Atlanta Heavy-Duty Vehicle and Equipment Inventory and Emissions Study (AHDVEIES)

Study Plan

Submitted to:

Georgia Regional Transportation Authority
and Study Partners

By:

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ENVIRON

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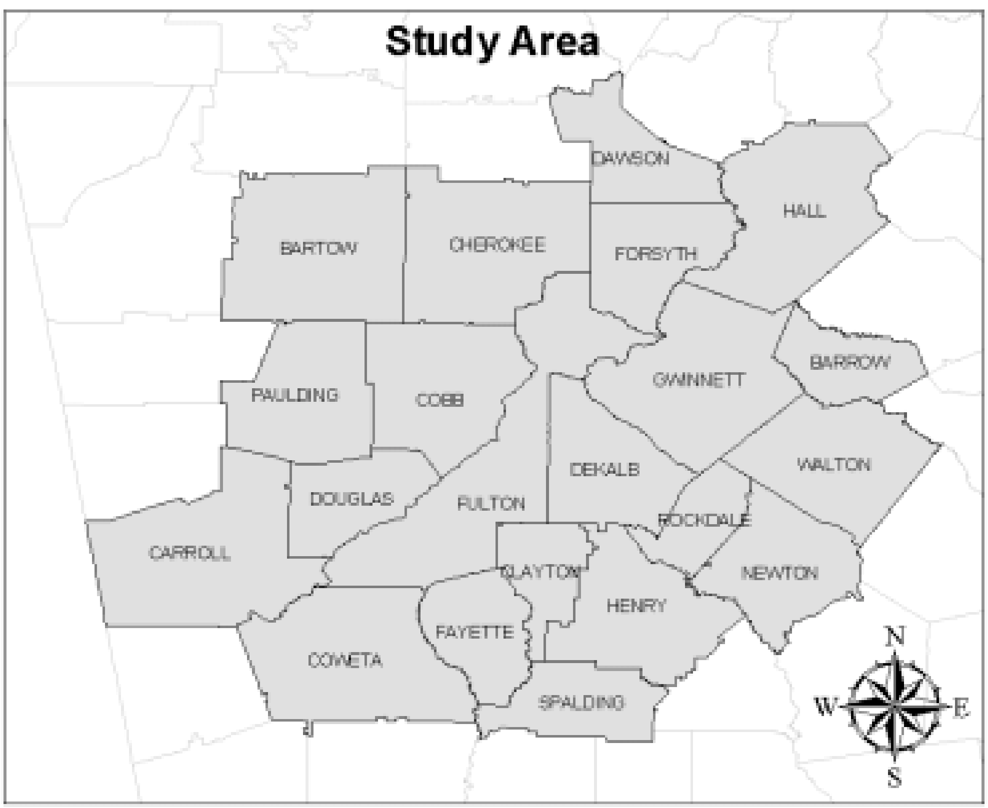
OVERVIEW

This project aims at collecting the information necessary to develop an accurate emissions inventory for heavy-duty vehicle and equipment emissions in the 21-county Atlanta, Georgia region and to evaluate the cost effectiveness of various possible control strategies for these emissions. These heavy-duty (HD) vehicles and equipment include diesel- and gasoline-powered heavy-duty on-road vehicles (> 8,500 lbs GVWR), and diesel- and gasoline-powered nonroad vehicles and equipment with engines rated above 19kW (25 hp). Similar engines powered by other fuel sources are also included in the study. The study area coincides with the prospective 21-county Atlanta 8-hour ozone nonattainment area, which is depicted in the figure below and includes the following counties: Barrow, Bartow, Carroll, Cherokee, Clayton, Cobb, Coweta, Dawson, DeKalb, Douglas, Fayette, Forsyth, Fulton, Gwinnett, Hall, Henry, Newton, Paulding, Rockdale, Spalding, and Walton. As a secondary objective, the study is to develop emissions source database that will aid the Georgia Department of Natural Resources Environmental Protection Division (EPD) in implementing these control strategies. This project is sponsored by the Georgia Regional Transportation Authority (GRTA), Georgia Department of Transportation (GDOT) and the EPD.



