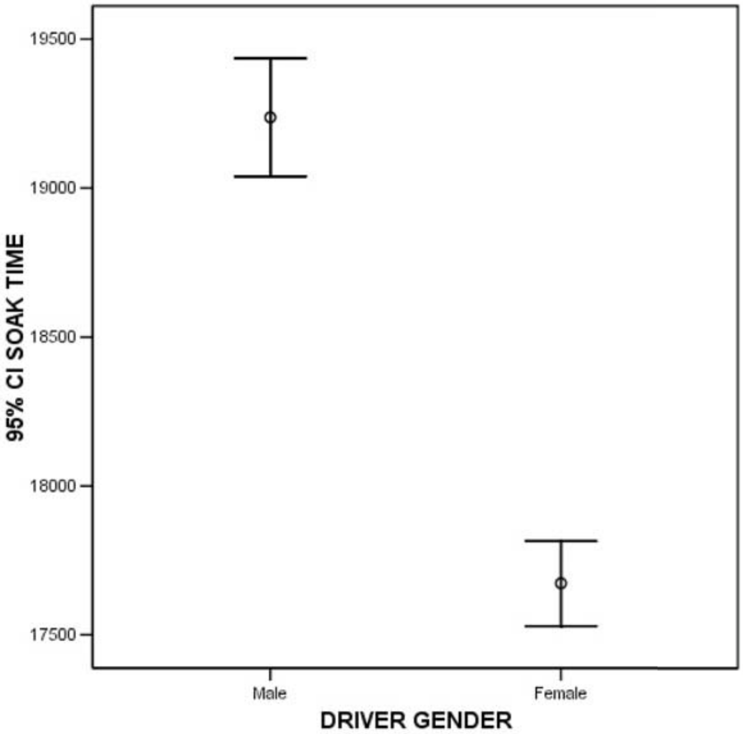

Figure 18: Average Soak Time Duration (Seconds) by Driver Gender

Soak Time Durations by Season and Vehicle Characteristic

Average soak time duration (seconds) by season differ significantly across vehicle model year/technology group and by vehicle type. The soak time durations in spring were the shortest of the four seasons, while soak time durations in winter were the longest. Soak time durations in summer varied across vehicle model year/technology groups more than any other season of the year. Average soak time durations for pre-1994 vehicles were longer than soak time durations for post-1996 vehicles. In general, younger vehicles exhibit shorter soak time durations (due to more frequent vehicle use). Figure 19 shows the average soak time durations by season for vehicle model year (i.e., technology) groups.

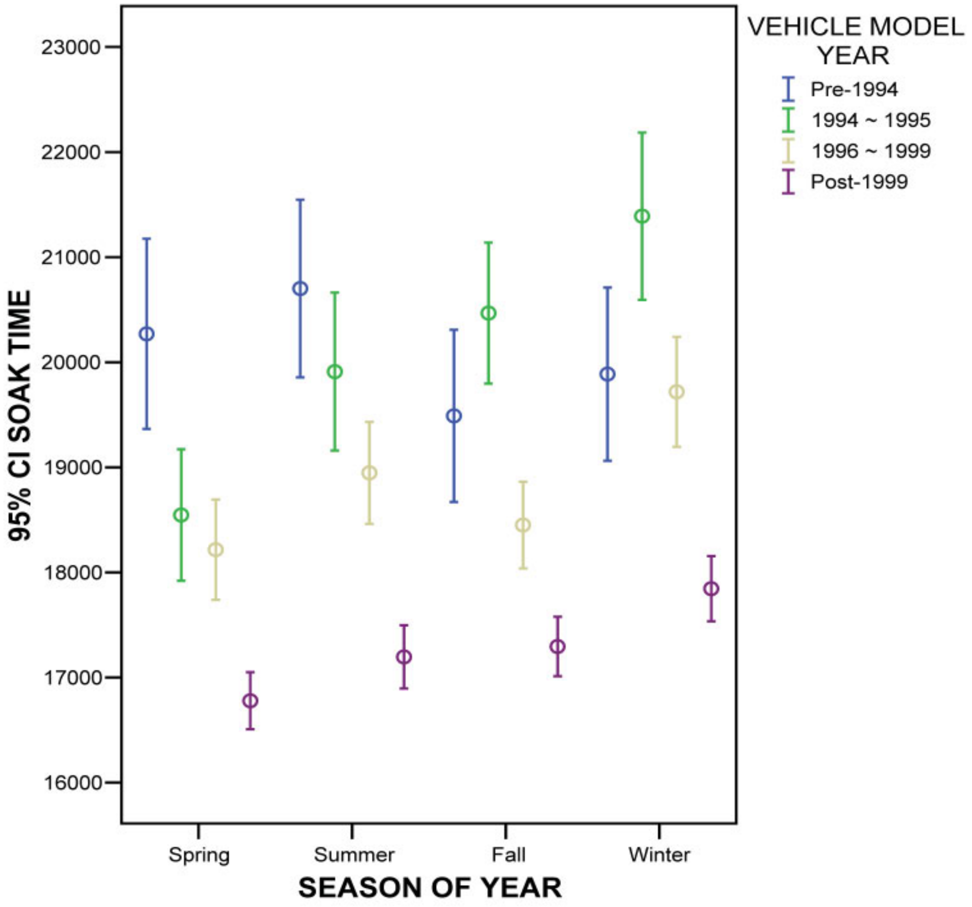

Figure 19: Average Soak Time Duration (Seconds) by Season, by Model Year Group

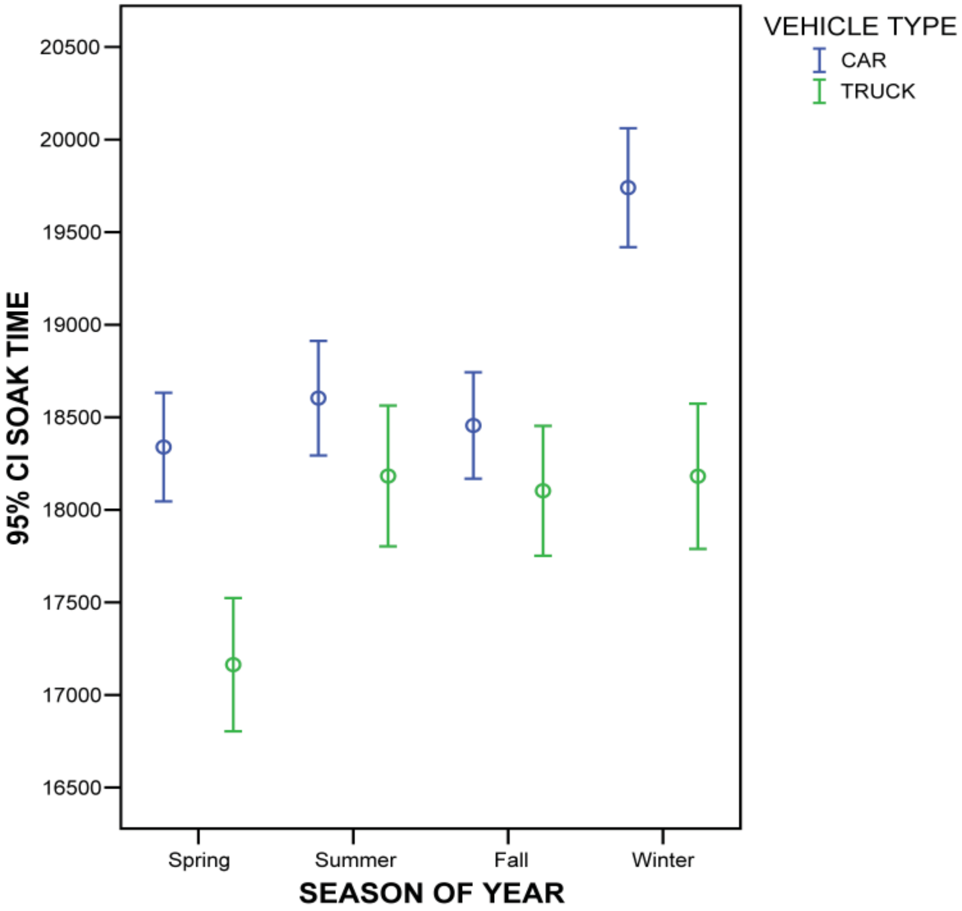

Figure 20: Average Soak Time Duration (Seconds) by Season, by Vehicle Type

Start Time Distributions

The research team developed weekday and weekend start time distributions from the Commute Atlanta vehicle trip data using the same start hour of day intervals as MOBILE6.2 (U.S. EPA, 2001; U.S. EPA, 2003). The Commute Atlanta weekday start time distribution exhibits three peaks (morning, noon, and late afternoon), which are similar to the MOBILE6.2 default start time distributions. However, the magnitudes of the engine start peaks and the time that each peak occurs in the Commute Atlanta start time distribution are significantly different than those observed in the MOBILE6.2 default distributions. The morning high peak occurred at 7 a.m. in the Commute Atlanta distribution, while the morning high peak occurred at 8 a.m. in the MOBIILE6.2 distribution. The noon high peaks occur in the same hours. However, the magnitude in the MOBILE6.2 distribution was greater than that observed in the Commute Atlanta distribution. In the evening, the high peak of MOBILE6.2 start time distribution for LDVs and LDTs occurred at 3 p.m., while the high peak of Commute Atlanta start time distribution occurred at 4 p.m. for

LDVs and 5 p.m. for LDTs. Each of these peaks was also significantly lower in magnitude in the Commute Atlanta distributions. In the MOBILE6.2 default start time distribution, engine start fractions sharply decreased from 6 p.m. to 7 p.m. and were essentially flat from 7 p.m. to 5 a.m. However, Commute Atlanta engine start time fractions gradually decreased from 6 p.m. to 2 a.m. and then increased from 2 a.m. to 6 a.m. Figure 21 shows weekday start time distributions for Commute Atlanta LDV, Commute Atlanta LDT and MOBILE6.2 LDV/LDT.

Soak time durations for LDVs and LDTs differed significantly by season. In general, the soak time distributions and average soak durations for were similar in summer and fall. However, the distributions and average soak durations were quite different in winter and spring. Soak time durations for LDVs were shorter than the soak time durations for LDTs in both winter and spring. Figure 20 shows the average soak time durations by season, by vehicle type.

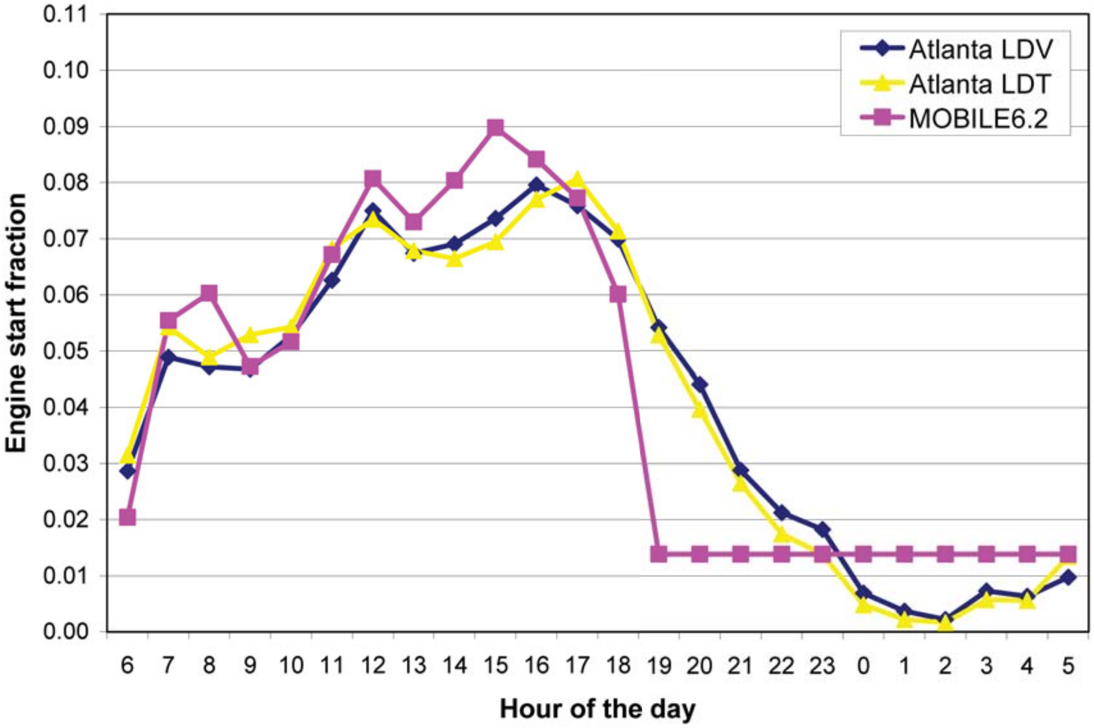

Figure 21: Weekday Engine Start Time Distributions for Commute Atlanta LDVs, Commute Atlanta LDTs, and the MOBILE6.2 Default LDV/LDT Distribution

On weekends, start time distributions for MOBILE6.2 defaults and Commute Atlanta data expressed similar patterns, but their high peaks were slightly different. The MOBILE6.2 default start time distribution had three high peaks at noon, 2 p.m., and 4 p.m., while Commute Atlanta start time distributions had one high peak at noon. In the MOBILE6.2 default start time distribution, engine start fractions sharply decreased from 6 p.m. to 7 p.m. and were essentially flat from 7 p.m. to 5 a.m. However, Commute Atlanta start time fractions gradually decreased from 6 p.m. to 2 a.m. and then increased again at 4 a.m. Figure 22 shows weekend engine start time distributions for Commute Atlanta LDV, Commute Atlanta LDT and MOBILE6.2 default LDV/LDT.

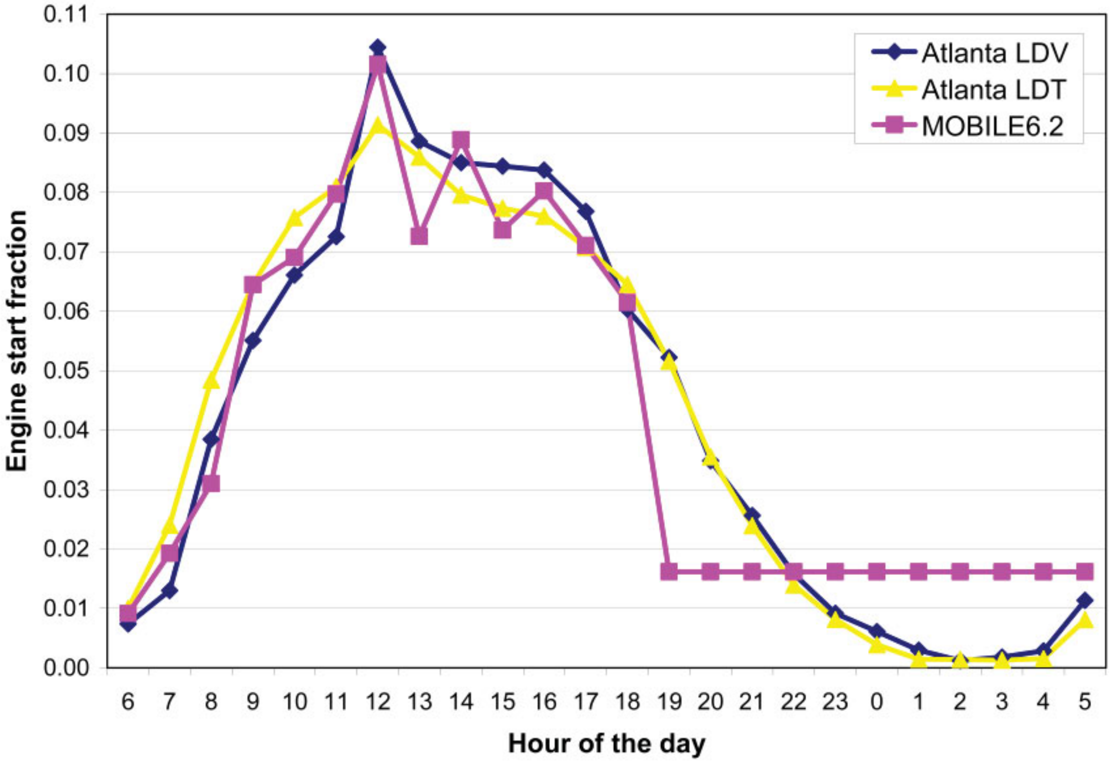

Figure 22: Weekend Engine Start Time Distributions for Commute Atlanta LDVs, Commute Atlanta LDTs, and the MOBILE6.2 Default LDV/LDT Distribution

The research team also developed demographic-parameter-weighted start time distributions for LDV and LDT as described in the section entitled “Demographic Weighting Factors”. The weighted Commute Atlanta weekday and weekend start time distributions (Figures 21 and 22) were almost identical to the unweighted Commute Atlanta start time distributions (see Figures 23 and 24). Appendix B presents weekday and weekend Commute Atlanta start time fractions both unweighted and weighted by demographic parameters.