The process of developing emissions inventories is, at best, an inexact science. Continual changes in equipment, locations, operating conditions, etc., make even the best inventories only a reasonable approximation of reality. Given the time and resource constraints of this program, perfection in terms of either the number of source categories considered or the complete enumeration of sources within the category is not an achievable goal. It is reasonable, however, to construct an inventory that makes useful predictions for air quality and planning purposes. The focus of this inventory will be on those emissions of greatest concern to modeling of ozone (i.e., VOC, CO, and nitrogen oxides (NO_x)) and on fine particulate matter (particles less than 2.5 microns in aerodynamic diameter ($PM_{2.5}$)).

This inventory is most effectively developed by concentrating available program resources on those activities and source categories that are most likely to contribute significantly to the overall HD emissions in the Atlanta area. This document outlines our current views as how to best allocate these limited resources. It should be stressed, however, that this is only a plan based upon our best estimates at this time. Subsequent events and findings are likely to cause the exact course of the study to deviate, at least in some details, from the study plan as currently proposed. In all cases, these deviations will be made in consultation with the project sponsors and will always be performed with the aim of improving the overall quality of the final output of the study.

In particular, it is important to note that not all emissions sources to be evaluated are of equal importance in terms of the quality of the final inventory. The sensitivity of the overall inventory to errors in characterizations depends both upon the magnitude of the error of source characterization, especially how the local area differs from national averages, and the relative contribution of the particular source to the overall inventory. To aid in evaluating those sources that are worthy of greatest attention we have evaluated the potential HD source categories for which, in our opinion, deviations from the national default values could result in greater than a 1% error in the total mobile source inventory for Atlanta and have developed contingency plans should the primary approach prove inadequate. These sources are: On Road Heavy Duty Trucks, Locomotives, Construction Equipment, and Buses and contingencies for these sources are discussed later in the text. For other sources, national defaults will be used should locally specific information prove to be inadequate.

STUDY PLAN

The document is organized in parallel to the statement-of-work and is divided by task and between the nonroad and onroad components. The plan is presented in brief form and is intended to convey the essence of the activities that are currently planned. More detailed documents (e.g., survey instruments and instructions for interviewers) will be prepared later and those presented here should be thought of as being representative of what is proposed. These current representations are, however, intended to include the data elements that are proposed to be collected and subsequent versions will be aimed at improving for example, wording, "look and feel", layout and ordering or questions. Likewise, the descriptions of the field and data analysis activities are aimed at representing the principal activities but not necessarily the exact ordering, timing or number of samples to be collected and/or analyzed. In particular, the field data collection activities will be finalized, along with appropriate quality assurance/quality control activities on an individual project basis prior to initiation of the primary data collection activities. The schedule of these activities, along with that of the other elements of the project, is provided in Appendix A and the organizational chart for research activities is presented in Appendix B.

NONROAD VEHICLES AND EQUIPMENT

The equipment survey and data collection efforts are outlined below in terms of how the data will be collected and used for nonroad equipment categories of construction and mining, locomotive, industrial/commercial, lawn and garden, agricultural, and pleasure craft. The data collection method, the survey information requested, how the firms are to be determined, and how the survey information will be used are described below:

Data Collection Methodology

The information sources listed below will be used to identify the likely owners of the nonroad equipment of interest, and the research team will survey as many of the identified entities as possible within the available project resources:

1. Dun and Bradstreet, a company that provides business information sorted by Standard Industrial Classification (SIC) code associated with businesses
2. Trade associations appropriate to the category of equipment
3. Equipment sales and service firms or through their trade associations
4. Equipment maintenance and service centers
5. State of Georgia (e.g., for landfills, mines, and other facilities that require permits)
6. Vessel registration for recreational marine boats

The Dun and Bradstreet lists of construction companies and landscaping professionals will be purchased to determine company contacts, revenue, and number of employees for construction and mining firms and lawn and garden services firms described in more detail below.

The survey will proceed by contacting, by phone, mail, and FAX, the firms provided in the lists of businesses identified as described below. If the knowledgeable personnel have been contacted (such as the company equipment manager), the survey data can typically be collected in minutes for small to medium sized entities. For larger firms, computerized lists of equipment and usage can be returned that provide the information requested on the survey forms.

In general, it is possible to increase survey response rates through the provision of an incentive payment. However, the use of incentives does not necessarily guarantee a more accurate estimate of the inventory. The changes in response rates due to the incentives will vary by incentive amount, across source category, and across company size. Hence, biases can result from the implementation of incentives. Unlike the use of incentives in household travel diary studies, there is no major body of research work that has evaluated these complex relationships for implementing surveys in the goods movement and equipment ownership arena. Furthermore, State law precludes such payments for state-funded projects (GDOT staff can provide details on this issue). Federally-funded projects may, under certain conditions, implement incentive payments (as is being done in the value pricing research program). However, the IRB approval process will require an extended review and a third-party firm will need to be contracted to handle incentive payments. Given the timeframe for completion of the survey elements in this project, incentive payments are precluded.

The team will contact the national (with local chapters) and local trade groups to solicit assistance. GRTA will assist by providing information and introductions to various fleet owners and by serving as a contact for providing information about this work to inquiring firms.

The information gathered for nonroad equipment will include:

1. Owner information
2. Vehicle/equipment type and model (used in NONROAD model)
3. Manufacturer and model year of the engine (used in NONROAD model)
4. Date engine started service (if different)
5. Estimate of rated power (used in NONROAD Model)
6. Refueling option typically used (used in NONROAD Model (refueling truck use))
7. Capacity of fuel supply (if contained fuel supply)
8. Average service hours accumulated per year and average load (within the study area) (used in NONROAD Model)
9. Area of operation
10. Other Information Selected by Team and Approved by Sponsors

The survey will also obtain information on temporal allocation factors for seasonal, day of week and time of day. Example survey questions (form/script) for the surveys are provided in Appendix C. This type of survey will be mailed or faxed to prospective survey respondents and used as a guide for phone interviews.

Table 1 shows typical summer day emissions for non-road engines greater than 25 hp for the 21-county Atlanta region for the non-road source categories of interest. For all but locomotives, these emissions estimates were derived using EPA's latest available draft NONROAD model.[1] For locomotives, the emissions estimates are from EPA's draft 1999 National Emissions Inventory.[2] The emissions categories in Table 1 are sorted by the contribution to the NO_X inventory. Table 1 shows that for all pollutants, construction and mining equipment are the dominant source of emissions, accounting for 70 percent of the estimated non-road NO_X emissions and 76 percent of the non-road $PM_{2.5}$ emissions. Therefore, we will devote the most effort to this ownership category.

[1] The NONROAD model estimates emissions by multiplying estimates of equipment population, average rated power by equipment, load factor (fraction of rated power), annual hours of use, and the emission factor in units of grams of emission per unit of work performed. The model performs these emissions calculations incorporating fleet turnover with newer engines complying with recently promulgated non-road equipment emissions standards. The information gathered for non-road equipment for the proposed project should thus include an estimate of rated power, load factor (determined from hourly fuel consumption), and hours of use.
[2] NEI99, available at ftp://ftp.epa.gov/pub/EmisInventory/draftnei99ver2/

Table 1
Non-road emissions from >25hp Engines
for the 21-County Area (Tons/Summer Day)

Source Category	$PM_{2.5}$	VOC	NO_X	SO_X
Construction and Mining Equipment	10.3	15.8	106.7	26.9
Locomotives	0.5	0.9	23.8	1.1
Industrial Equipment	1.0	1.9	7.7	3.2
Commercial Equipment	0.7	1.8	6.4	1.5
Lawn and Garden Equipment (Commercial)	0.5	2.3	5.1	1.2
Agricultural Equipment	0.1	0.1	1.2	0.2
Airport Equipment	0.1	0.2	1.2	0.3
Logging Equipment	0.0	0.0	0.2	0.0
Railroad Equipment	0.0	0.0	0.2	0.1
Pleasure Craft	0.1	2.1	0.2	0.1
Recreational Equipment	0.0	1.5	0.1	0.0

Construction and Mining Equipment

Construction and mining equipment is the dominant source of nonroad emissions in the study area, and is thus the category of most interest for cataloging and improving local regional estimates of activity and emissions. Construction firms also own and use equipment catalogued by EPA under industrial and commercial categories, including such types as aerial lifts, sweepers, generator sets, pumps, compressors, welders, and some agricultural tractors. The overwhelming majority of the greater than 25 hp nonroad equipment will likely be found with firms that own construction equipment. Survey work conducted by ENVIRON or with assistance by ENVIRON staff has identified the types of construction equipment owners listed below by SIC code.