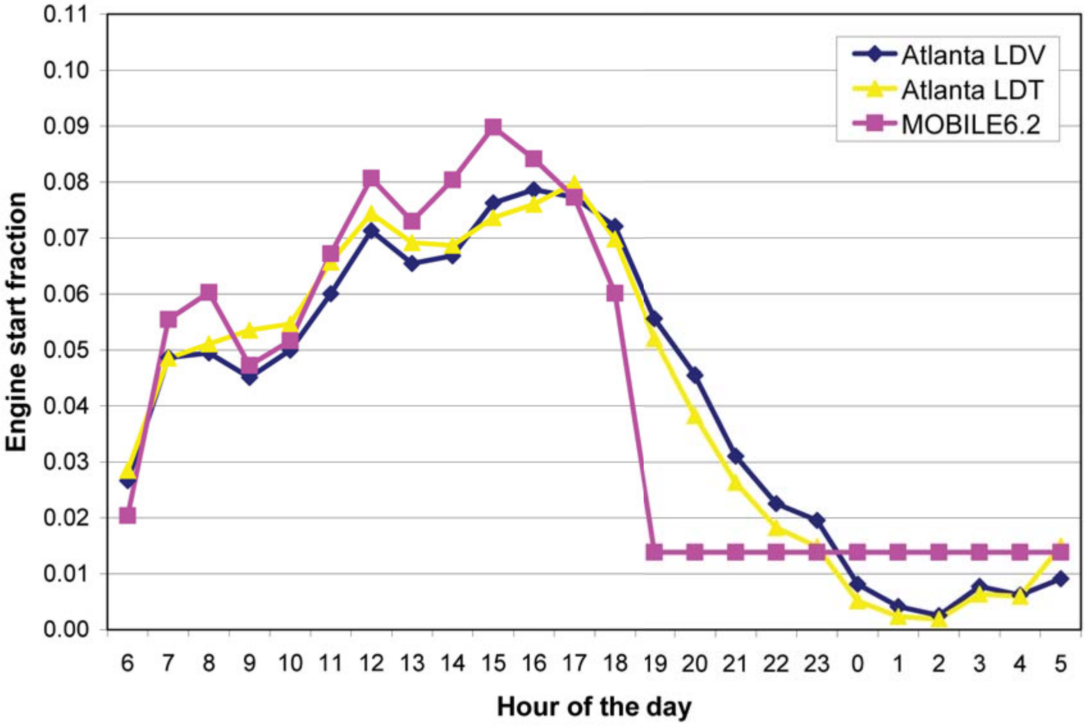

Figure 23: Demographic-Parameter-Weighted Weekday Start Time Distributions for Commute Atlanta LDV, Commute Atlanta LDT, and MOBILE6.2 LDV/LDT

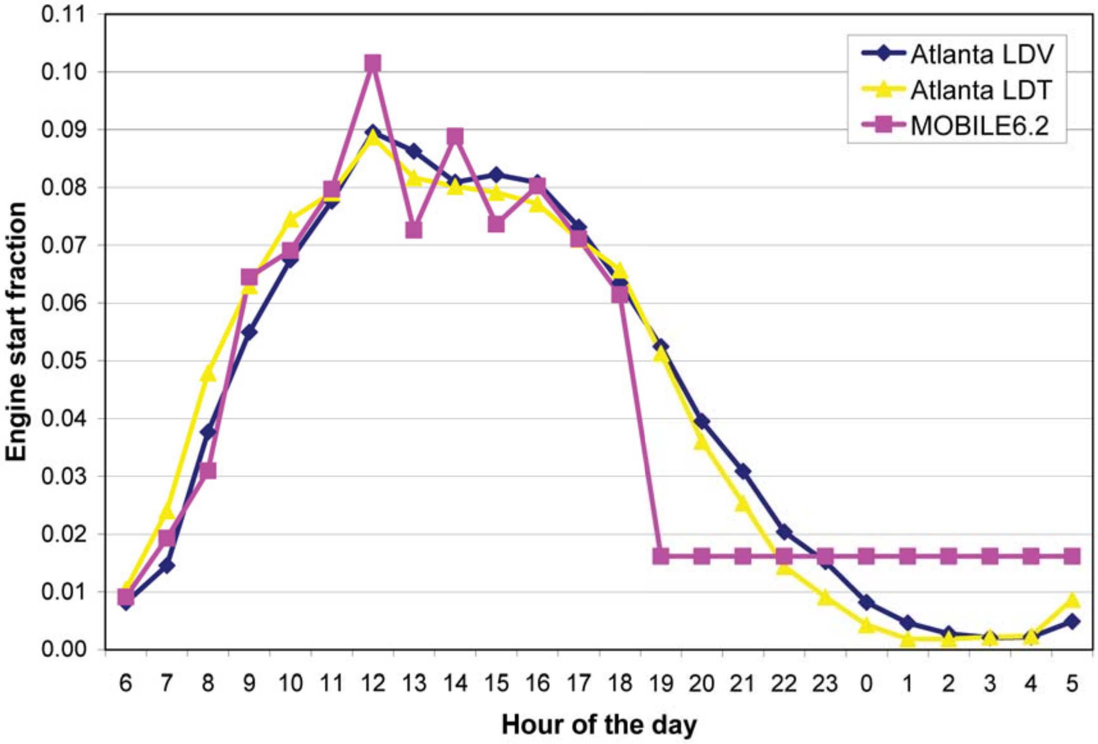

Figure 24: Demographic-Parameter-Weighted Weekend Engine Start Time Distributions for Commute Atlanta LDV, Commute Atlanta LDT, and MOBILE6.2 LDV/LDT

The Commute Atlanta weekday and weekend start time distributions can be readily substituted for MOBILE6.2 default weekday and weekend start time distributions in emission rate modeling for use in Atlanta metropolitan area regional emissions inventory development. The section entitled “Impacts on MOBILE6.2 Modeling and Implications on Emissions Inventory Development” explores the impacts on emission rates and on the regional emission inventory when Commute Atlanta start time distributions replace the default MOBILE6.2 distributions in modeling runs.

Engine Starts per Day

In undertaking the analyses reported herein, the research team noted a significant issue associated with the use of average number of vehicle engine starts per day in the MOBILE6.2 model. The MOBILE6.2 model is used to predict emissions from vehicles that are operating on the roadway (i.e., applied to VMT and VHT data). Hence, the average number of trips pervehicle per day should reflect the activity of those vehicles that are being driven on any given day. Vehicle inactivity, the tendency for some vehicles to sit idle for multiple days, is a major issue in using the instrumented vehicle and in using data collected through standard travel diary survey efforts for the purposes of estimating starts per vehicle per day. If all participating Commute Atlanta vehicles are used to derive average number of trips per day, LDVs make an average of 4.62 trips per vehicle per day. However, for vehicles operating on any given weekday (i.e., if all vehicles that sit idle for the day are excluded from the calculation), Atlanta LDVs make an average of 5.29 trips per vehicle per day. The analyses prepared for this report employed the higher values for average number of trips per vehicle per day for the region, based upon all active vehicles (5.72 trips/day value for LDTs). We believe that most states would probably calculate these values from multi-day travel diary studies in the same manner. Soak and start time distributions only include vehicles that actually made a trip, so these distributions are not affected by this issue.

Engine starts per day in Atlanta were significantly different from MOBILE6.2 default engine starts per day (U.S. EPA, 2001). Commute Atlanta weekday engine starts per day were 27% and 29% lower than MOBILE6.2 default weekday engine starts per day for LDVs and LDTs, respectively. Commute Atlanta weekend engine stars per day were also 5% lower for LDVs and 4% lower for LDTs compared to the MOBILE6.2 default engine starts per day. Commute Atlanta weekday and weekend engine starts per day for LDV and LDT could replace MOBILE6.2 default engine starts per day for emissions impact analysis (see the Section entitled Impacts on MOBILE6.2 Modeling and Implications on Emissions Inventory Development). Demographic-parameter-weighted Commute Atlanta engine starts per day were similar to the Commute Atlanta engine starts per day. The weighted engine starts per day were slightly higher for LDVs and lower for LDTs than the Commute Atlanta engine starts per day. Table 5 shows weekday and weekend engine starts per day for LDVs and LDTs using EPA default data, unweighted Commute Atlanta data, and weighted Commute Atlanta.

Table 5: Weekday and Weekend Engine Starts per Day for LDVs and LDTs

Day	Vehicle Type	Data Source	Starts/Day
Weekday	LDV	EPA[1]	7.28
		ATL[2]	5.29
		WATL[3]	5.35
	LDT	EPA	8.06
		ATL	5.72
		WATL	5.46
Weekend	LDV	EPA	5.41
		ATL	5.12
		WATL	5.41
	LDT	EPA	5.68
		ATL	5.45
		WATL	5.43

1) EPA: MOBILE6.2 Default Engine Starts per Day

2) ATL: Commute Atlanta Engine Starts per Day

3) WATL: Demographic Parameter Weighted Commute Atlanta Engine Starts per Day

Impacts on MOBILE6.2 Modeling and Emissions Inventory Development Implications

The research team conducted emissions impact analysis for emission rates and mobile source emissions inventory development using start and soak time distributions and engine starts per day from: MOBILE6.2 default files, 2004 Commute Atlanta data, and 2004 Commute Atlanta data weighted by Atlanta demographic-parameters.

Impacts on MOBILE6.2 Modeling

The research team developed fifteen scenarios using mutually exclusive combinations of MOBILE6.2 defaults, unweighted Commute Atlanta data, and weighted Commute Atlanta data, for soak time distributions, start distributions, and engine starts per day. Based upon MO-

BILE6.2 modeling results for these scenarios, exhaust engine start emission rates (at trip starts) and evaporative hot soak emission rates (at trip ends) are significantly affected by the various combinations of soak time distribution, start time distribution and engine starts per day.

LDV Exhaust Engine Start Emission Rates

The research team evaluated the effect on LDV engine start exhaust volatile organic compound (VOC) emission rates (g/mi) across the fifteen scenarios (see Figure 25). In this figure, "EPA" is MOBILE6.2 defaults, "ATL" is the unweighted Commute Atlanta data, and "WATL" is the weighted Commute Atlanta data. Scenario 1 provides the results for engine start emission rates using MOBILE6.2 default control variables for all three inputs. Scenario 2 provides the results for start emission rates using the Commute Atlanta soak time distribution and MOBILE6.2 start time distribution and starts per day. The LDV exhaust engine start emission rate in the Scenario 2 was 15.9% greater than the Scenario 1. This is because Commute Atlanta soak time distributions have longer average soak durations than MOBILE6.2 default soak time durations and longer soak durations yield higher engine start emission rates. Scenario 3 provides start emission rates using the Commute Atlanta start distribution and MOBILE6.2 soak time distribution and engine starts per day. The engine start emission rate in the Scenario 3 was only 1.2% greater than Scenario 1. The differences were not significant because Commute Atlanta start time distributions are very similar to MOBILE6.2 default start time distributions. Scenario 4 examines engine start emission rate using Commute Atlanta engine starts per day and MOBILE6.2 default soak and start time distributions. The engine start emissions rate in Scenario 4 (grams/mile) was 27.3% lower than Scenario 1 because the average number of engine starts per day from the Commute Atlanta data was 27.3% lower than the MOBILE6.2 default number of engine starts per day.

It is important to note that the grams per start emission rate is unaffected by the number of engine starts per day. The reduction in MOBILE6.2-predicted gram/mile emission rates arises from the internal MOBILE6.2 calculations that translate embedded grams per start emission rates into grams/mile emission rates for use in regional modeling undertaken by agencies that inventory model using only mileage (i.e., by agencies that do not track the temporal and spatial locations of engine starts). Average number of starts per day, multiplied by the embedded grams per start emission rate by vehicle class, divided by average daily mileage accumulation by vehicle class yields the grams/mile start emission rates. Modeling runs that employ a combination of default and field data could produce seemingly reasonable results but are completely erroneous due to the misunderstanding that engine starts per day and mileage accumulation rate data are co-dependent. For example, in estimating the emissions inventory for Atlanta, modelers could choose to use the default MOBILE6.2 mileage accumulation rates with field-derived starts/day observations. If this occurs, the predicted inventory for engine start emissions (miles of travel multiplied by the grams/mile engine start emission rate) is significantly lower when the engine start field data are used, even though the emission rate in grams per start did not really change. It may be prudent to require modelers to use default data unless field data are available for both engine starts per day and mileage accumulation, as these parameters are not completely independent.

Nonattainment areas typically employ field data to estimate annual mileage accumulation rates in their inventory modeling. Inspection and maintenance programs that record odometer readings every year or two provide more estimates of mileage accumulation that are more accurate than the default MOBILE6.2 distributions. However, few regions have access to field data to estimate starts/day activity. It may be prudent to require modeling runs that use default data for mileage accumulation to also use default data for engine starts per day. Similarly, it may be prudent to require agencies that use regional mileage accumulation rates based upon inspection and maintenance data to collect sufficient field data to estimate regional engine starts per day. Because engine start emission rates are unaffected by the number of engine starts per day, and because the spatial and temporal distribution of engine start activity is critical to the regional ozone modeling process, it seems even more prudent to urge regions to model engine starts and running exhaust emissions separately, with engine start emissions calculated as number of starts by vehicle class and model year multiplied by applicable grams per start emission rates (embedded in the model). The next generation of the MOBILE model would need to be modified to provide applicable emission rate outputs to support this recommendation.

It is also important to note here that the number of engine starts per day and the shape of soak time distributions are not independent. That is, when a vehicle makes more trips per day, the soak times between trips must necessarily decline. Even start time distributions and soak time distributions are not independent. Given that long soaks (greater than 8 hours) occur more frequently associated with overnight inactivity, changes in start time distributions are correlated with changes in soak time distributions (and engine starts per day). In effect, to properly compare differences between the use of EPA default values and regionally-derived values (such as from Commute Atlanta data) should only be done when all three distributions are taken from regional data.

Start emission rates using soak time distributions, start time distributions, and engine starts par day all taken from Commute Atlanta data (Scenario 8) were 17.4% lower than start emission rates based upon MOBILE6.2 default data. Start emission rates using weighted Commute Atlanta soak and start time distributions and engine starts per day were only about 1% higher than the rates based upon unweighted Commute Atlanta data (and still more than 16.5%

lower than the emission rates based upon EPA default values). Table 6 provides the percentage differences across the unweighted commute data scenarios relative to the MOBILE6.2 default analysis. Table 7 illustrates the marginal percentage difference in these emission rate changes hen weighted Commute Atlanta data are used in lieu of unweighted Commute Atlanta data.

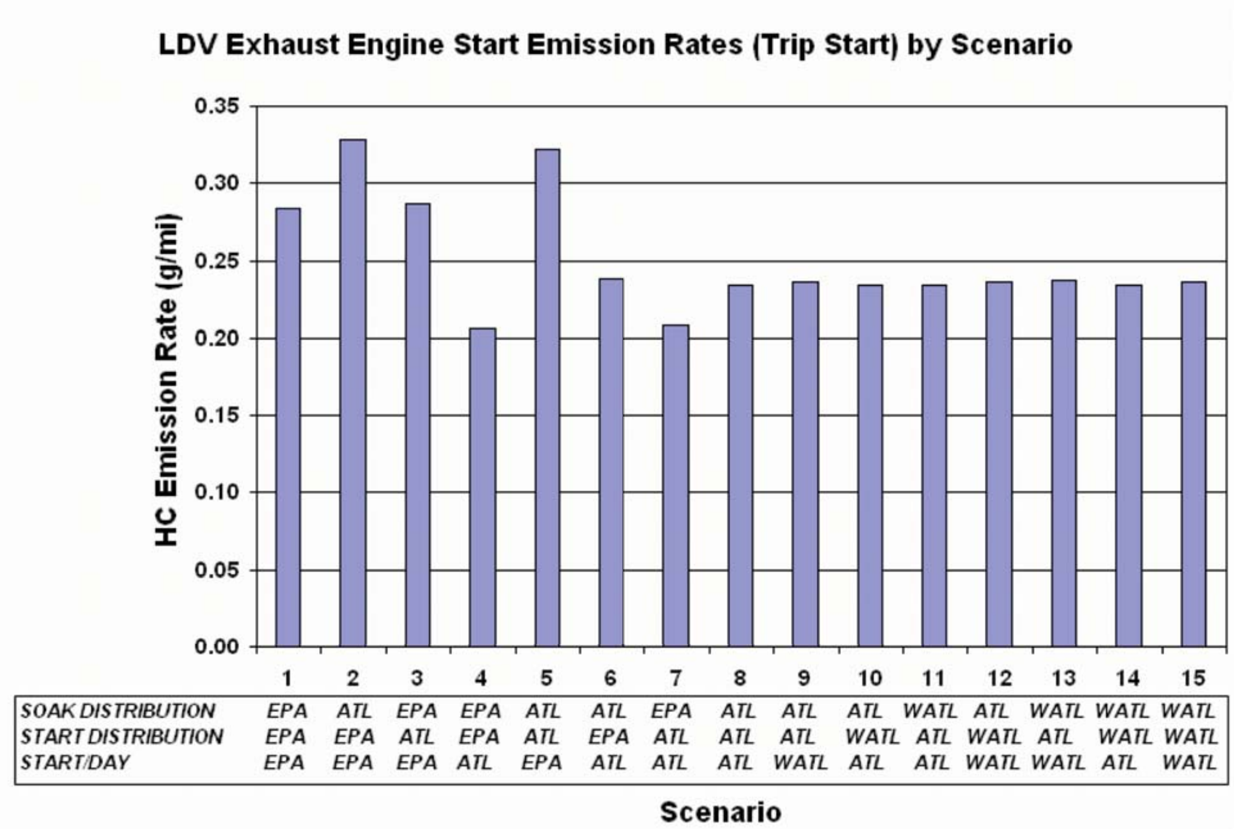

Figure 25: LDV Exhaust Engine Start Emission Rates for each Modeling Scenario

Table 6: Commute Atlanta LDV Exhaust Engine Start Emission Rate Changes Relative to MOBILE6.2 Default Data

Scenario	Combination of Control Data			Change in Engine Start Emission Rates Relative to MOBILE6.2 Default Data (%)
	Soak Time	Engine Start Time	Engine Starts per Day	
1	EPA	EPA	EPA	0.0
2	ATL	EPA	EPA	+15.9
3	EPA	ATL	EPA	+1.2
4	EPA	EPA	ATL	-27.3
5	ATL	ATL	EPA	+13.6
6	ATL	EPA	ATL	-15.8
7	EPA	ATL	ATL	-26.5
8	ATL	ATL	ATL	-17.4

Table 7: Demographic-Parameter-Weighted LDV Exhaust Engine Start Emission Rate Changes from Commute Atlanta Data

Scenario	Combination of Control Data			Change in Engine Start Emission Rates Relative to Commute Atlanta Data (%)
	Soak Time	Engine Start Time	Engine Starts per Day	
8	ATL	ATL	ATL	0.0
9	ATL	ATL	WATL	+1.1
10	ATL	WATL	ATL	0.0
11	WATL	ATL	ATL	+0.1
12	ATL	WATL	WATL	+1.1
13	WATL	ATL	WATL	+1.2
14	WATL	WATL	ATL	0.0
15	WATL	WATL	WATL	+1.1

LDV Evaporative Hot Soak Emission Rates

In the MOBILE6.2 model, evaporative hot soak emission rates (g/mi) are only affected by engine starts per day. Trip end evaporative hot soak emission rates are not affected by soak and start time distributions. Because the number of Commute Atlanta engine starts per day was 27.3% lower than the MOBILE6.2 default engine starts per day, evaporative hot soak emission rate with Commute Atlanta engine starts per day were 27.3% lower than emission rate with MOBILE6.2 default. Because the number of weighted Commute Atlanta engine starts per day was 1.1% greater than Commute Atlanta engine starts per day, evaporative hot soak emission rates with weighted Commute Atlanta engine starts per day was 1.1% greater than emission rate with unweighted Commute Atlanta engine starts per day. Figure 26 shows LDV evaporative hot soak emission rates for scenarios.

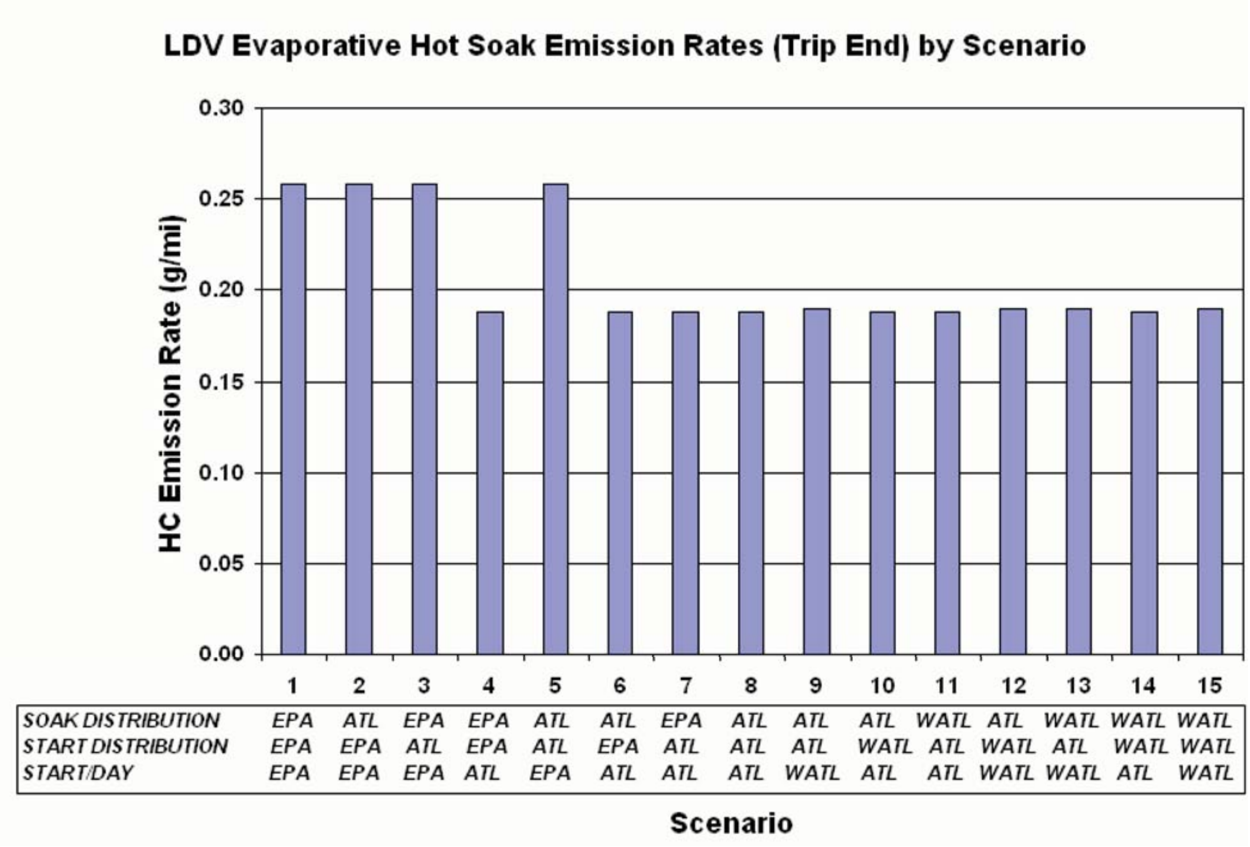

Figure 26: LDV Evaporative Hot Soak Emission Rates for each Modeling Scenario

Impacts on Atlanta Mobile Source Emissions Inventory Development

The research team evaluated impacts of using Commute Atlanta data in developing the volatile organic compound (VOC) onroad mobile source emissions inventory for the 13-county Atlanta metropolitan area. Because the State Implementation Plan (SIP) inventory for onroad mobile source VOC emissions does not distinguish emissions by start, soak, and stabilized contribution in Atlanta, the research team assumed that VOC emissions contributed by start and soak activity are in proportion to the start and hot soak VOC emission rates for the calendar year 2005. Because LDV and LDT contribute 90.2% (Morton, 2005) of total onroad mobile source VOC emissions in the region in 2004, the contribution was multiplied by the total mobile source VOC emissions to estimate LDV and LDT start and hot soak emissions. Using Mobile6.2 default soak and engine start time distributions and engine starts per day, engine starts contribute 25.6% of the VOC composite emission rates and hot soaks contribute 14.2% of VOC composite emission rates for calendar year 2005. These percentages were multiplied by the aggregated daily onroad VOC inventory to estimate start and hot soak VOC emissions in the region. Because start and hot soak VOC emission rates decreased by 17.4% and 27.3%, respectively, using Commute Atlanta soak and engine start distributions and engine starts per day (see the previous section), these reduction rates could be directly applied to estimate reduced VOC emissions by start and hot soak activities. By applying start and hot soak reduction rates, the research team estimates an 8.3% reduction in onroad VOC emissions. This implies that VOC emissions from Atlanta regional mobile source emissions inventory appear to be significantly overestimated when MOBILE6.2 default soak and engine start time distributions and engine starts per day are used for the Atlanta 13-county metropolitan area.

Impact on Emissions Inventory Development in Other Cities

The research team conducted emissions inventory impact analysis for three additional areas. For this impact analysis, the research team obtained MOBILE6.2 control files for: Gaston County, NC, Mecklenburg County, NC, and York County, SC. The research team modeled engine start and hot soak emission rates with the three county MOBILE6.2 control files and compared them to emission rates modeled with the Atlanta 13-county MOBILE6.2 control file. Table 8 shows control parameters for the three counties and the 13-county Atlanta region. Appendix C shows the MOBILE6.2 control files for Gaston County, NC, Mecklenburg County, NC, York County, SC, and the 13-county Atlanta Metropolitan Area, GA.

Table 8: MOBILE6.2 Control Parameters for Gaston County, NC, Mecklenburg County, NC, York County, SC, and the 13-county Atlanta Metropolitan Area, GA

Parameters	Region or Counties			
	Atlanta, GA	Gaston, NC	Mecklenburg, NC	York, SC
Temperature (Min/Max)	72/94	69.7/92.3	69.9/90.5	70.0/92.9
Humidity (Min/Max)	32/70	48.7/90.2	47.5/89.9	47.7/90.5
Pressure	28.98	29.0	29.2	29.2
Fuel RVP	7.0	7.4	7.4	7.4
Fuel Program	YES	YES[iii]	YES[iii]	YES[iii]
Anti-Temp Program	YES	YES	YES	NO
I/M Program	YES	YES	YES	NO
Registration Distribution	ATL(i)	EPA(ii)	EPA	EPA
Soak Time Distribution	ATL	EPA	EPA	EPA
Start Time Distribution	ATL	EPA	EPA	EPA
Starts per Day	ATL	EPA	EPA	EPA

(i) MOBILE6.2 Control Parameters for the 13-County Atlanta Metropolitan Area

(ii) MOBILE6.2 Default Control Parameters

(iii) National Default Fuel Program

Hourly ambient temperature and pressure for counties in Table 8 all differ slightly from the 13-county Atlanta region. Ambient humidity distribution for Atlanta was much drier than other counties. Fuel RVP for Atlanta was 7.0 while 7.4 for other counties. Atlanta, Gaston, and Mecklenburg had inspection/maintenance (I/M) and anti-tempering programs. York County, SC had no inspection and maintenance program in place (accounting for the large difference in emission rates across the three counties). Atlanta used their own registration distribution, soak and start time distributions, and engine start per day files while the other three counties used MOBILE6.2 default data files created by the U.S. EPA.

The research team modeled start and hot soak emission rates using the MOBILE6.2 control files for each county and then compared the emission rate outputs for each county to the outputs for the Atlanta Metropolitan Area with Commute Atlanta data. Start and hot soak emission rates predicted for these three counties were higher than the emission rates predicted for the Atlanta region. Start emission rates were 8.9%, 8.7%, and 25.8% higher than Atlanta for Gaston, Mecklenburg, and York counties, respectively. Hot soak emission rates were 34.7%, 34.3%, and 35.6% higher for Gaston, Mecklenburg, and York counties, respectively. Table 9 shows the ratio of start and hot soak emissions rates for the three cities compared to the Atlanta metropolitan area emission rates.

Table 9: Ratios of Start and Hot Soak Emission Rates for Gaston County, NC, Mecklenburg County, NC, and York County, SC (Using MOBILE6.2 Default Data) to the Emission Rates for the Atlanta Metropolitan Area (Using Commute Atlanta Data)

Emission Rates	**Emission Rate Ratio of County Emission Rates (MOBILE6.2 Default Data) to Atlanta Metropolitan Area Emission Rates (Commute Atlanta Data)**		
	Gaston	Mecklenburg	York
Start	1.089	1.087	1.258
Hot Soak	1.347	1.343	1.356

Start and hot soak emission rates with EPA default soak and engine start time distributions and engine starts per day for the three counties were greater than those emissions rates with the Commute Atlanta data files. If these three counties used the Commute Atlanta data files, predicted start emission rates would change by -9.2%, -9.2% and +3.9%, for Gaston, Mecklenburg, and York, respectively. Similarly, hot soak emission rates change by -2.1%, -2.4% and -1.5% for Gaston, Mecklenburg, and York, respectively. By applying the Commute Atlanta data files, start and hot soak emission rates for the three counties were significantly lower than when the EPA default data files were employed in emission rate and emission inventory analysis. Table 10 shows the three county LDV start and hot soak emission rate ratios to the 13-county Atlanta metropolis.

Table 10: Ratios of Start and Hot Soak Emission Rates for Gaston County, NC, Mecklenburg County, NC, and York County, SC (Using Commute Atlanta Data) to the Emission Rates for the Atlanta Metropolitan Area (Using Commute Atlanta Data)

Emission Type	Emission Rate Ratio of County Emission Rates (Commute Atlanta Data) to Atlanta Metropolitan Area Emission Rates (Commute Atlanta Data)		
	Gaston	Mecklenburg	York
Start	0.898	0.898	1.039
Hot Soak	0.979	0.976	0.985

To investigate the counties' emission rate differences from Atlanta, the research team conducted a sensitivity analysis of start and hot soak emission rates across various modeling parameters. For this analysis, the research team used MOBILE6.2 control files for York County and the 13-county Atlanta area and developed five scenarios with five modeling parameters including environmental parameters (temperature, humidity, and pressure), fuel RVP, state fuel programs, I/M programs, and registration distributions. For each scenario, each of the five modeling parameters for York County was replaced one at a time by the applicable modeling parameter for the Atlanta region. Environmental parameters, state fuel programs, I/M programs, and registration distributions all impact start emission rates. Start emission rates changed by more than -15% and +15% across the differences in I/M programs and registration distributions. Fuel program effects were very small and ignorable. Fuel RVP did not affect engine start emission rates.

Differences in environmental parameters, fuel RVP, I/M programs, and registration distributions all impacted hot soak emission rates. Environmental parameter differences yielded small and ignorable effects on hot soak emission rates. Hot soak emission rate changes by fuel RVP and I/M programs were moderate, hot soak emission rates decreased by about 5% after replacing York County fuel RVP and I/M program parameters with the parameters from the Atlanta region. However, hot soak emission rate increased more than 10% by replacing the registration distributions. Fuel program did not affect hot soak emission rate. Table 11 shows MOBILE6.2 control parameters affecting start and hot soak emission rates by replacing York County control parameters to parameters for the Atlanta. YES means start and hot soak emission rates were affected by control parameter, and NO means that no impact was noted.

Table 11: MOBILE6.2 Control Parameters Affecting Start and Hot Soak Emission Rates

Emission Type	Environmental Parameters	Fuel RVP	Parameters Fuel Program	I/M Program	Registration Distribution
Start	YES	NO	YES	YES	YES
Hot Soak	YES	YES	NO	YES	YES

If Commute Atlanta soak and start distributions and engine start per day are applicable in other regions, such as Gaston, Mecklenburg, and York counties, those counties can also expect to predict significantly lower onroad VOC emissions. For example, if LDV and LDT contribute the same percentage of total onroad mobile source VOC emissions as observed in the Atlanta emission inventory (90.2%), Gaston, Mecklenburg and York counties would likely predict lower onroad mobile source VOC inventory emissions by 7.76%, 7.76%, and 7.80%, respectively.

Conclusions

The Georgia Tech research team developed soak and start time distributions and engine starts per day using LDV and LDT trip data collected in the Commute Atlanta study during 2004. Commute Atlanta soak and start time distributions show similar distribution patterns to MOBILE6.2 default soak and start time distributions. However, Commute Atlanta soak time distributions exhibited longer soak durations (i.e., especially for soaks greater than 720 minutes) with a wider stretch from 3 a.m. to 11 a.m. and 4 a.m. to 2 p.m. for weekday and weekend. Commute Atlanta start time distributions gradually decrease from 6 p.m. to 2 a.m. and increase from 2 a.m., while MOBILE6.2 default start time distributions sharply decrease at 6 p.m. to 7 p.m. and show more flat patterns from 7 p.m. to 5 a.m. Commute Atlanta engine starts per day for LDVs were significantly lower in Atlanta than are currently employed as MOBILE6.2 defaults: 27% lower on weekdays and 5% lower on weekends.

Commute Atlanta soak and start time distributions and engine starts per day significantly influence VOC start and hot soak emission rates and mobile source emissions inventory development. By applying Commute Atlanta soak and start time distributions and engine starts per day in MOBILE6.2 emission rate modeling, engine start VOC emission rates are predicted to be 17.4% lower and hot soak VOC emission rates are predicted to be 27.3% lower. These significant reductions can account for an 8.3% reduction in predicted onroad VOC emissions in the 13-county Atlanta metropolitan area. If the Commute Atlanta soak and start time distributions and engine starts per day are applicable to other cities, predicted onroad mobile source VOC emissions inventories in these regions would also significantly decrease. Given the effect on regional emissions inventories predictions, the results of the study indicate that additional start/soak data collection and analytical efforts are warranted and that longitudinal instrumented vehicle studies may be the preferred method for collecting such data.