- General Building Contractors; SIC- 15
- Heavy Construction Contractors; SIC - 16
- Specialty Trade Contractors; SIC - 17
- Rental Equipment; SIC – 7353, 7359, 5082, 5083, 35, 42,
- Mining (Metals, coal -not significant-, and nonmetallic); SIC 10, 12, 14
- Stone, Glass, and Concrete Products; SIC – 32, 5032
- Forestry; SIC - 08
- Lumber and Wood Products; SIC - 24
- Garden Supply and Nurseries; SIC - 5261
- Landfills; SIC - 495
- Fertilizer-Mixing (such as composting facilities); SIC - 2875
- Asphalt Paving and Roofing Material; SIC - 295
- Metals and Minerals Wholesalers-except petroleum (scrap yards); SIC – 505, 5093
- Municipal, State, Federal

A database of individual firms will be compiled primarily by purchasing it from Dun and Bradstreet (D&B) data. D&B information will provide a nearly complete list of entities that own construction equipment, though it may not be possible to identify all businesses that could own construction equipment, especially for lower powered equipment of less than 50 hp. D&B information includes much helpful information for conducting and analyzing surveys. The information available per business includes the type of business(es), location, phone number, contact names, number of employees, revenue, and other pertinent information for selecting and conducting surveys. The sales revenue and number of employees will determine how much construction activity is accounted for in the survey responses, and also to provide a method for scaling survey results to a given county.

Municipal owners will be removed from the list because earlier work has shown that D&B lists do not completely account for publicly-owned equipment, and the list of public entities will be determined through county-level resources. However, it may be necessary to add firms to the D&B list that appear in other sources. This circumstance could arise; for example, in the case of equipment used in "non –traditional" ways by companies outside the normal SIC codes (e.g. an agricultural firm using a front-end loader to load products into trucks). This circumstance will most likely be identified through contacts with maintenance firms that will be asked to estimate the fraction of such activity. If significant, these estimates will be used to scale up the inventory figures.

D&B data will be verified with additional data sources. Additional identification and cross references to this data will be compiled, especially for rental equipment companies, landfills, and municipal publicly-owned entities, through permits, trade associations, and other State and local information sources. Within some segments, additional information sources may be used to supplement and verify the D&B lists. Such additional data sources include, but are not limited to, permit data from the State of Georgia, public bids (such as road construction and other public works projects), and discussions with local trade associations such as those identified below. The railway intermodal facilities, described below, may also use construction and mining or other industrial equipment for material handling.

Additional resources have been preliminarily identified:

- Rental stores can also be found at http://www.rentalhq.com/FindStore/Default.asp
- http://www.thebluebook.com/ : key words 'rental' and 'construction equipment'
- Georgia Highway Contractors Association; http://ghca.home.mindspring.com/
- Georgia Association of General Contractors; http://www.agcga.org/
- Georgia Mining Association; http://www.georgiamining.org/
- Georgia DOT Contractor List; http://www.dot.state.ga.us/dot/construction/contractsadm/contractor_directory.shtml
- Georgia Concrete & Products Association; http://www.gcpa.org/
- Southern Brick Institute; http://www.bia.org/ brick manufacturers
- Associated Builders and Contractors of Georgia; http://www.abcga.org/page.cfm?keyPageID=803

For construction and mining equipment, the survey results in this work will be compared with other survey results such as those in the Northeast and Houston to determine differences and check the reasonableness of the results. The Northeast survey response rates are shown in Table 2 and indicate a significant risk of low voluntary cooperation. Not shown, but a likely important segment, are rental equipment firms that did not respond to this survey work at all in any county. The most important other categories for equipment ownership were the excavation and demolition contractors (SIC 1794 + 1795), road contractors (SIC 16), and municipal ownership, and these owners had lower response rates than other types of owners (the rural Franklin County survey work produced the highest response rates for two reasons; fewer entities to survey and more aggressive survey researchers). Given the significance of this source, as a contingency, the twenty largest construction firms operating in the Atlanta area (based on figures from the Atlanta Business Chronicle) will be targeted for direct contact by the survey team in an effort to improve response rate.