Appendix A: Commute Atlanta Soak Time Distributions

Appendix A1: Commute Atlanta Weekday Soak Time Distributions

		MOBILE6.2 HOUR OF DAY																							
		6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5
	1	0.0287	0.0332	0.0381	0.0401	0.0359	0.0353	0.0332	0.0331	0.0356	0.0358	0.0319	0.0340	0.0327	0.0317	0.0336	0.0371	0.0264	0.0206	0.0311	0.0410	0.0333	0.0118	0.0097	0.0199
	2	0.0299	0.0350	0.0383	0.0444	0.0401	0.0376	0.0365	0.0386	0.0379	0.0400	0.0380	0.0377	0.0354	0.0359	0.0376	0.0402	0.0302	0.0199	0.0235	0.0271	0.0241	0.0050	0.0090	0.0214
	3	0.0267	0.0293	0.0367	0.0441	0.0438	0.0385	0.0383	0.0387	0.0399	0.0424	0.0384	0.0365	0.0369	0.0369	0.0351	0.0328	0.0239	0.0155	0.0246	0.0217	0.0276	0.0091	0.0041	0.0146
	4	0.0193	0.0212	0.0290	0.0360	0.0371	0.0327	0.0331	0.0355	0.0350	0.0333	0.0345	0.0334	0.0295	0.0286	0.0312	0.0252	0.0203	0.0135	0.0181	0.0193	0.0218	0.0064	0.0041	0.0122
	5	0.0147	0.0157	0.0220	0.0275	0.0305	0.0296	0.0268	0.0285	0.0303	0.0283	0.0290	0.0263	0.0248	0.0247	0.0264	0.0221	0.0162	0.0088	0.0123	0.0170	0.0207	0.0027	0.0026	0.0088
	6	0.0093	0.0123	0.0175	0.0236	0.0251	0.0256	0.0252	0.0244	0.0225	0.0247	0.0229	0.0214	0.0211	0.0199	0.0231	0.0147	0.0109	0.0069	0.0094	0.0124	0.0092	0.0010	0.0019	0.0034
	7	0.0062	0.0093	0.0142	0.0182	0.0219	0.0206	0.0199	0.0203	0.0215	0.0221	0.0193	0.0194	0.0183	0.0190	0.0158	0.0153	0.0114	0.0063	0.0069	0.0085	0.0069	0.0020	0.0004	0.0032
	8	0.0037	0.0070	0.0133	0.0169	0.0177	0.0191	0.0191	0.0189	0.0198	0.0179	0.0168	0.0172	0.0165	0.0146	0.0150	0.0131	0.0099	0.0059	0.0043	0.0062	0.0092	0.0013	0.0019	0.0032
	9	0.0030	0.0054	0.0106	0.0138	0.0161	0.0167	0.0147	0.0180	0.0158	0.0167	0.0167	0.0165	0.0155	0.0142	0.0135	0.0118	0.0068	0.0046	0.0076	0.0062	0.0092	0.0013	0.0022	0.0019
	10	0.0031	0.0050	0.0091	0.0125	0.0136	0.0154	0.0147	0.0148	0.0151	0.0153	0.0146	0.0154	0.0140	0.0154	0.0132	0.0108	0.0070	0.0039	0.0043	0.0039	0.0103	0.0013	0.0019	0.0015
	11	0.0029	0.0041	0.0084	0.0105	0.0129	0.0139	0.0130	0.0144	0.0126	0.0135	0.0133	0.0122	0.0122	0.0133	0.0117	0.0125	0.0075	0.0034	0.0040	0.0039	0.0023	0.0010	0.0030	0.0011
	12	0.0025	0.0031	0.0073	0.0088	0.0118	0.0128	0.0128	0.0122	0.0133	0.0134	0.0128	0.0135	0.0111	0.0113	0.0100	0.0104	0.0060	0.0042	0.0033	0.0023	0.0046	0.0010	0.0007	0.0009
	13	0.0015	0.0029	0.0062	0.0088	0.0113	0.0119	0.0116	0.0120	0.0124	0.0113	0.0116	0.0115	0.0106	0.0106	0.0100	0.0085	0.0061	0.0034	0.0069	0.0046	0.0046	0.0017	0.0007	0.0006
	14	0.0011	0.0027	0.0058	0.0081	0.0105	0.0105	0.0118	0.0122	0.0123	0.0105	0.0111	0.0099	0.0113	0.0117	0.0099	0.0074	0.0064	0.0037	0.0040	0.0085	0.0011	0.0013	0.0011	0.0004
	15	0.0012	0.0026	0.0053	0.0068	0.0109	0.0102	0.0109	0.0116	0.0110	0.0104	0.0096	0.0102	0.0097	0.0098	0.0085	0.0081	0.0056	0.0022	0.0054	0.0039	0.0023	0.0017	0.0015	0.0007
	16	0.0018	0.0024	0.0049	0.0072	0.0085	0.0100	0.0097	0.0096	0.0111	0.0117	0.0090	0.0098	0.0097	0.0077	0.0094	0.0064	0.0050	0.0030	0.0018	0.0031	0.0034	0.0013	0.0007	0.0011
	17	0.0018	0.0025	0.0050	0.0066	0.0084	0.0096	0.0096	0.0108	0.0100	0.0097	0.0095	0.0090	0.0078	0.0082	0.0072	0.0060	0.0039	0.0033	0.0025	0.0023	0.0000	0.0013	0.0007	0.0009
	18	0.0013	0.0020	0.0055	0.0074	0.0079	0.0088	0.0096	0.0096	0.0097	0.0096	0.0088	0.0077	0.0090	0.0080	0.0085	0.0057	0.0037	0.0034	0.0014	0.0062	0.0023	0.0010	0.0000	0.0009
	19	0.0015	0.0020	0.0042	0.0062	0.0087	0.0087	0.0084	0.0099	0.0088	0.0091	0.0081	0.0083	0.0083	0.0076	0.0077	0.0059	0.0041	0.0031	0.0047	0.0062	0.0011	0.0030	0.0007	0.0004
	20	0.0015	0.0019	0.0046	0.0056	0.0075	0.0082	0.0087	0.0089	0.0098	0.0077	0.0081	0.0078	0.0081	0.0075	0.0075	0.0063	0.0044	0.0041	0.0043	0.0023	0.0046	0.0007	0.0011	0.0009
	21	0.0016	0.0020	0.0036	0.0048	0.0072	0.0076	0.0089	0.0091	0.0086	0.0075	0.0072	0.0071	0.0065	0.0078	0.0068	0.0043	0.0035	0.0033	0.0025	0.0039	0.0000	0.0017	0.0007	0.0004
S	22	0.0018	0.0013	0.0040	0.0039	0.0074	0.0068	0.0080	0.0076	0.0093	0.0080	0.0080	0.0064	0.0071	0.0078	0.0067	0.0056	0.0036	0.0025	0.0022	0.0046	0.0011	0.0003	0.0000	0.0004
O	23	0.0016	0.0018	0.0031	0.0043	0.0058	0.0076	0.0082	0.0082	0.0074	0.0072	0.0073	0.0064	0.0066	0.0059	0.0055	0.0059	0.0027	0.0024	0.0040	0.0039	0.0034	0.0007	0.0000	0.0007
A	24	0.0023	0.0014	0.0037	0.0048	0.0062	0.0068	0.0069	0.0087	0.0074	0.0069	0.0072	0.0057	0.0073	0.0061	0.0064	0.0044	0.0038	0.0014	0.0018	0.0031	0.0011	0.0003	0.0007	0.0007
K	25	0.0015	0.0017	0.0031	0.0051	0.0053	0.0077	0.0079	0.0077	0.0066	0.0070	0.0064	0.0061	0.0064	0.0066	0.0058	0.0044	0.0034	0.0024	0.0033	0.0008	0.0046	0.0013	0.0007	0.0006
C	26	0.0012	0.0014	0.0030	0.0047	0.0063	0.0068	0.0072	0.0073	0.0070	0.0066	0.0064	0.0057	0.0064	0.0065	0.0055	0.0053	0.0035	0.0026	0.0040	0.0031	0.0000	0.0003	0.0000	0.0006
O	27	0.0010	0.0017	0.0028	0.0045	0.0051	0.0065	0.0081	0.0071	0.0068	0.0064	0.0064	0.0061	0.0064	0.0063	0.0060	0.0049	0.0032	0.0028	0.0040	0.0054	0.0011	0.0000	0.0004	0.0006
D	28	0.0008	0.0015	0.0036	0.0049	0.0049	0.0060	0.0076	0.0078	0.0068	0.0058	0.0052	0.0059	0.0060	0.0061	0.0052	0.0046	0.0026	0.0016	0.0025	0.0031	0.0011	0.0000	0.0004	0.0002
E	29	0.0010	0.0014	0.0031	0.0039	0.0056	0.0061	0.0067	0.0077	0.0068	0.0053	0.0054	0.0057	0.0060	0.0049	0.0046	0.0032	0.0019	0.0017	0.0022	0.0000	0.0023	0.0007	0.0007	0.0011
	30	0.0007	0.0015	0.0033	0.0029	0.0049	0.0054	0.0071	0.0073	0.0069	0.0054	0.0051	0.0045	0.0058	0.0066	0.0055	0.0035	0.0016	0.0021	0.0018	0.0008	0.0023	0.0003	0.0007	0.0006
	31	0.0026	0.0029	0.0055	0.0078	0.0104	0.0113	0.0146	0.0136	0.0105	0.0099	0.0098	0.0102	0.0110	0.0122	0.0101	0.0085	0.0054	0.0038	0.0054	0.0070	0.0000	0.0007	0.0007	0.0007
	32	0.0023	0.0033	0.0055	0.0071	0.0094	0.0098	0.0144	0.0136	0.0123	0.0092	0.0092	0.0096	0.0116	0.0109	0.0077	0.0064	0.0038	0.0034	0.0047	0.0062	0.0023	0.0000	0.0007	0.0002
	33	0.0022	0.0020	0.0051	0.0066	0.0096	0.0106	0.0129	0.0134	0.0105	0.0098	0.0096	0.0083	0.0102	0.0114	0.0100	0.0078	0.0057	0.0026	0.0051	0.0039	0.0023	0.0010	0.0004	0.0009
	34	0.0018	0.0027	0.0056	0.0064	0.0080	0.0091	0.0130	0.0111	0.0105	0.0092	0.0085	0.0086	0.0099	0.0098	0.0081	0.0071	0.0054	0.0034	0.0029	0.0008	0.0069	0.0003	0.0004	0.0002
	35	0.0008	0.0027	0.0055	0.0063	0.0083	0.0092	0.0116	0.0116	0.0104	0.0083	0.0076	0.0080	0.0093	0.0101	0.0087	0.0059	0.0047	0.0041	0.0040	0.0046	0.0057	0.0010	0.0007	0.0004
	36	0.0013	0.0020	0.0050	0.0048	0.0076	0.0079	0.0113	0.0115	0.0096	0.0075	0.0081	0.0079	0.0089	0.0102	0.0085	0.0078	0.0057	0.0022	0.0040	0.0031	0.0034	0.0003	0.0015	0.0015
	37	0.0004	0.0016	0.0050	0.0052	0.0071	0.0080	0.0101	0.0108	0.0094	0.0080	0.0079	0.0076	0.0094	0.0096	0.0090	0.0065	0.0066	0.0050	0.0036	0.0046	0.0011	0.0003	0.0011	0.0007
	38	0.0007	0.0018	0.0040	0.0053	0.0076	0.0068	0.0099	0.0093	0.0077	0.0077	0.0068	0.0073	0.0085	0.0103	0.0071	0.0073	0.0041	0.0043	0.0051	0.0046	0.0034	0.0003	0.0000	0.0006
	39	0.0007	0.0018	0.0047	0.0050	0.0080	0.0069	0.0099	0.0100	0.0076	0.0066	0.0059	0.0065	0.0088	0.0112	0.0083	0.0067	0.0044	0.0029	0.0043	0.0062	0.0000	0.0003	0.0004	0.0006
	40	0.0010	0.0012	0.0039	0.0044	0.0072	0.0067	0.0091	0.0099	0.0079	0.0071	0.0068	0.0064	0.0088	0.0108	0.0082	0.0061	0.0046	0.0030	0.0047	0.0046	0.0023	0.0013	0.0000	0.0004
	41	0.0007	0.0016	0.0036	0.0048	0.0054	0.0065	0.0087	0.0087	0.0081	0.0069	0.0057	0.0066	0.0082	0.0098	0.0088	0.0072	0.0056	0.0039	0.0025	0.0031	0.0034	0.0017	0.0011	0.0002
	42	0.0012	0.0018	0.0038	0.0048	0.0058	0.0058	0.0084	0.0083	0.0078	0.0064	0.0059	0.0061	0.0078	0.0090	0.0082	0.0076	0.0041	0.0033	0.0054	0.0023	0.0069	0.0003	0.0011	0.0011
	43	0.0010	0.0015	0.0033	0.0043	0.0061	0.0064	0.0065	0.0083	0.0075	0.0065	0.0050	0.0061	0.0073	0.0088	0.0083	0.0058	0.0045	0.0029	0.0054	0.0054	0.0011	0.0003	0.0004	0.0006
	44	0.0007	0.0013	0.0035	0.0044	0.0047	0.0062	0.0058	0.0081	0.0067	0.0059	0.0053	0.0059	0.0078	0.0098	0.0081	0.0052	0.0061	0.0034	0.0036	0.0031	0.0057	0.0010	0.0000	0.0011
	45	0.0008	0.0017	0.0039	0.0051	0.0063	0.0058	0.0064	0.0073	0.0063	0.0053	0.0051	0.0054	0.0073	0.0085	0.0088	0.0055	0.0062	0.0026	0.0040	0.0023	0.0057	0.0003	0.0004	0.0004
	46	0.0112	0.0179	0.0308	0.0557	0.0685	0.0589	0.0625	0.0743	0.0715	0.0646	0.0615	0.0629	0.0822	0.1004	0.1173	0.0820	0.0642	0.0457	0.0553	0.0449	0.0322	0.0081	0.0064	0.0124
	47	0.0062	0.0055	0.0129	0.0319	0.0405	0.0370	0.0329	0.0416	0.0421	0.0371	0.0374	0.0417	0.0517	0.0632	0.0933	0.0777	0.0592	0.0528	0.0387	0.0588	0.0425	0.0111	0.0056	0.0079
	48	0.0067	0.0043	0.0118	0.0168	0.0273	0.0322	0.0289	0.0271	0.0330	0.0306	0.0304	0.0330	0.0377	0.0429	0.0631	0.0922	0.0558	0.0478	0.0520	0.0626	0.0425	0.0087	0.0101	0.0062
	49	0.0114	0.0050	0.0054	0.0063	0.0204	0.0326	0.0268	0.0240	0.0261	0.0288	0.0258	0.0244	0.0289	0.0312	0.0418	0.0737	0.0576	0.0461	0.0484	0.0472	0.0379	0.0118	0.0067	0.0034
	50	0.0113	0.0080	0.0035	0.0043	0.0103	0.0349	0.0256	0.0180	0.0178	0.0236	0.0304	0.0251	0.0229	0.0215	0.0268	0.0498	0.0638	0.0478	0.0441	0.0348	0.0402	0.0232	0.0052	0.0032
	51	0.0031	0.0078	0.0051	0.0035	0.0062	0.0349	0.0294	0.0181	0.0133	0.0181	0.0312	0.0279	0.0190	0.0178	0.0172	0.0312	0.0572	0.0477	0.0434	0.0503	0.0322	0.0672	0.0105	0.0045
	52	0.0022	0.0052	0.0058	0.0032	0.0041	0.0227	0.0371	0.0216	0.0154	0.0158	0.0232	0.0349	0.0175	0.0147	0.0127	0.0218	0.0422	0.0525	0.0405	0.0302	0.0368	0.0521	0.0464	0.0028
	53	0.0032	0.0011	0.0045	0.0035	0.0026	0.0146	0.0246	0.0199	0.0117	0.0104	0.0135	0.0205	0.0177	0.0113	0.0092	0.0163	0.0315	0.0435	0.0311	0.0178	0.0575	0.0494	0.0876	0.0079
	54	0.0049	0.0032	0.0030	0.0041	0.0024	0.0109	0.0141	0.0176	0.0173	0.0100	0.0092	0.0145	0.0169	0.0120	0.0085	0.0125	0.0260	0.0402	0.0390	0.0317	0.0402	0.0373	0.0472	0.0193
	55	0.0074	0.0026	0.0016	0.0045	0.0023	0.0060	0.0088	0.0143	0.0134	0.0109	0.0070	0.0088	0.0124	0.0101	0.0065	0.0097	0.0214	0.0295	0.0611	0.0263	0.0264	0.0252	0.0341	0.0262
	56	0.0139	0.0028	0.0018	0.0026	0.0033	0.0026	0.0050	0.0080	0.0158	0.0109	0.0075	0.0058	0.0092	0.0095	0.0055	0.0085	0.0206	0.0311	0.0249	0.0294	0.0402	0.0313	0.0367	0.0485
	57	0.0137	0.0062	0.0025	0.0016	0.0034	0.0020	0.0019	0.0037	0.0123	0.0131	0.0085	0.0076	0.0078	0.0075	0.0046	0.0054	0.0182	0.0245	0.0271	0.0302	0.0368	0.0360	0.0345	0.0217
	58	0.0213	0.0127	0.0039	0.0017	0.0023	0.0021	0.0013	0.0023	0.0128	0.0145	0.0107	0.0079	0.0072	0.0060	0.0041	0.0075	0.0117	0.0224	0.0202	0.0232	0.0333	0.0349	0.0348	0.0182
	59	0.0216	0.0182	0.0061	0.0021	0.0011	0.0018	0.0015	0.0033	0.0116	0.0224	0.0151	0.0102	0.0069	0.0058	0.0049	0.0045	0.0114	0.0193	0.0155	0.0224	0.0218	0.0376	0.0337	0.0270
	60	0.0199	0.0175	0.0101	0.0026	0.0006	0.0008	0.0012	0.0023	0.0060	0.0240	0.0183	0.0157	0.0093	0.0083	0.0039	0.0038	0.0096	0.0178	0.0206	0.0240	0.0207	0.0380	0.0326	0.0336
	61	0.0247	0.0177	0.0146	0.0044	0.0014	0.0006	0.0014	0.0036	0.0083	0.0247	0.0378	0.0195	0.0106	0.0075	0.0032	0.0063	0.0075	0.0296	0.0228	0.0178	0.0195	0.0343	0.0337	0.0345
	62	0.0305	0.0204	0.0178	0.0074	0.0020	0.0007	0.0007	0.0037	0.0083	0.0131	0.0335	0.0341	0.0146	0.0079	0.0042	0.0034	0.0084	0.0159	0.0090	0.0232	0.0149	0.0383	0.0326	0.0405
	63	0.0361	0.0298	0.0182	0.0122	0.0037	0.0007	0.0004	0.0011	0.0015	0.0061	0.0152	0.0215	0.0144	0.0086	0.0041	0.0031	0.0078	0.0086	0.0098	0.0162	0.0149	0.0390	0.0333	0.0463
	64	0.0391	0.0361	0.0167	0.0105	0.0065	0.0012	0.0006	0.0007	0.0011	0.0021	0.0084	0.0138	0.0121	0.0088	0.0061	0.0027	0.0069	0.0063	0.0119	0.0108	0.0230	0.0373	0.0330	0.0482
	65	0.0440	0.0409	0.0204	0.0112	0.0073	0.0024	0.0004	0.0004	0.0012	0.0013	0.0028	0.0063	0.0108	0.0072	0.0054	0.0029	0.0045	0.0069	0.0087	0.0077	0.0126	0.0276	0.0315	0.0534
	66	0.0508	0.0434	0.0266	0.0114	0.0076	0.0035	0.0009	0.0008	0.0008	0.0009	0.0008	0.0020	0.0073	0.0053	0.0043	0.0030	0.0042	0.0080	0.0054	0.0046	0.0046	0.0262	0.0352	0.0469
	67	0.0490	0.0435	0.0307	0.0143	0.0075	0.0041	0.0012	0.0006	0.0005	0.0010	0.0007	0.0011	0.0036	0.0054	0.0033	0.0030	0.0044	0.0052	0.0083	0.0039	0.0080	0.0255	0.0285	0.0598
	68	0.3741	0.4046	0.3592	0.3051	0.2184	0.1332	0.0959	0.0768	0.0671	0.0524	0.0353	0.0331	0.0374	0.0330	0.0291	0.0316	0.0839	0.1373	0.0889	0.0851	0.0943	0.2288	0.2783	0.3143