Table 2
Response Rate for the NESCAUM Construction and Mining Survey[3]

SIC	Ownership Categories	Providence	Albany	Franklin County, MA
8	Forestry	5%	0%	100%
14	Nonmetallic mining	61%	0%	100%
15	Building contractors	88%	9%	83%
16	Road contractors	13%	4%	54%
17	Special contractors	40%	20%	86%
1794 + 1795	Excavation and demolition	23%	4%	67%
24	Lumber and wood products	75%	37%	92%
32	Stone, glass, and concrete	8%	0%	96%
5261	Garden Supply and Nurseries	69%	10%	80%
	Publicly or municipal owners	16%	0.3%	87%

Total activity in each type of owner/operator grouping will be estimated by dividing the total activity within the survey results by the response rate as determined from total dollar revenue or other appropriate indicator of activity. For example, human population served by municipalities or tonnage of material for landfill and mining activities can be used for developing appropriate survey response rates.

A stratification analysis after the surveys are collected will be used to determine if the size of the company (determined as a strata of revenue or number of employees) affects the average equipment ownership. If the size of the company affects the estimate of average equipment ownership, then the equipment will be scaled according to the average ownership per strata of the size of the company, response rate within each stratum, and relative importance of that size of company to the entire ownership category.

Industrial and Commercial

Industrial and commercial equipment categories include such ubiquitous equipment types as generators, pumps, compressors, forklifts, and other general purpose equipment. It is much more

3 As a fraction of revenue or human population for municipal ownership.

difficult to determine owner/operators of these equipment categories because they are used in so many diverse applications and entities, and relevant trade associations and owner lists will be much more difficult to identify. However, often these equipment types have service contracts with local dealers and service centers, and these dealers and service centers can be contacted to identify owner/operators. The local representatives/chapter of the Associated Equipment Distributors (http://www.aednet.org/local_group/localgroup.cfm?localgroup=20) will be solicited for information and contacts. In addition, some of the owners of equipment types categorized as industrial/commercial will be found and surveyed when approaching owners of construction equipment.

Lawn and Garden Equipment

Landscaping service firms will be surveyed as part of the interviews with potential owners of construction equipment such as (SIC-5261, Garden Supply and Nurseries). In addition, the owners of Landscape and Horticultural services (SIC-0780) and golf courses (not included in Dun and Bradstreet lists; Georgia Golf Course Superintendents Association; http://www.ggcsa.com/) will be contacted to identify owners of equipment rated above 25 hp. These equipment types would be smaller tractors and other turf equipment that are powered by engines above 25 hp.

Agricultural Equipment

For most areas for which ENVIRON has estimated detailed nonroad emission inventories, the NONROAD model has predicted much less agricultural equipment in use than available estimates from the US Department of Agriculture. For the State of Georgia, the USDA estimates 43,656 agricultural tractors of greater than 40 hp, while the EPA NONROAD model estimates only 21,952. Agricultural extension services, trade associations, and the USDA (especially the National Agricultural Statistics Service) will be consulted to determine a more appropriate estimate of the numbers of these equipment types and to identify potential owners.

Pleasure Craft

State boating registration data will form the basis to determine counts of boats within the State; these State counts will be substituted for the default State counts assumed by EPA and will be used along with water surface area to improve the county allocation of recreation boating activity. State registration data files usually identify where the boats are housed to determine how many might be captured within the study area. Project resources do not allow for a detailed boating survey; nor is this warranted as pleasure craft account for only about two percent of the study area nonroad VOC emissions.

Locomotives

Locomotives are the second most important category for nonroad NO_x emissions, and owners should be easily identified because a limited number of railways operate in the study area. Typically the larger railways, called Class I and classified by revenues and car loadings, dominate the locomotive activity nationally and the greater Atlanta is likely no exception. Norfolk Southern and CSX are the primary Class I railways operating near Atlanta. Norfolk Southern also operates a recently opened intermodal facility in Austell, and CSX operates freight facilities in Atlanta and Cartersville, likely using switching locomotives. Other, smaller Class II and III, regional railways operating in the study area include the Georgia Northeastern Railroad and the Great Walton Railroad. The railroads operating within the study area will be approached to request activity and locomotive count information, distinguishing between line-haul and switching (Georgia Northeastern Railroad actually provides a list of their 10 locomotives on line at http://www.gnrr.com/Fact_Sheet.htm but individual activity needs to be gathered as well).

The research team will contact CSX and Norfolk Southern to obtain directly any information on their mainline and switching activity in Atlanta that they are willing to provide. The main problem is that the shipping information is proprietary in nature. In general, neither company wants their competitor to have access to the information on shipping quantities. The information that we will seek includes train movements (engines and loads) by line, by time of day, and engine-hours of operation and typical loads for switching engines assigned to Atlanta yards. During the interviews, researchers will also be looking for information on the seasonal and weekly variability of shipment volumes into and out of the region.

In the event that direct data are unavailable, or insufficient to evaluate rail flows, the researchers will implement the following sampling plan:

1. Screenline Cordon - The team will establish a screenline cordon around the Atlanta metro area. A preliminary GIS review of rail lines in the GDOT transportation coverage indicates that a screenline across 21 rail lines will isolate the main traffic coming into and out of the Atlanta region.
2. Screenline Site Review - The team will inspect each screenline location to examine the tracks, interview local residents and business operators, and observe typical operations. The observations will be used to eliminate abandoned lines from the cordon. Interviews will establish the approximate number of train movements per hour during daytime and nighttime periods, to eliminate unused and extremely low-volume lines from the sampling plan. The team estimates that 10-12 final screenlines should be sufficient to capture 95% of the rail traffic volume.
3. Screenline Count Program - The team will conduct simultaneous screenline counts at the final selection of screenline stations in which observers will record engine numbers and count the number and type of rail cars (boxcars, refrigeration units, containers, tank cars, flatcars, etc.) moving into and out of the region. In the mass-balance approach, this provides net flows into and out of the system. On at least three days, data will be collected at all sites. Additional data collection days will be conducted at high volume sites and any sites that exhibit high traffic variability (based upon interview data or observation). Screenline data will be used to estimate emissions from the on-network trains entering and exiting the region. The total on-network time for each train will first be estimated using travel times to the closest major terminal. If rail companies will make basic data available, the team will investigate the development of a basic gravity model to allocate trains to terminals based upon train size and terminal movements.
4. Intermodal Terminal Inventory – The team will visit the 17 major intermodal terminals in the metro area. The observations and interviews will determine whether the terminals operate switching engines and will provide initial information on the approximate number of freight movements into, and out of, the terminals. Major terminals will be

identified and included in a terminal count data collection effort to be conducted in concert with regional screenline counts.

5. Terminal Counts – The team will deploy traffic count and classification units (tube counters) at the entrance to each major freight terminal to count the movements of trucks into and out of each terminal. Observation (video) data will be used to establish the ratios of rail cars to trucks for each terminal will be established through video count observation. The net result from the terminal counts will be an estimate of rail car traffic into and out of each major freight terminal.
6. Switching Yard and Rail Terminal Studies – The team will observe operations in switching yards to develop switching engine use estimates for assembling/loading and offloading trains. Trains and engines will be observed during these processes and estimates of hours of operation per rail car inflow and outflow will be developed from the observational data.
7. Support Equipment Activity – The team will observe and quantify the operations of heavy-duty nonroad support equipment during switching yard and terminal studies. Observers will record train sizes and hours of operation for each equipment operation associated with assembling/loading and offloading trains. Results will provide average support equipment activity estimates per rail car during these operations which can be applied to net rail commodity flows.
8. Estimation of Total Switching Yard Activity – Using the results of the terminal count study (freight movements into and out of the terminal) and the switching yard study (hours of engine operation per unit rail car loaded and unloaded), the team will estimate daily hours of operation at these facilities. Temporal allocation will be based upon observed rail yard traffic patterns (the presence of warehousing and storage means that freight movements into and out of the freight terminal will occur at different times than the trains are assembled or unloaded).
9. Reconciliation of Regional and Terminal Data – Inflows to intermodal terminals leave the region, they do not flow out at other terminals within the region. Hence, the observed regional railcar inflows and outflows can be reconciled with terminal flow counts (which will very likely be lower due to counting efficiency). Unallocated freight movements and associated yard activity will be allocated to terminals in proportion to estimated daily movements.
10. Special Generators – The team will pay special attention to unit-train movements that occur in the region. Through movements of unit coal trains will be verified by contacting Georgia Power and used to evaluate observational count efficiencies. Automobile shipments from the local GM Doraville and Ford Hapeville plants will be specifically addressed as well. During the rail company interviews and field review of lines and terminals, the team will seek additional information on special generators.