Appendix A2: Commute Atlanta Weekend Soak Time Distributions

		MOBILE6.2 HOUR OF DAY																							
		6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5
	1	0.0341	0.0333	0.0293	0.0287	0.0338	0.0335	0.0309	0.0320	0.0316	0.0312	0.0339	0.0319	0.0307	0.0326	0.0349	0.0314	0.0364	0.0284	0.0295	0.0420	0.0381	0.0476	0.0445	0.0196
	2	0.0468	0.0316	0.0364	0.0333	0.0392	0.0359	0.0351	0.0369	0.0386	0.0382	0.0406	0.0337	0.0328	0.0320	0.0374	0.0388	0.0337	0.0373	0.0295	0.0509	0.0381	0.0357	0.0205	0.0196
	3	0.0412	0.0336	0.0331	0.0355	0.0357	0.0422	0.0378	0.0382	0.0364	0.0362	0.0379	0.0363	0.0322	0.0347	0.0351	0.0356	0.0255	0.0343	0.0284	0.0376	0.0346	0.0159	0.0342	0.0196
	4	0.0199	0.0282	0.0254	0.0299	0.0313	0.0337	0.0324	0.0285	0.0335	0.0319	0.0313	0.0294	0.0298	0.0277	0.0263	0.0300	0.0271	0.0355	0.0197	0.0221	0.0346	0.0079	0.0205	0.0157
	5	0.0185	0.0146	0.0205	0.0242	0.0251	0.0242	0.0258	0.0236	0.0275	0.0263	0.0262	0.0267	0.0263	0.0259	0.0201	0.0195	0.0251	0.0166	0.0164	0.0177	0.0242	0.0079	0.0137	0.0078
	6	0.0106	0.0102	0.0175	0.0166	0.0203	0.0209	0.0192	0.0200	0.0245	0.0226	0.0233	0.0230	0.0215	0.0201	0.0222	0.0188	0.0143	0.0148	0.0131	0.0088	0.0069	0.0159	0.0171	0.0088
	7	0.0078	0.0119	0.0119	0.0149	0.0178	0.0189	0.0183	0.0185	0.0213	0.0222	0.0220	0.0198	0.0177	0.0202	0.0194	0.0171	0.0139	0.0154	0.0098	0.0221	0.0208	0.0198	0.0034	0.0049
	8	0.0064	0.0061	0.0098	0.0141	0.0164	0.0177	0.0174	0.0185	0.0185	0.0193	0.0185	0.0167	0.0142	0.0156	0.0143	0.0149	0.0143	0.0124	0.0120	0.0088	0.0208	0.0040	0.0034	0.0059
	9	0.0057	0.0058	0.0101	0.0103	0.0141	0.0161	0.0160	0.0159	0.0160	0.0147	0.0174	0.0134	0.0148	0.0151	0.0134	0.0117	0.0124	0.0077	0.0120	0.0111	0.0035	0.0040	0.0000	0.0010
	10	0.0035	0.0058	0.0089	0.0113	0.0140	0.0168	0.0134	0.0172	0.0172	0.0146	0.0172	0.0151	0.0132	0.0143	0.0139	0.0095	0.0093	0.0089	0.0066	0.0177	0.0035	0.0119	0.0068	0.0020
	11	0.0057	0.0048	0.0048	0.0100	0.0114	0.0138	0.0119	0.0146	0.0147	0.0148	0.0126	0.0134	0.0143	0.0152	0.0152	0.0090	0.0066	0.0036	0.0033	0.0133	0.0069	0.0040	0.0205	0.0039
	12	0.0043	0.0048	0.0047	0.0076	0.0120	0.0153	0.0121	0.0126	0.0137	0.0133	0.0127	0.0130	0.0114	0.0096	0.0092	0.0098	0.0124	0.0071	0.0098	0.0133	0.0104	0.0159	0.0000	0.0029
	13	0.0050	0.0031	0.0053	0.0081	0.0109	0.0105	0.0124	0.0130	0.0123	0.0134	0.0129	0.0133	0.0115	0.0100	0.0115	0.0073	0.0074	0.0083	0.0077	0.0088	0.0000	0.0000	0.0103	0.0010
	14	0.0014	0.0034	0.0056	0.0064	0.0080	0.0105	0.0127	0.0130	0.0117	0.0146	0.0124	0.0112	0.0090	0.0070	0.0108	0.0076	0.0070	0.0059	0.0088	0.0133	0.0069	0.0119	0.0068	0.0000
	15	0.0028	0.0041	0.0041	0.0061	0.0093	0.0105	0.0115	0.0113	0.0130	0.0120	0.0110	0.0109	0.0102	0.0088	0.0109	0.0080	0.0066	0.0030	0.0055	0.0044	0.0069	0.0000	0.0000	0.0020
	16	0.0007	0.0044	0.0050	0.0068	0.0078	0.0108	0.0124	0.0113	0.0119	0.0107	0.0115	0.0098	0.0096	0.0096	0.0093	0.0083	0.0058	0.0041	0.0088	0.0044	0.0000	0.0040	0.0068	0.0010
	17	0.0028	0.0027	0.0048	0.0061	0.0079	0.0095	0.0102	0.0097	0.0114	0.0098	0.0104	0.0093	0.0100	0.0088	0.0079	0.0078	0.0054	0.0012	0.0055	0.0044	0.0104	0.0000	0.0034	0.0010
	18	0.0014	0.0044	0.0035	0.0059	0.0062	0.0093	0.0094	0.0105	0.0114	0.0100	0.0080	0.0117	0.0076	0.0072	0.0099	0.0056	0.0062	0.0047	0.0033	0.0044	0.0035	0.0119	0.0000	0.0010
	19	0.0035	0.0031	0.0039	0.0044	0.0084	0.0080	0.0092	0.0091	0.0102	0.0112	0.0097	0.0088	0.0087	0.0086	0.0079	0.0054	0.0062	0.0065	0.0011	0.0044	0.0104	0.0040	0.0034	0.0010
	20	0.0007	0.0044	0.0033	0.0055	0.0069	0.0087	0.0076	0.0093	0.0095	0.0092	0.0093	0.0091	0.0076	0.0060	0.0076	0.0046	0.0035	0.0030	0.0033	0.0022	0.0035	0.0040	0.0034	0.0020
	21	0.0035	0.0027	0.0032	0.0045	0.0069	0.0080	0.0086	0.0094	0.0098	0.0096	0.0081	0.0094	0.0072	0.0087	0.0069	0.0076	0.0066	0.0024	0.0033	0.0022	0.0000	0.0040	0.0068	0.0010
S	22	0.0014	0.0041	0.0033	0.0047	0.0063	0.0081	0.0071	0.0075	0.0087	0.0084	0.0089	0.0103	0.0072	0.0058	0.0074	0.0066	0.0031	0.0024	0.0022	0.0022	0.0000	0.0079	0.0000	0.0010
O	23	0.0014	0.0027	0.0047	0.0053	0.0063	0.0074	0.0078	0.0071	0.0076	0.0093	0.0084	0.0092	0.0073	0.0060	0.0062	0.0056	0.0023	0.0036	0.0011	0.0022	0.0035	0.0079	0.0000	0.0010
A	24	0.0007	0.0048	0.0038	0.0037	0.0061	0.0078	0.0087	0.0093	0.0088	0.0083	0.0083	0.0073	0.0066	0.0060	0.0095	0.0049	0.0062	0.0030	0.0022	0.0022	0.0035	0.0198	0.0068	0.0010
K	25	0.0014	0.0037	0.0047	0.0041	0.0053	0.0063	0.0084	0.0089	0.0075	0.0088	0.0078	0.0084	0.0064	0.0068	0.0041	0.0051	0.0054	0.0036	0.0000	0.0044	0.0000	0.0000	0.0034	0.0010
C	26	0.0014	0.0024	0.0023	0.0053	0.0058	0.0058	0.0077	0.0077	0.0084	0.0080	0.0076	0.0082	0.0066	0.0068	0.0065	0.0076	0.0019	0.0036	0.0044	0.0022	0.0000	0.0040	0.0000	0.0000
O	27	0.0021	0.0034	0.0036	0.0045	0.0046	0.0054	0.0060	0.0093	0.0079	0.0070	0.0072	0.0080	0.0073	0.0063	0.0041	0.0046	0.0035	0.0053	0.0033	0.0022	0.0069	0.0079	0.0000	0.0000
D	28	0.0021	0.0024	0.0020	0.0036	0.0047	0.0066	0.0066	0.0066	0.0079	0.0083	0.0058	0.0083	0.0066	0.0060	0.0055	0.0061	0.0035	0.0024	0.0022	0.0022	0.0000	0.0079	0.0000	0.0020
E	29	0.0007	0.0024	0.0026	0.0045	0.0051	0.0058	0.0061	0.0072	0.0078	0.0072	0.0072	0.0073	0.0062	0.0055	0.0041	0.0056	0.0066	0.0024	0.0066	0.0066	0.0104	0.0000	0.0000	0.0010
	30	0.0014	0.0027	0.0024	0.0046	0.0046	0.0057	0.0054	0.0067	0.0065	0.0067	0.0061	0.0071	0.0058	0.0061	0.0053	0.0041	0.0054	0.0036	0.0033	0.0066	0.0000	0.0000	0.0000	0.0000
	31	0.0021	0.0068	0.0047	0.0073	0.0112	0.0094	0.0123	0.0139	0.0130	0.0125	0.0132	0.0125	0.0102	0.0105	0.0095	0.0078	0.0077	0.0083	0.0120	0.0177	0.0138	0.0000	0.0034	0.0010
	32	0.0007	0.0071	0.0053	0.0059	0.0097	0.0100	0.0104	0.0137	0.0128	0.0135	0.0142	0.0101	0.0121	0.0099	0.0092	0.0059	0.0058	0.0071	0.0066	0.0155	0.0000	0.0000	0.0034	0.0000
	33	0.0014	0.0020	0.0050	0.0068	0.0089	0.0098	0.0122	0.0137	0.0123	0.0138	0.0118	0.0106	0.0091	0.0113	0.0085	0.0085	0.0070	0.0024	0.0011	0.0022	0.0000	0.0079	0.0034	0.0000
	34	0.0035	0.0024	0.0042	0.0074	0.0066	0.0087	0.0096	0.0117	0.0109	0.0096	0.0083	0.0113	0.0086	0.0097	0.0093	0.0085	0.0050	0.0036	0.0000	0.0111	0.0000	0.0079	0.0000	0.0010
	35	0.0014	0.0014	0.0039	0.0046	0.0074	0.0092	0.0088	0.0108	0.0122	0.0109	0.0091	0.0118	0.0106	0.0091	0.0081	0.0076	0.0031	0.0047	0.0098	0.0044	0.0138	0.0040	0.0068	0.0010
	36	0.0007	0.0048	0.0026	0.0055	0.0071	0.0084	0.0081	0.0128	0.0111	0.0112	0.0088	0.0091	0.0098	0.0091	0.0108	0.0066	0.0070	0.0065	0.0066	0.0000	0.0104	0.0040	0.0000	0.0010
	37	0.0000	0.0020	0.0032	0.0056	0.0064	0.0075	0.0099	0.0113	0.0091	0.0095	0.0098	0.0080	0.0104	0.0086	0.0081	0.0063	0.0074	0.0059	0.0044	0.0111	0.0069	0.0000	0.0000	0.0020
	38	0.0000	0.0017	0.0039	0.0051	0.0066	0.0087	0.0069	0.0108	0.0098	0.0085	0.0095	0.0089	0.0080	0.0088	0.0092	0.0071	0.0046	0.0053	0.0055	0.0088	0.0069	0.0040	0.0034	0.0000
	39	0.0021	0.0027	0.0036	0.0039	0.0064	0.0065	0.0083	0.0108	0.0096	0.0090	0.0082	0.0082	0.0087	0.0093	0.0090	0.0068	0.0066	0.0053	0.0022	0.0111	0.0035	0.0079	0.0000	0.0010
	40	0.0000	0.0007	0.0023	0.0031	0.0056	0.0067	0.0075	0.0096	0.0093	0.0085	0.0079	0.0081	0.0091	0.0083	0.0092	0.0054	0.0074	0.0053	0.0044	0.0066	0.0035	0.0000	0.0068	0.0000
	41	0.0007	0.0017	0.0035	0.0034	0.0050	0.0085	0.0068	0.0109	0.0084	0.0079	0.0069	0.0087	0.0089	0.0093	0.0078	0.0073	0.0062	0.0036	0.0088	0.0088	0.0069	0.0040	0.0034	0.0020
	42	0.0000	0.0017	0.0023	0.0043	0.0056	0.0063	0.0080	0.0077	0.0076	0.0073	0.0070	0.0073	0.0088	0.0082	0.0072	0.0059	0.0039	0.0030	0.0055	0.0044	0.0104	0.0000	0.0000	0.0000
	43	0.0000	0.0031	0.0027	0.0039	0.0053	0.0063	0.0058	0.0104	0.0074	0.0073	0.0069	0.0070	0.0077	0.0083	0.0085	0.0046	0.0058	0.0047	0.0077	0.0066	0.0000	0.0119	0.0000	0.0000
	44	0.0000	0.0007	0.0032	0.0032	0.0041	0.0058	0.0068	0.0071	0.0065	0.0067	0.0072	0.0057	0.0091	0.0068	0.0092	0.0051	0.0050	0.0047	0.0044	0.0111	0.0069	0.0119	0.0034	0.0010
	45	0.0007	0.0007	0.0023	0.0041	0.0053	0.0052	0.0065	0.0074	0.0083	0.0074	0.0065	0.0063	0.0072	0.0072	0.0067	0.0049	0.0054	0.0059	0.0088	0.0088	0.0035	0.0000	0.0000	0.0000
	46	0.0057	0.0126	0.0197	0.0458	0.0676	0.0723	0.0867	0.0815	0.0825	0.0788	0.0704	0.0786	0.0876	0.1041	0.0975	0.0773	0.0758	0.0580	0.0624	0.0597	0.0484	0.0397	0.0240	0.0029
	47	0.0057	0.0031	0.0099	0.0200	0.0376	0.0523	0.0545	0.0408	0.0515	0.0518	0.0520	0.0490	0.0519	0.0677	0.0711	0.0756	0.0495	0.0545	0.0547	0.0509	0.0554	0.0317	0.0205	0.0020
	48	0.0050	0.0034	0.0066	0.0079	0.0236	0.0318	0.0374	0.0349	0.0358	0.0436	0.0397	0.0369	0.0415	0.0440	0.0503	0.0722	0.0592	0.0557	0.0580	0.0597	0.0900	0.0397	0.0137	0.0000
	49	0.0064	0.0071	0.0059	0.0073	0.0134	0.0256	0.0379	0.0287	0.0221	0.0308	0.0330	0.0310	0.0367	0.0361	0.0429	0.0573	0.0592	0.0438	0.0624	0.0420	0.0727	0.0357	0.0240	0.0010
	50	0.0092	0.0071	0.0026	0.0080	0.0092	0.0139	0.0236	0.0172	0.0205	0.0229	0.0257	0.0274	0.0252	0.0282	0.0344	0.0461	0.0476	0.0497	0.0569	0.0376	0.0484	0.0595	0.0103	0.0010
	51	0.0035	0.0122	0.0120	0.0067	0.0028	0.0061	0.0135	0.0137	0.0148	0.0153	0.0216	0.0197	0.0210	0.0213	0.0222	0.0339	0.0449	0.0456	0.0580	0.0221	0.0450	0.0317	0.0103	0.0049
	52	0.0014	0.0061	0.0205	0.0042	0.0020	0.0042	0.0098	0.0103	0.0091	0.0127	0.0185	0.0240	0.0220	0.0183	0.0169	0.0258	0.0433	0.0420	0.0306	0.0332	0.0311	0.0635	0.0103	0.0010
	53	0.0050	0.0027	0.0199	0.0028	0.0009	0.0024	0.0059	0.0090	0.0083	0.0121	0.0142	0.0179	0.0191	0.0184	0.0162	0.0190	0.0313	0.0414	0.0274	0.0221	0.0173	0.0198	0.0137	0.0029
	54	0.0057	0.0010	0.0015	0.0026	0.0012	0.0012	0.0048	0.0070	0.0082	0.0069	0.0094	0.0148	0.0173	0.0146	0.0159	0.0149	0.0240	0.0237	0.0219	0.0133	0.0242	0.0159	0.0171	0.0029
	55	0.0057	0.0007	0.0018	0.0037	0.0034	0.0008	0.0017	0.0039	0.0063	0.0056	0.0077	0.0116	0.0155	0.0141	0.0108	0.0122	0.0190	0.0237	0.0492	0.0221	0.0138	0.0238	0.0171	0.0039
	56	0.0170	0.0034	0.0023	0.0021	0.0020	0.0007	0.0009	0.0024	0.0058	0.0058	0.0063	0.0082	0.0126	0.0104	0.0095	0.0132	0.0139	0.0195	0.0164	0.0199	0.0069	0.0238	0.0205	0.0069
	57	0.0142	0.0068	0.0026	0.0014	0.0017	0.0010	0.0004	0.0022	0.0025	0.0057	0.0062	0.0097	0.0136	0.0083	0.0083	0.0061	0.0132	0.0160	0.0131	0.0155	0.0000	0.0278	0.0205	0.0157
	58	0.0220	0.0119	0.0048	0.0015	0.0010	0.0018	0.0002	0.0009	0.0029	0.0038	0.0054	0.0044	0.0085	0.0064	0.0069	0.0066	0.0174	0.0136	0.0131	0.0066	0.0138	0.0198	0.0274	0.0147
	59	0.0305	0.0197	0.0060	0.0029	0.0014	0.0013	0.0006	0.0005	0.0016	0.0027	0.0055	0.0057	0.0075	0.0063	0.0097	0.0168	0.0097	0.0207	0.0088	0.0088	0.0000	0.0119	0.0205	0.0275
	60	0.0376	0.0302	0.0107	0.0033	0.0020	0.0007	0.0013	0.0005	0.0007	0.0024	0.0044	0.0066	0.0048	0.0069	0.0046	0.0056	0.0054	0.0095	0.0055	0.0155	0.0173	0.0040	0.0479	0.0480
	61	0.0348	0.0367	0.0169	0.0051	0.0017	0.0008	0.0011	0.0011	0.0005	0.0024	0.0024	0.0040	0.0053	0.0037	0.0041	0.0063	0.0066	0.0112	0.0098	0.0044	0.0173	0.0079	0.0308	0.0363
	62	0.0312	0.0333	0.0224	0.0085	0.0033	0.0016	0.0010	0.0019	0.0009	0.0008	0.0053	0.0042	0.0040	0.0044	0.0032	0.0039	0.0054	0.0213	0.0077	0.0177	0.0035	0.0040	0.0205	0.0392
	63	0.0319	0.0299	0.0259	0.0139	0.0041	0.0013	0.0006	0.0005	0.0007	0.0002	0.0016	0.0025	0.0039	0.0031	0.0041	0.0020	0.0066	0.0166	0.0109	0.0088	0.0208	0.0278	0.0411	0.0431
	64	0.0419	0.0360	0.0302	0.0134	0.0081	0.0018	0.0015	0.0005	0.0006	0.0003	0.0007	0.0010	0.0030	0.0029	0.0012	0.0027	0.0062	0.0095	0.0131	0.0066	0.0069	0.0040	0.0137	0.0441
	65	0.0412	0.0353	0.0241	0.0190	0.0111	0.0028	0.0009	0.0007	0.0003	0.0006	0.0005	0.0011	0.0018	0.0028	0.0019	0.0022	0.0035	0.0036	0.0142	0.0044	0.0035	0.0198	0.0240	0.0382
	66	0.0369	0.0272	0.0271	0.0198	0.0117	0.0043	0.0020	0.0013	0.0007	0.0007	0.0000	0.0005	0.0006	0.0014	0.0016	0.0027	0.0027	0.0047	0.0066	0.0088	0.0069	0.0317	0.0103	0.0373
	67	0.0277	0.0418	0.0278	0.0200	0.0146	0.0066	0.0029	0.0014	0.0007	0.0007	0.0003	0.0003	0.0006	0.0010	0.0016	0.0010	0.0015	0.0071	0.0088	0.0066	0.0035	0.0079	0.0342	0.0284
	68	0.3272	0.3408	0.3665	0.3752	0.2821	0.2146	0.1550	0.1331	0.1087	0.0915	0.0797	0.0673	0.0573	0.0480	0.0383	0.0402	0.0429	0.0414	0.0405	0.0398	0.0588	0.0992	0.2568	0.4598

Appendix A3: Commute Atlanta Weekday Soak Time Distributions Weighted by Sample Strata (Household Size, Household Income, and Vehicle Ownership)

		MOBILE6.2 HOUR OF DAY																							
		6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5
	1	0.0279	0.0332	0.0364	0.0408	0.0369	0.0364	0.0345	0.0339	0.0353	0.0388	0.0329	0.0346	0.0340	0.0326	0.0357	0.0361	0.0270	0.0236	0.0321	0.0405	0.0327	0.0134	0.0089	0.0164
	2	0.0270	0.0351	0.0401	0.0448	0.0397	0.0379	0.0381	0.0391	0.0372	0.0411	0.0386	0.0380	0.0357	0.0361	0.0361	0.0422	0.0348	0.0223	0.0230	0.0225	0.0211	0.0068	0.0107	0.0186
	3	0.0251	0.0271	0.0360	0.0435	0.0437	0.0382	0.0380	0.0386	0.0393	0.0433	0.0395	0.0369	0.0368	0.0377	0.0368	0.0347	0.0269	0.0167	0.0253	0.0161	0.0279	0.0104	0.0043	0.0142
	4	0.0170	0.0194	0.0277	0.0351	0.0377	0.0327	0.0333	0.0354	0.0345	0.0363	0.0350	0.0345	0.0294	0.0289	0.0308	0.0266	0.0216	0.0160	0.0181	0.0181	0.0184	0.0080	0.0045	0.0097
	5	0.0139	0.0147	0.0215	0.0268	0.0309	0.0302	0.0276	0.0277	0.0309	0.0302	0.0290	0.0265	0.0246	0.0240	0.0267	0.0235	0.0163	0.0110	0.0129	0.0170	0.0196	0.0023	0.0016	0.0075
	6	0.0086	0.0113	0.0166	0.0229	0.0259	0.0264	0.0253	0.0239	0.0236	0.0271	0.0227	0.0208	0.0210	0.0203	0.0235	0.0160	0.0120	0.0088	0.0086	0.0122	0.0106	0.0015	0.0015	0.0032
	7	0.0059	0.0086	0.0133	0.0175	0.0207	0.0202	0.0211	0.0211	0.0219	0.0228	0.0207	0.0200	0.0197	0.0198	0.0166	0.0162	0.0121	0.0061	0.0075	0.0113	0.0089	0.0028	0.0003	0.0030
	8	0.0039	0.0064	0.0142	0.0167	0.0172	0.0194	0.0186	0.0197	0.0192	0.0183	0.0174	0.0176	0.0161	0.0148	0.0156	0.0133	0.0093	0.0068	0.0029	0.0076	0.0097	0.0020	0.0039	0.0036
	9	0.0028	0.0052	0.0107	0.0136	0.0163	0.0164	0.0141	0.0182	0.0164	0.0166	0.0165	0.0162	0.0168	0.0144	0.0150	0.0130	0.0076	0.0054	0.0092	0.0082	0.0115	0.0024	0.0022	0.0022
	10	0.0033	0.0048	0.0087	0.0111	0.0132	0.0151	0.0153	0.0151	0.0169	0.0149	0.0151	0.0153	0.0153	0.0157	0.0134	0.0130	0.0072	0.0044	0.0038	0.0032	0.0076	0.0008	0.0016	0.0014
	11	0.0033	0.0040	0.0084	0.0103	0.0129	0.0152	0.0130	0.0138	0.0125	0.0131	0.0138	0.0121	0.0127	0.0137	0.0120	0.0130	0.0081	0.0041	0.0034	0.0041	0.0024	0.0008	0.0061	0.0013
	12	0.0028	0.0028	0.0073	0.0092	0.0110	0.0124	0.0130	0.0117	0.0131	0.0134	0.0140	0.0134	0.0118	0.0123	0.0097	0.0109	0.0051	0.0056	0.0040	0.0034	0.0058	0.0007	0.0006	0.0011
	13	0.0016	0.0029	0.0060	0.0082	0.0114	0.0126	0.0119	0.0120	0.0119	0.0109	0.0115	0.0111	0.0104	0.0102	0.0099	0.0082	0.0059	0.0039	0.0071	0.0028	0.0048	0.0016	0.0015	0.0011
	14	0.0009	0.0024	0.0057	0.0085	0.0107	0.0108	0.0117	0.0125	0.0124	0.0107	0.0109	0.0101	0.0122	0.0123	0.0101	0.0077	0.0071	0.0042	0.0045	0.0119	0.0016	0.0008	0.0012	0.0003
	15	0.0014	0.0025	0.0054	0.0057	0.0104	0.0109	0.0107	0.0114	0.0104	0.0104	0.0100	0.0101	0.0094	0.0103	0.0086	0.0082	0.0056	0.0027	0.0057	0.0046	0.0024	0.0020	0.0024	0.0010
	16	0.0023	0.0022	0.0050	0.0071	0.0086	0.0099	0.0098	0.0096	0.0104	0.0107	0.0088	0.0098	0.0106	0.0080	0.0099	0.0070	0.0058	0.0030	0.0027	0.0031	0.0053	0.0009	0.0014	0.0012
	17	0.0028	0.0022	0.0048	0.0066	0.0088	0.0096	0.0094	0.0110	0.0101	0.0094	0.0101	0.0094	0.0081	0.0079	0.0080	0.0061	0.0042	0.0035	0.0029	0.0019	0.0000	0.0010	0.0006	0.0007
	18	0.0024	0.0017	0.0051	0.0074	0.0079	0.0086	0.0096	0.0096	0.0090	0.0092	0.0092	0.0077	0.0091	0.0080	0.0086	0.0053	0.0040	0.0039	0.0009	0.0094	0.0038	0.0017	0.0000	0.0013
	19	0.0027	0.0018	0.0043	0.0064	0.0082	0.0084	0.0078	0.0092	0.0087	0.0093	0.0080	0.0083	0.0092	0.0077	0.0075	0.0055	0.0041	0.0026	0.0043	0.0063	0.0007	0.0029	0.0008	0.0005
	20	0.0021	0.0016	0.0045	0.0051	0.0072	0.0076	0.0085	0.0083	0.0097	0.0076	0.0086	0.0080	0.0085	0.0082	0.0072	0.0067	0.0047	0.0040	0.0032	0.0023	0.0039	0.0004	0.0008	0.0014
	21	0.0026	0.0016	0.0033	0.0048	0.0080	0.0074	0.0089	0.0091	0.0084	0.0074	0.0070	0.0072	0.0067	0.0078	0.0066	0.0045	0.0035	0.0038	0.0035	0.0045	0.0000	0.0028	0.0005	0.0005
S	22	0.0031	0.0012	0.0043	0.0037	0.0075	0.0068	0.0072	0.0079	0.0090	0.0081	0.0075	0.0062	0.0078	0.0076	0.0068	0.0058	0.0041	0.0028	0.0025	0.0055	0.0008	0.0003	0.0000	0.0008
O	23	0.0027	0.0017	0.0027	0.0039	0.0054	0.0076	0.0075	0.0079	0.0070	0.0068	0.0079	0.0068	0.0070	0.0060	0.0056	0.0054	0.0028	0.0030	0.0031	0.0059	0.0047	0.0012	0.0000	0.0009
A	24	0.0033	0.0015	0.0036	0.0044	0.0063	0.0063	0.0068	0.0085	0.0073	0.0062	0.0074	0.0060	0.0077	0.0066	0.0065	0.0043	0.0035	0.0015	0.0015	0.0030	0.0008	0.0010	0.0005	0.0007
K	25	0.0024	0.0016	0.0029	0.0053	0.0051	0.0077	0.0073	0.0075	0.0067	0.0067	0.0063	0.0065	0.0060	0.0066	0.0059	0.0043	0.0039	0.0022	0.0052	0.0020	0.0035	0.0017	0.0023	0.0011
C	26	0.0013	0.0013	0.0030	0.0043	0.0061	0.0068	0.0068	0.0072	0.0066	0.0062	0.0065	0.0056	0.0064	0.0066	0.0051	0.0058	0.0030	0.0024	0.0039	0.0041	0.0000	0.0005	0.0000	0.0012
O	27	0.0012	0.0014	0.0034	0.0043	0.0053	0.0065	0.0082	0.0069	0.0068	0.0062	0.0069	0.0058	0.0066	0.0063	0.0059	0.0053	0.0030	0.0025	0.0038	0.0060	0.0008	0.0000	0.0003	0.0009
D	28	0.0008	0.0012	0.0038	0.0046	0.0050	0.0063	0.0070	0.0079	0.0065	0.0059	0.0053	0.0054	0.0060	0.0063	0.0046	0.0039	0.0029	0.0017	0.0014	0.0032	0.0005	0.0000	0.0002	0.0001
E	29	0.0012	0.0011	0.0031	0.0036	0.0052	0.0056	0.0059	0.0079	0.0063	0.0049	0.0058	0.0057	0.0063	0.0053	0.0041	0.0029	0.0018	0.0019	0.0027	0.0000	0.0013	0.0003	0.0013	0.0011
	30	0.0007	0.0012	0.0032	0.0029	0.0047	0.0050	0.0068	0.0074	0.0064	0.0053	0.0052	0.0044	0.0058	0.0064	0.0058	0.0038	0.0017	0.0023	0.0020	0.0005	0.0035	0.0010	0.0005	0.0006
	31	0.0027	0.0025	0.0054	0.0082	0.0109	0.0121	0.0138	0.0132	0.0100	0.0092	0.0101	0.0093	0.0115	0.0128	0.0094	0.0099	0.0059	0.0035	0.0045	0.0055	0.0000	0.0007	0.0006	0.0008
	32	0.0016	0.0028	0.0057	0.0063	0.0102	0.0096	0.0137	0.0134	0.0120	0.0090	0.0092	0.0094	0.0113	0.0107	0.0083	0.0061	0.0041	0.0035	0.0063	0.0060	0.0038	0.0000	0.0005	0.0003
	33	0.0016	0.0020	0.0051	0.0062	0.0094	0.0103	0.0125	0.0131	0.0111	0.0092	0.0100	0.0081	0.0098	0.0114	0.0101	0.0078	0.0056	0.0024	0.0065	0.0042	0.0013	0.0008	0.0011	0.0008
	34	0.0017	0.0021	0.0060	0.0062	0.0074	0.0089	0.0123	0.0108	0.0098	0.0079	0.0083	0.0083	0.0101	0.0100	0.0082	0.0066	0.0061	0.0035	0.0034	0.0021	0.0092	0.0003	0.0002	0.0002
	35	0.0007	0.0024	0.0059	0.0061	0.0074	0.0087	0.0106	0.0110	0.0095	0.0086	0.0078	0.0075	0.0091	0.0096	0.0076	0.0067	0.0038	0.0045	0.0044	0.0075	0.0046	0.0015	0.0005	0.0003
	36	0.0013	0.0017	0.0054	0.0045	0.0073	0.0073	0.0100	0.0113	0.0094	0.0066	0.0084	0.0079	0.0085	0.0091	0.0080	0.0072	0.0062	0.0021	0.0040	0.0024	0.0020	0.0003	0.0023	0.0012
	37	0.0004	0.0016	0.0051	0.0047	0.0070	0.0075	0.0101	0.0106	0.0094	0.0075	0.0077	0.0076	0.0086	0.0092	0.0080	0.0059	0.0064	0.0067	0.0027	0.0033	0.0030	0.0002	0.0013	0.0005
	38	0.0010	0.0016	0.0042	0.0048	0.0073	0.0069	0.0093	0.0089	0.0075	0.0068	0.0073	0.0077	0.0080	0.0103	0.0066	0.0072	0.0036	0.0041	0.0044	0.0033	0.0032	0.0002	0.0000	0.0004
	39	0.0010	0.0021	0.0046	0.0051	0.0073	0.0066	0.0098	0.0103	0.0075	0.0064	0.0058	0.0064	0.0080	0.0109	0.0081	0.0077	0.0043	0.0034	0.0057	0.0062	0.0000	0.0002	0.0011	0.0004
	40	0.0012	0.0015	0.0035	0.0046	0.0066	0.0064	0.0087	0.0092	0.0083	0.0067	0.0064	0.0063	0.0077	0.0113	0.0079	0.0058	0.0047	0.0036	0.0052	0.0058	0.0017	0.0022	0.0000	0.0004
	41	0.0008	0.0017	0.0033	0.0044	0.0051	0.0066	0.0079	0.0084	0.0081	0.0063	0.0060	0.0062	0.0072	0.0096	0.0087	0.0068	0.0048	0.0046	0.0021	0.0017	0.0020	0.0034	0.0008	0.0001
	42	0.0010	0.0019	0.0035	0.0045	0.0053	0.0058	0.0079	0.0080	0.0075	0.0062	0.0059	0.0062	0.0070	0.0076	0.0079	0.0081	0.0047	0.0034	0.0062	0.0038	0.0068	0.0002	0.0021	0.0008
	43	0.0009	0.0019	0.0028	0.0040	0.0067	0.0062	0.0064	0.0082	0.0069	0.0059	0.0051	0.0059	0.0067	0.0087	0.0083	0.0062	0.0049	0.0032	0.0067	0.0076	0.0016	0.0002	0.0007	0.0004
	44	0.0007	0.0012	0.0030	0.0046	0.0050	0.0059	0.0054	0.0074	0.0062	0.0060	0.0051	0.0055	0.0073	0.0088	0.0080	0.0054	0.0058	0.0033	0.0047	0.0017	0.0055	0.0007	0.0000	0.0007
	45	0.0009	0.0022	0.0031	0.0046	0.0057	0.0064	0.0060	0.0069	0.0059	0.0055	0.0050	0.0056	0.0065	0.0080	0.0092	0.0054	0.0060	0.0029	0.0052	0.0011	0.0079	0.0010	0.0002	0.0003
	46	0.0109	0.0194	0.0258	0.0525	0.0693	0.0587	0.0610	0.0707	0.0695	0.0617	0.0612	0.0633	0.0769	0.0959	0.1130	0.0824	0.0669	0.0499	0.0514	0.0474	0.0302	0.0094	0.0087	0.0138
	47	0.0060	0.0055	0.0122	0.0285	0.0381	0.0357	0.0321	0.0395	0.0396	0.0344	0.0370	0.0399	0.0504	0.0622	0.0904	0.0794	0.0650	0.0591	0.0399	0.0663	0.0406	0.0096	0.0073	0.0099
	48	0.0061	0.0036	0.0104	0.0160	0.0263	0.0320	0.0275	0.0255	0.0289	0.0292	0.0286	0.0319	0.0380	0.0418	0.0639	0.0901	0.0572	0.0490	0.0546	0.0669	0.0399	0.0112	0.0097	0.0069
	49	0.0103	0.0051	0.0055	0.0059	0.0183	0.0339	0.0256	0.0236	0.0243	0.0262	0.0242	0.0238	0.0294	0.0314	0.0433	0.0685	0.0588	0.0445	0.0542	0.0476	0.0375	0.0134	0.0079	0.0024
	50	0.0107	0.0075	0.0032	0.0047	0.0096	0.0363	0.0270	0.0190	0.0178	0.0219	0.0299	0.0240	0.0219	0.0236	0.0271	0.0432	0.0614	0.0465	0.0479	0.0427	0.0444	0.0208	0.0057	0.0049
	51	0.0041	0.0076	0.0047	0.0034	0.0054	0.0324	0.0344	0.0173	0.0131	0.0168	0.0292	0.0282	0.0181	0.0193	0.0175	0.0317	0.0496	0.0478	0.0484	0.0583	0.0422	0.0620	0.0127	0.0083
	52	0.0028	0.0073	0.0063	0.0030	0.0041	0.0202	0.0371	0.0222	0.0151	0.0144	0.0228	0.0329	0.0176	0.0138	0.0138	0.0233	0.0393	0.0518	0.0396	0.0329	0.0414	0.0470	0.0466	0.0037
	53	0.0055	0.0016	0.0038	0.0034	0.0025	0.0133	0.0234	0.0209	0.0113	0.0092	0.0128	0.0196	0.0178	0.0113	0.0099	0.0153	0.0309	0.0414	0.0294	0.0141	0.0660	0.0539	0.0878	0.0101
	54	0.0078	0.0038	0.0028	0.0042	0.0029	0.0096	0.0137	0.0166	0.0206	0.0094	0.0086	0.0138	0.0181	0.0110	0.0086	0.0132	0.0224	0.0344	0.0354	0.0320	0.0483	0.0376	0.0476	0.0197
	55	0.0098	0.0025	0.0016	0.0044	0.0021	0.0048	0.0117	0.0131	0.0129	0.0126	0.0078	0.0086	0.0123	0.0116	0.0066	0.0103	0.0205	0.0244	0.0505	0.0213	0.0236	0.0242	0.0316	0.0241
	56	0.0159	0.0038	0.0022	0.0026	0.0031	0.0023	0.0057	0.0075	0.0149	0.0110	0.0092	0.0058	0.0094	0.0104	0.0052	0.0094	0.0203	0.0298	0.0234	0.0252	0.0414	0.0322	0.0331	0.0465
	57	0.0148	0.0071	0.0029	0.0015	0.0030	0.0019	0.0020	0.0033	0.0114	0.0126	0.0096	0.0091	0.0077	0.0073	0.0054	0.0054	0.0168	0.0229	0.0259	0.0255	0.0320	0.0338	0.0343	0.0200
	58	0.0226	0.0148	0.0040	0.0018	0.0020	0.0025	0.0014	0.0027	0.0144	0.0121	0.0117	0.0093	0.0078	0.0052	0.0040	0.0068	0.0127	0.0203	0.0176	0.0224	0.0326	0.0369	0.0333	0.0180
	59	0.0218	0.0212	0.0061	0.0024	0.0011	0.0018	0.0016	0.0031	0.0154	0.0263	0.0158	0.0100	0.0074	0.0049	0.0047	0.0044	0.0123	0.0178	0.0169	0.0214	0.0145	0.0400	0.0288	0.0231
	60	0.0196	0.0203	0.0125	0.0032	0.0008	0.0010	0.0013	0.0029	0.0075	0.0230	0.0185	0.0173	0.0084	0.0079	0.0035	0.0038	0.0090	0.0202	0.0215	0.0211	0.0225	0.0356	0.0271	0.0296
	61	0.0243	0.0213	0.0156	0.0051	0.0019	0.0008	0.0016	0.0038	0.0118	0.0276	0.0345	0.0239	0.0103	0.0071	0.0030	0.0051	0.0067	0.0273	0.0197	0.0156	0.0157	0.0339	0.0349	0.0324
	62	0.0301	0.0246	0.0185	0.0090	0.0020	0.0010	0.0012	0.0089	0.0099	0.0148	0.0297	0.0344	0.0159	0.0069	0.0034	0.0034	0.0091	0.0133	0.0111	0.0174	0.0102	0.0333	0.0276	0.0346
	63	0.0381	0.0335	0.0213	0.0130	0.0046	0.0010	0.0004	0.0015	0.0022	0.0068	0.0127	0.0194	0.0176	0.0078	0.0047	0.0022	0.0082	0.0073	0.0092	0.0160	0.0136	0.0355	0.0311	0.0464
	64	0.0371	0.0377	0.0192	0.0105	0.0072	0.0016	0.0006	0.0010	0.0014	0.0025	0.0093	0.0130	0.0136	0.0100	0.0062	0.0025	0.0065	0.0063	0.0090	0.0110	0.0170	0.0361	0.0308	0.0475
	65	0.0403	0.0432	0.0226	0.0136	0.0071	0.0027	0.0006	0.0008	0.0018	0.0019	0.0023	0.0050	0.0101	0.0092	0.0054	0.0025	0.0046	0.0071	0.0098	0.0102	0.0150	0.0294	0.0318	0.0579
	66	0.0461	0.0428	0.0278	0.0126	0.0093	0.0037	0.0009	0.0009	0.0009	0.0013	0.0008	0.0020	0.0062	0.0066	0.0041	0.0023	0.0041	0.0080	0.0034	0.0064	0.0025	0.0264	0.0339	0.0467
	67	0.0446	0.0423	0.0307	0.0143	0.0091	0.0044	0.0013	0.0006	0.0009	0.0012	0.0007	0.0011	0.0030	0.0049	0.0032	0.0029	0.0047	0.0060	0.0076	0.0029	0.0104	0.0273	0.0300	0.0585
	68	0.3766	0.3904	0.3589	0.3163	0.2238	0.1382	0.0998	0.0843	0.0707	0.0572	0.0372	0.0361	0.0373	0.0338	0.0301	0.0301	0.0766	0.1274	0.0902	0.0716	0.0916	0.2265	0.2853	0.3300

Appendix A4: Commute Atlanta Weekend Soak Time Distributions Weighted by Sample Strata (Household Size, Household Income, and Vehicle Ownership)

		MOBILE6.2 HOUR OF DAY																							
		6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	1	2	3	4	5
	1	0.0319	0.0369	0.0283	0.0292	0.0371	0.0347	0.0310	0.0351	0.0325	0.0310	0.0340	0.0346	0.0325	0.0344	0.0372	0.0307	0.0431	0.0295	0.0298	0.0564	0.0411	0.0525	0.0472	0.0186
	2	0.0444	0.0334	0.0354	0.0318	0.0380	0.0383	0.0351	0.0358	0.0409	0.0389	0.0434	0.0341	0.0323	0.0342	0.0388	0.0427	0.0352	0.0443	0.0315	0.0439	0.0254	0.0355	0.0152	0.0181
	3	0.0363	0.0323	0.0338	0.0372	0.0357	0.0446	0.0381	0.0380	0.0376	0.0384	0.0396	0.0371	0.0340	0.0372	0.0358	0.0365	0.0244	0.0301	0.0284	0.0346	0.0407	0.0088	0.0298	0.0188
	4	0.0206	0.0275	0.0261	0.0295	0.0292	0.0365	0.0338	0.0289	0.0354	0.0339	0.0322	0.0308	0.0312	0.0268	0.0278	0.0289	0.0295	0.0321	0.0192	0.0189	0.0372	0.0123	0.0177	0.0227
	5	0.0190	0.0159	0.0218	0.0250	0.0251	0.0245	0.0269	0.0247	0.0292	0.0258	0.0265	0.0281	0.0287	0.0263	0.0212	0.0208	0.0253	0.0156	0.0161	0.0254	0.0239	0.0123	0.0147	0.0079
	6	0.0125	0.0111	0.0190	0.0167	0.0193	0.0190	0.0197	0.0197	0.0241	0.0230	0.0215	0.0262	0.0223	0.0211	0.0235	0.0201	0.0148	0.0151	0.0167	0.0070	0.0038	0.0157	0.0180	0.0094
	7	0.0104	0.0111	0.0130	0.0137	0.0169	0.0189	0.0175	0.0175	0.0217	0.0234	0.0238	0.0184	0.0189	0.0191	0.0180	0.0165	0.0156	0.0150	0.0093	0.0292	0.0392	0.0193	0.0016	0.0077
	8	0.0065	0.0069	0.0093	0.0153	0.0177	0.0174	0.0167	0.0182	0.0182	0.0189	0.0189	0.0149	0.0138	0.0155	0.0146	0.0138	0.0159	0.0157	0.0134	0.0094	0.0176	0.0031	0.0025	0.0105
	9	0.0057	0.0071	0.0088	0.0116	0.0143	0.0155	0.0146	0.0170	0.0153	0.0148	0.0176	0.0116	0.0145	0.0166	0.0146	0.0130	0.0137	0.0123	0.0105	0.0075	0.0022	0.0026	0.0000	0.0006
	10	0.0045	0.0071	0.0084	0.0106	0.0143	0.0163	0.0130	0.0171	0.0180	0.0148	0.0183	0.0151	0.0131	0.0140	0.0141	0.0081	0.0086	0.0104	0.0066	0.0177	0.0022	0.0149	0.0040	0.0026
	11	0.0042	0.0058	0.0057	0.0087	0.0108	0.0136	0.0110	0.0139	0.0157	0.0151	0.0134	0.0139	0.0157	0.0163	0.0146	0.0095	0.0054	0.0040	0.0017	0.0156	0.0105	0.0022	0.0109	0.0049
	12	0.0059	0.0054	0.0040	0.0081	0.0124	0.0149	0.0123	0.0119	0.0146	0.0135	0.0130	0.0120	0.0117	0.0095	0.0084	0.0111	0.0150	0.0104	0.0088	0.0072	0.0079	0.0171	0.0000	0.0041
	13	0.0042	0.0051	0.0056	0.0076	0.0115	0.0111	0.0128	0.0128	0.0117	0.0130	0.0122	0.0141	0.0114	0.0118	0.0120	0.0064	0.0062	0.0124	0.0041	0.0060	0.0000	0.0000	0.0144	0.0006
	14	0.0012	0.0030	0.0061	0.0069	0.0070	0.0110	0.0121	0.0123	0.0111	0.0144	0.0123	0.0114	0.0071	0.0067	0.0103	0.0079	0.0079	0.0037	0.0137	0.0130	0.0037	0.0066	0.0037	0.0000
	15	0.0020	0.0043	0.0038	0.0065	0.0087	0.0096	0.0114	0.0113	0.0113	0.0116	0.0120	0.0111	0.0101	0.0101	0.0107	0.0068	0.0066	0.0037	0.0072	0.0022	0.0105	0.0000	0.0000	0.0026
	16	0.0004	0.0047	0.0051	0.0069	0.0077	0.0103	0.0132	0.0116	0.0109	0.0104	0.0114	0.0098	0.0099	0.0089	0.0099	0.0079	0.0071	0.0044	0.0074	0.0040	0.0000	0.0022	0.0119	0.0018
	17	0.0028	0.0020	0.0047	0.0052	0.0076	0.0099	0.0113	0.0103	0.0114	0.0103	0.0100	0.0087	0.0106	0.0083	0.0092	0.0078	0.0046	0.0008	0.0043	0.0030	0.0095	0.0000	0.0024	0.0009
	18	0.0011	0.0037	0.0034	0.0065	0.0061	0.0084	0.0092	0.0093	0.0111	0.0091	0.0079	0.0124	0.0077	0.0080	0.0091	0.0054	0.0064	0.0042	0.0020	0.0028	0.0022	0.0079	0.0000	0.0007
	19	0.0035	0.0032	0.0042	0.0036	0.0080	0.0078	0.0094	0.0085	0.0115	0.0103	0.0092	0.0082	0.0091	0.0087	0.0076	0.0048	0.0063	0.0077	0.0019	0.0070	0.0123	0.0022	0.0021	0.0006
	20	0.0004	0.0042	0.0040	0.0046	0.0071	0.0080	0.0067	0.0092	0.0097	0.0089	0.0085	0.0083	0.0079	0.0071	0.0083	0.0058	0.0032	0.0020	0.0047	0.0010	0.0022	0.0017	0.0016	0.0015
	21	0.0063	0.0022	0.0037	0.0040	0.0058	0.0071	0.0078	0.0093	0.0096	0.0094	0.0097	0.0094	0.0074	0.0086	0.0068	0.0062	0.0096	0.0033	0.0034	0.0013	0.0000	0.0026	0.0037	0.0021
S	22	0.0035	0.0042	0.0031	0.0038	0.0055	0.0080	0.0067	0.0062	0.0082	0.0083	0.0094	0.0109	0.0089	0.0065	0.0079	0.0059	0.0021	0.0025	0.0015	0.0010	0.0000	0.0048	0.0000	0.0006
O	23	0.0020	0.0031	0.0047	0.0042	0.0061	0.0075	0.0072	0.0074	0.0070	0.0078	0.0091	0.0091	0.0071	0.0048	0.0063	0.0060	0.0022	0.0036	0.0016	0.0015	0.0086	0.0128	0.0000	0.0018
A	24	0.0004	0.0054	0.0034	0.0039	0.0053	0.0069	0.0086	0.0095	0.0075	0.0085	0.0086	0.0069	0.0062	0.0071	0.0101	0.0050	0.0057	0.0044	0.0027	0.0015	0.0086	0.0202	0.0119	0.0010
K	25	0.0029	0.0031	0.0040	0.0039	0.0054	0.0054	0.0083	0.0073	0.0073	0.0076	0.0082	0.0072	0.0063	0.0064	0.0038	0.0043	0.0072	0.0048	0.0000	0.0028	0.0000	0.0000	0.0016	0.0006
C	26	0.0020	0.0031	0.0022	0.0064	0.0060	0.0059	0.0076	0.0070	0.0087	0.0078	0.0072	0.0076	0.0069	0.0065	0.0068	0.0065	0.0017	0.0042	0.0050	0.0010	0.0000	0.0026	0.0000	0.0000
O	27	0.0053	0.0043	0.0029	0.0038	0.0048	0.0052	0.0056	0.0091	0.0072	0.0060	0.0068	0.0070	0.0070	0.0070	0.0034	0.0040	0.0044	0.0043	0.0039	0.0030	0.0045	0.0039	0.0000	0.0000
D	28	0.0017	0.0020	0.0020	0.0041	0.0053	0.0062	0.0062	0.0063	0.0081	0.0085	0.0056	0.0080	0.0063	0.0055	0.0051	0.0064	0.0036	0.0021	0.0023	0.0015	0.0000	0.0118	0.0000	0.0026
E	29	0.0006	0.0020	0.0022	0.0045	0.0049	0.0050	0.0065	0.0065	0.0078	0.0077	0.0084	0.0070	0.0068	0.0058	0.0034	0.0059	0.0047	0.0028	0.0035	0.0069	0.0126	0.0000	0.0000	0.0006
	30	0.0011	0.0037	0.0019	0.0050	0.0050	0.0056	0.0057	0.0067	0.0066	0.0061	0.0050	0.0075	0.0055	0.0072	0.0054	0.0047	0.0052	0.0044	0.0019	0.0081	0.0000	0.0000	0.0000	0.0000
	31	0.0018	0.0049	0.0038	0.0072	0.0117	0.0089	0.0130	0.0132	0.0112	0.0129	0.0130	0.0129	0.0087	0.0093	0.0085	0.0070	0.0073	0.0080	0.0144	0.0198	0.0208	0.0000	0.0094	0.0033
	32	0.0005	0.0061	0.0051	0.0055	0.0098	0.0096	0.0115	0.0145	0.0119	0.0130	0.0147	0.0090	0.0121	0.0105	0.0080	0.0049	0.0069	0.0066	0.0055	0.0187	0.0000	0.0000	0.0024	0.0000
	33	0.0011	0.0023	0.0051	0.0063	0.0094	0.0088	0.0114	0.0137	0.0109	0.0141	0.0111	0.0103	0.0082	0.0118	0.0094	0.0089	0.0060	0.0026	0.0008	0.0015	0.0000	0.0052	0.0021	0.0000
	34	0.0044	0.0015	0.0049	0.0071	0.0057	0.0085	0.0105	0.0116	0.0111	0.0094	0.0089	0.0130	0.0091	0.0085	0.0097	0.0079	0.0031	0.0040	0.0000	0.0072	0.0000	0.0130	0.0000	0.0033
	35	0.0010	0.0012	0.0044	0.0040	0.0069	0.0092	0.0085	0.0103	0.0125	0.0111	0.0082	0.0128	0.0098	0.0100	0.0067	0.0097	0.0039	0.0040	0.0060	0.0068	0.0220	0.0026	0.0119	0.0009
	36	0.0023	0.0054	0.0026	0.0051	0.0065	0.0081	0.0076	0.0123	0.0107	0.0112	0.0093	0.0090	0.0086	0.0090	0.0101	0.0071	0.0051	0.0069	0.0092	0.0000	0.0130	0.0108	0.0000	0.0033
	37	0.0000	0.0028	0.0032	0.0049	0.0054	0.0072	0.0090	0.0097	0.0080	0.0097	0.0086	0.0070	0.0101	0.0090	0.0070	0.0072	0.0062	0.0041	0.0034	0.0068	0.0045	0.0000	0.0000	0.0023
	38	0.0000	0.0014	0.0046	0.0051	0.0065	0.0090	0.0068	0.0107	0.0095	0.0074	0.0094	0.0094	0.0086	0.0081	0.0092	0.0065	0.0065	0.0057	0.0045	0.0098	0.0105	0.0017	0.0094	0.0000
	39	0.0033	0.0034	0.0030	0.0033	0.0069	0.0057	0.0076	0.0095	0.0093	0.0072	0.0084	0.0087	0.0095	0.0098	0.0087	0.0069	0.0054	0.0065	0.0011	0.0108	0.0022	0.0123	0.0000	0.0009
	40	0.0000	0.0004	0.0021	0.0032	0.0053	0.0066	0.0073	0.0092	0.0088	0.0092	0.0077	0.0085	0.0080	0.0071	0.0097	0.0048	0.0067	0.0048	0.0055	0.0035	0.0015	0.0000	0.0066	0.0000
	41	0.0004	0.0030	0.0034	0.0034	0.0040	0.0076	0.0062	0.0111	0.0078	0.0088	0.0071	0.0085	0.0076	0.0082	0.0070	0.0054	0.0083	0.0027	0.0086	0.0075	0.0068	0.0101	0.0016	0.0017
	42	0.0000	0.0021	0.0023	0.0040	0.0049	0.0056	0.0083	0.0075	0.0067	0.0074	0.0077	0.0072	0.0078	0.0077	0.0076	0.0065	0.0031	0.0043	0.0031	0.0028	0.0060	0.0000	0.0000	0.0000
	43	0.0000	0.0049	0.0026	0.0032	0.0055	0.0055	0.0047	0.0098	0.0075	0.0065	0.0060	0.0074	0.0082	0.0079	0.0087	0.0048	0.0051	0.0061	0.0081	0.0035	0.0000	0.0061	0.0000	0.0000
	44	0.0000	0.0010	0.0027	0.0032	0.0038	0.0058	0.0061	0.0069	0.0061	0.0063	0.0073	0.0054	0.0080	0.0068	0.0090	0.0050	0.0057	0.0067	0.0041	0.0073	0.0072	0.0144	0.0021	0.0009
	45	0.0005	0.0010	0.0018	0.0038	0.0046	0.0049	0.0064	0.0074	0.0090	0.0067	0.0055	0.0059	0.0075	0.0062	0.0074	0.0032	0.0059	0.0073	0.0088	0.0102	0.0015	0.0000	0.0000	0.0000
	46	0.0067	0.0145	0.0217	0.0451	0.0634	0.0715	0.0842	0.0792	0.0811	0.0745	0.0679	0.0804	0.0921	0.0978	0.0962	0.0742	0.0690	0.0602	0.0528	0.0658	0.0445	0.0385	0.0237	0.0020
	47	0.0043	0.0050	0.0103	0.0185	0.0386	0.0493	0.0533	0.0387	0.0525	0.0497	0.0513	0.0496	0.0522	0.0667	0.0687	0.0767	0.0491	0.0544	0.0646	0.0614	0.0419	0.0234	0.0155	0.0015
	48	0.0036	0.0032	0.0088	0.0070	0.0234	0.0313	0.0385	0.0374	0.0346	0.0454	0.0374	0.0359	0.0422	0.0446	0.0491	0.0726	0.0634	0.0493	0.0678	0.0606	0.0855	0.0441	0.0078	0.0000
	49	0.0075	0.0079	0.0088	0.0078	0.0160	0.0242	0.0381	0.0311	0.0237	0.0303	0.0304	0.0305	0.0354	0.0351	0.0381	0.0573	0.0504	0.0362	0.0683	0.0506	0.0511	0.0258	0.0275	0.0018
	50	0.0109	0.0068	0.0032	0.0090	0.0090	0.0129	0.0235	0.0175	0.0204	0.0261	0.0260	0.0282	0.0255	0.0293	0.0349	0.0426	0.0431	0.0444	0.0530	0.0372	0.0428	0.0491	0.0086	0.0021
	51	0.0054	0.0129	0.0123	0.0073	0.0031	0.0055	0.0134	0.0147	0.0149	0.0179	0.0203	0.0193	0.0206	0.0185	0.0239	0.0338	0.0435	0.0474	0.0615	0.0234	0.0536	0.0236	0.0090	0.0035
	52	0.0038	0.0045	0.0209	0.0046	0.0019	0.0038	0.0099	0.0104	0.0092	0.0144	0.0211	0.0232	0.0207	0.0202	0.0192	0.0252	0.0367	0.0405	0.0374	0.0488	0.0365	0.0413	0.0069	0.0007
	53	0.0058	0.0020	0.0180	0.0035	0.0009	0.0025	0.0053	0.0092	0.0084	0.0123	0.0130	0.0178	0.0180	0.0199	0.0158	0.0218	0.0311	0.0351	0.0252	0.0174	0.0163	0.0122	0.0182	0.0017
	54	0.0090	0.0017	0.0021	0.0025	0.0018	0.0012	0.0044	0.0074	0.0085	0.0064	0.0084	0.0139	0.0168	0.0152	0.0165	0.0154	0.0276	0.0216	0.0223	0.0124	0.0237	0.0096	0.0178	0.0045
	55	0.0079	0.0005	0.0024	0.0051	0.0048	0.0013	0.0018	0.0033	0.0058	0.0055	0.0092	0.0106	0.0147	0.0141	0.0115	0.0128	0.0192	0.0251	0.0397	0.0209	0.0067	0.0289	0.0205	0.0030
	56	0.0256	0.0050	0.0027	0.0026	0.0023	0.0009	0.0007	0.0025	0.0056	0.0059	0.0066	0.0076	0.0116	0.0098	0.0094	0.0125	0.0164	0.0169	0.0206	0.0196	0.0076	0.0216	0.0205	0.0054
	57	0.0186	0.0110	0.0025	0.0011	0.0017	0.0012	0.0006	0.0022	0.0031	0.0056	0.0072	0.0094	0.0128	0.0083	0.0077	0.0073	0.0126	0.0198	0.0141	0.0087	0.0000	0.0376	0.0189	0.0160
	58	0.0265	0.0105	0.0044	0.0019	0.0010	0.0028	0.0005	0.0014	0.0031	0.0035	0.0046	0.0039	0.0081	0.0063	0.0068	0.0088	0.0173	0.0139	0.0138	0.0040	0.0169	0.0202	0.0271	0.0139
	59	0.0269	0.0202	0.0082	0.0038	0.0023	0.0013	0.0007	0.0004	0.0014	0.0027	0.0049	0.0061	0.0064	0.0057	0.0083	0.0111	0.0095	0.0195	0.0111	0.0101	0.0000	0.0075	0.0220	0.0280
	60	0.0351	0.0318	0.0125	0.0039	0.0022	0.0008	0.0016	0.0008	0.0006	0.0026	0.0035	0.0065	0.0043	0.0065	0.0039	0.0044	0.0052	0.0130	0.0056	0.0162	0.0097	0.0026	0.0410	0.0321
	61	0.0352	0.0364	0.0182	0.0058	0.0026	0.0015	0.0012	0.0013	0.0005	0.0024	0.0020	0.0033	0.0056	0.0031	0.0033	0.0075	0.0097	0.0111	0.0106	0.0070	0.0112	0.0118	0.0300	0.0281
	62	0.0256	0.0319	0.0242	0.0087	0.0038	0.0019	0.0015	0.0043	0.0007	0.0008	0.0036	0.0037	0.0039	0.0038	0.0023	0.0054	0.0055	0.0169	0.0122	0.0115	0.0053	0.0022	0.0152	0.0383
	63	0.0289	0.0296	0.0264	0.0152	0.0043	0.0024	0.0010	0.0006	0.0006	0.0001	0.0012	0.0019	0.0034	0.0029	0.0045	0.0027	0.0050	0.0146	0.0071	0.0042	0.0270	0.0562	0.0367	0.0420
	64	0.0363	0.0397	0.0302	0.0144	0.0084	0.0034	0.0020	0.0006	0.0007	0.0005	0.0004	0.0010	0.0031	0.0024	0.0012	0.0031	0.0089	0.0068	0.0091	0.0103	0.0037	0.0017	0.0090	0.0376
	65	0.0374	0.0320	0.0233	0.0199	0.0131	0.0030	0.0010	0.0012	0.0006	0.0007	0.0003	0.0008	0.0012	0.0024	0.0013	0.0026	0.0039	0.0040	0.0098	0.0030	0.0019	0.0276	0.0189	0.0301
	66	0.0375	0.0232	0.0267	0.0186	0.0128	0.0053	0.0031	0.0020	0.0010	0.0007	0.0000	0.0006	0.0004	0.0014	0.0018	0.0024	0.0036	0.0050	0.0044	0.0061	0.0045	0.0431	0.0175	0.0386
	67	0.0220	0.0393	0.0292	0.0196	0.0156	0.0093	0.0042	0.0016	0.0010	0.0004	0.0006	0.0002	0.0005	0.0007	0.0018	0.0013	0.0010	0.0066	0.0055	0.0035	0.0092	0.0075	0.0552	0.0243
	68	0.3206	0.3250	0.3508	0.3758	0.2813	0.2183	0.1585	0.1364	0.1109	0.0934	0.0836	0.0692	0.0577	0.0494	0.0424	0.0435	0.0417	0.0479	0.0374	0.0408	0.0779	0.1120	0.2723	0.4846

Appendix B: Commute Atlanta Engine Start Time Distributions

Hour	Actual Hours	Commute Atlanta		Weighted Commute Atlanta	
		Weekday	Weekend	Weekday	Weekend
6	06:00	0.029849	0.009031	0.027345	0.009019
7	07:00	0.051204	0.019971	0.048600	0.018141
8	08:00	0.047942	0.044756	0.050070	0.041503
9	09:00	0.049401	0.061087	0.048261	0.057981
10	10:00	0.053386	0.072213	0.051706	0.070145
11	11:00	0.065006	0.077888	0.062166	0.078169
12	12:00	0.074324	0.096156	0.072485	0.089239
13	13:00	0.067611	0.08692	0.066832	0.084535
14	14:00	0.067956	0.081577	0.067509	0.080641
15	15:00	0.071843	0.079943	0.075297	0.081039
16	16:00	0.078472	0.078847	0.077637	0.079463
17	17:00	0.077938	0.072996	0.078203	0.072323
18	18:00	0.070553	0.063005	0.071226	0.064334
19	19:00	0.053573	0.051831	0.054206	0.052036
20	20:00	0.04219	0.035265	0.042810	0.038207
21	21:00	0.027818	0.02457	0.029292	0.028809
22	22:00	0.01962	0.014609	0.020948	0.018118
23	23:00	0.016342	0.008513	0.017813	0.012908
0	24:00	0.006019	0.004707	0.007042	0.006722
1	01:00	0.00305	0.001996	0.003502	0.003576
2	02:00	0.001968	0.001311	0.002335	0.002425
3	03:00	0.006612	0.001487	0.007245	0.002111
4	04:00	0.006024	0.002045	0.006133	0.002236
5	05:00	0.0113	0.009276	0.011336	0.00632

Appendix C: MOBILE6.2 Control Files

Appendix C1: Mobile6.2 Control File for the 13-County Atlanta Metropolitan Area, GA

```
MOBILE6 INPUT FILE :
DAILY OUTPUT       :
NO DESC OUTPUT     :
DATABASE EMISSIONS : 2222 2221 11
DATABASE FACILITIES: NONE
DATABASE OUTPUT    :
DATABASE VEHICLES  : 22222 11111111 1 111 11111111 111
POLLUTANTS         : HC CO NOX
WITH FIELDNAMES    :

RUN DATA
HOURLY TEMPERATURES: 74 74 74 84 84 84 92 92 92 94 94 94
                     89 89 89 81 81 81 75 75 75 72 72 72
FUEL RVP           : 7.0
EXPRESS HC AS VOC  :
EXPAND EXHAUST     :
EXPAND EVAPORATIVE :
EXPAND LDT EFS     :

STAGE II REFUELING :
92 3 81. 81.

FUEL PROGRAM       : 4
  150.0  150.0  150.0   90.0   30.0   30.0   30.0   30.0
   30.0   30.0   30.0   30.0   30.0   30.0   30.0   30.0
 1000.0 1000.0 1000.0 1000.0  150.0  150.0   87.0   87.0
   80.0   80.0   80.0   80.0   80.0   80.0   80.0   80.0

REG DIST           : 02regis2.d

ANTI-TAMP PROG     :
82 75 97 22222 11111111 1 11 097. 12111111

I/M DESCRIPT FILE  : iminfo-p.d
I/M CREDIT FILE    : Tech12.d

STARTS PER DAY     : ASTPERD.D
START DIST         : ASDIST.D

SCENARIO REC       : Georgia, 13-county Atlanta Region
SOAK DISTRIBUTION  : ASOAK.D
CALENDAR YEAR      : 2005
EVALUATION MONTH   : 7
ALTITUDE           : 1
RELATIVE HUMIDITY  : 68 68 68 50 50 50 37 37 37 32 32 32
                     40 40 40 56 56 56 64 64 64 70 70 70
BAROMETRIC PRES    : 28.98

END OF RUN
```

Appendix C2: Mobile6.2 Control File for Gaston County, NC

```
MOBILE6 INPUT FILE
DAILY OUTPUT       :
NO DESC OUTPUT     :
DATABASE EMISSIONS : 2222 2221 11
DATABASE FACILITIES: NONE
DATABASE OUTPUT    :
DATABASE VEHICLES  : 22222 11111111 1 111 11111111 111
POLLUTANTS         : HC CO NOX
WITH FIELDNAMES    :

RUN DATA           :
HOURLY TEMPERATURES: 69.7 72.9 76.9 81.0 84.4 87.5 89.9 91.3 92.1 92.5 92.3
91.5
                     88.9 85.4 81.5 79.4 77.5 76.0 74.3 73.3 72.2 71.1 70.2
69.7
FUEL RVP           : 7.4
EXPRESS HC AS VOC  :
EXPAND EXHAUST     :
EXPAND EVAPORATIVE :
EXPAND LDT EFS     :

FUEL PROGRAM       : 4
  239.6  239.6  239.6  239.6  239.6  239.6  239.6  239.6
  239.6  239.6  239.6  239.6  239.6  239.6  239.6  239.6
 1000.0 1000.0 1000.0 1000.0 1000.0 1000.0 1000.0 1000.0
 1000.0 1000.0 1000.0 1000.0 1000.0 1000.0 1000.0 1000.0

ANTI-TAMP PROG     :
92 68 50 22222 22222222 2 11 096. 22212222

I/M DESC FILE      : 3705792.imp

SCENARIO REC       : North Carolina, Gaston (071) County
CALENDAR YEAR      : 2005
EVALUATION MONTH   : 7
ALTITUDE           : 1
RELATIVE HUMIDITY  : 90.2 85.2 78.0 70.5 64.3 58.8 54.1 51.3 49.5 48.7 48.9
49.3
                       52.9 58.7 65.4 69.8 73.1 76.6 80.7 82.4 85.2 87.5 88.7
89.6
BAROMETRIC PRES    : 29.0

END OF RUN
```

Appendix C3: Mobile6.2 Control File for Mecklenburg County, NC

```
MOBILE6 INPUT FILE
DAILY OUTPUT        :
NO DESC OUTPUT      :
DATABASE EMISSIONS : 2222 2221 11
DATABASE FACILITIES: NONE
DATABASE OUTPUT     :
DATABASE VEHICLES  : 22222 11111111 1 111 11111111 111
POLLUTANTS          : HC CO NOX
WITH FIELDNAMES     :

RUN DATA            :
HOURLY TEMPERATURES: 69.6 72.9 76.9 80.8 84.2 87.3 89.4 90.9 91.5 92.0 91.8 90.9
                     88.4 85.3 81.4 79.2 77.6 76.1 74.4 73.1 72.2 71.1 70.2 69.5
FUEL RVP            : 7.4
EXPRESS HC AS VOC  :
EXPAND EXHAUST      :
EXPAND EVAPORATIVE :
EXPAND LDT EFS      :

FUEL PROGRAM        : 4
  239.6  239.6  239.6  239.6  239.6  239.6  239.6  239.6
  239.6  239.6  239.6  239.6  239.6  239.6  239.6  239.6
 1000.0 1000.0 1000.0 1000.0 1000.0 1000.0 1000.0 1000.0
 1000.0 1000.0 1000.0 1000.0 1000.0 1000.0 1000.0 1000.0

ANTI-TAMP PROG      :
83 68 50 22222 22222222 2 11 096. 22212222

I/M DESC FILE       : 3711983.imp

SCENARIO REC        : North Carolina, Mecklenburg (119) County
CALENDAR YEAR       : 2005
EVALUATION MONTH   : 7
ALTITUDE            : 1
RELATIVE HUMIDITY  : 89.9 84.6 76.9 69.3 62.7 57.4 52.6 49.9 48.6 47.5 47.5 48.2
                     51.4 56.1 63.4 68.4 71.6 75.5 79.9 82.3 84.9 86.9 88.4 89.9
BAROMETRIC PRES     : 29.2

END OF RUN
```

Appendix C4: Mobile6.2 Control File for York County, SC

```
MOBILE6 INPUT FILE

DAILY OUTPUT       :
NO DESC OUTPUT     :
DATABASE EMISSIONS : 2222 2221 11
DATABASE FACILITIES: NONE
DATABASE OUTPUT    :
DATABASE VEHICLES  : 22222 11111111 1 111 11111111 111
POLLUTANTS         : HC CO NOX
WITH FIELDNAMES    :

RUN DATA
HOURLY TEMPERATURES: 70.1 73.4 77.5 81.7 85.3 88.2 90.5 91.9 92.9 93.0 92.9
92.2
                        89.6 86.0 82.0 79.7 78.0 76.5 74.7 73.6 72.4 71.3 70.6
70.0
FUEL RVP           : 7.4
EXPRESS HC AS VOC  :
EXPAND EXHAUST     :
EXPAND EVAPORATIVE :
EXPAND LDT EFS     :

FUEL PROGRAM       : 4
  242.3  242.3  242.3  242.3  242.3  242.3  242.3  242.3
  242.3  242.3  242.3  242.3  242.3  242.3  242.3  242.3
 1000.0 1000.0 1000.0 1000.0 1000.0 1000.0 1000.0 1000.0
 1000.0 1000.0 1000.0 1000.0 1000.0 1000.0 1000.0 1000.0

SCENARIO REC       : South Carolina, York (091) County

CALENDAR YEAR      : 2005
EVALUATION MONTH   : 7
ALTITUDE           : 1
RELATIVE HUMIDITY  : 90.5 85.8 78.0 69.9 63.1 57.7 53.3 50.2 48.1 47.8 47.7
48.0
                        51.4 58.0 65.1 70.1 73.1 76.3 81.1 83.5 86.4 88.4 89.3
90.5
BAROMETRIC PRES    : 29.2

END OF RUN
```

References

ARC (2002). Transportation Solutions for a New Century Appendix 4: Model Documentation. Atlanta Regional Commission.

GDNR, Georgia Department of Natural Resources (2005). Existing State Implementation Plans. Georgia Department of Natural Resources (See http://www.dnr.state.ga.us/dnr/environ/, Accessed November 2005).

Guensler, R., S. Yoon, H. Li, V. Elango, J. Ogle, and M. Rodgers (2004). Soak Time Distributions for 400,000 Atlanta Vehicle Trips. Conference Presentation for March 2004, 14th CRC On-Road Vehicle Emissions Workshop.

Morton, Jonathan (2005). The 13-County Atlanta Metropolitan Area Mobile Source Emissions Inventory Data. Personal communication (November, 2005).

Ogle, J., Guensler, R., and V. Elango (2005). "Commute Atlanta Value Pricing Program: Recruitment Methods and Travel Diary Response Rates"; Transportation Research Record; No. 1931; pp. 28-37. National Academy of Sciences; Washington, DC.

U.S. EPA (2001). Soak Length Activity Factors for Start Emissions. Publication No. EPA420-R-01-011. U.S. Environmental Protection Agency.

U.S. EPA (2003). User's Guide to MOBILE6.1 and MOBIILE6.2 Mobile Source Emission Factor Model. Publication No. EPA420-R-0.-010. U.S. Environmental Protection Agency.