Because observation of train movements could trigger homeland security concerns; the team will work with the rail companies, Federal Railway Administration, Governors' Office, GDOT, and local authorities to ensure that all are aware that team will be conducting counts.

The research team will compare the estimates generated for the region with those contained in EPA's National Emission Inventory (NEI). The NEI employed national rail activity allocated to the county level based upon the Department of Transportation's rail freight density estimates.

The National Transportation Atlas depicts rail routes and classifies each route in terms of a rail freight density rating. The Department of Transportation conversion software converted the NTA data into ArcInfo compatible files. The rail freight density can then be associated with spatial features in the GIS data. It is important to note, however, that the data sources employed in the NEI development are known to underestimate the actual freight transfers reported by the railways operating in some areas. As such, the use of NEI estimates would be secondary (for illustrative purposes only) and lower priority than the direct collection of regional data.

Emission Estimates

For all nonroad equipment except locomotives, ENVIRON will estimate emissions using the NONROAD model calculations with modified input files reflecting the survey results from data collected in this work. Locomotive emissions estimates are discussed below. As previously developed for TNRCC, ENVIRON will prepare alternative NONROAD input files for equipment population, annual usage, seasonal adjustment, and load factors (associated with actual fuel use) to reflect the specific data estimates determined with this work's survey. The estimates from this work will be compared to those estimates obtained using default inputs in the latest NONROAD model. Through these input files the range of input data (derived from an uncertainty analysis of the collected data) will be incorporated into the emission estimates to provide the range of possible results. Also, a chemical speciation profile will be appropriately applied (matching emissions by engine and fuel type) to individual equipment types from chemical composition profiles available from EPA.

Historically, activity estimates from railroads have been provided in units of ton-miles and converted to gallons of fuel consumed. This estimate will be distinguished between line-haul and switching locomotive fuel consumption because EPA provides unique emission factors for each. The gallons of fuel consumed will then be associated with the EPA or more recent emission factors given in terms of emissions per gallon of fuel used and incorporating fleet turnover to engines meeting the emission standards.

ON ROAD VEHICLES

Overview

Like the nonroad emissions activities, the onroad heavy-duty vehicle emissions inventory is prepared by linking vehicle activity estimates (miles traveled or hours of operation) with the applicable emission rates for these activities under the appropriate operating and environmental conditions. Current modeling methods require a base knowledge of the fleet composition, onroad vehicle miles of travel (or vehicle hours of travel), onroad operating conditions (facility type and average speed in the case of MOBILE6), and environmental conditions such as temperature and humidity. The research plan first outlines the importance of fleet characterization across the various onroad vehicle categories (trucking/goods movement, municipal/private heavy-duty service vehicle activity, and bus operations). Because the activities within and across each sector are so different, and because the availability of data within these sectors varies tremendously, different inventory strategies are applied to each category.

On the vehicle activity side, the research approach starts with the quantification of truck activities on freeways as the foundation to which all goods movement and service activities for all truck classes will be referenced. After outlining the freeway procedures, the research plan discusses how various sampling and survey activities will be used to apportion and scale arterial and other off-network activity to measured freeway travel. Finally, the research plan outlines the proposed procedures for addressing truck idling and municipal and commercial bus operations, which are handled separately from truck activity.

Heavy-duty trucks are defined as vehicles exceeding 8,500 pounds gross vehicle weight rating (GVWR); the maximum allowable gross weight of the vehicle defined by the manufacturer. Trucks range in size from small panel vans and utility trucks just over the weight threshold to tractor-trailer rigs exceeding 80,000 pounds. Heavy-duty service vehicles include: fire trucks, utility trucks (cable, telephone, electricity, gas), street sweepers, local roadway repair trucks, water department vehicles, maintenance vehicles, etc. Parcel delivery vehicles (e.g., FedEx and UPS) and large postal service vehicles also accumulate large daily VMT totals. Heavy-duty diesel buses vary considerably in weight and engine power, as a function of vehicle size and service type.

Table 3 presents the percentage of trucks by FHWA truck class, using data collected in the Georgia Department of Transportation (GDOT) Highway Performance Monitoring System (HPMS) on Interstates outside of the perimeter in the 13-county Atlanta region. The table shows that 5-axle, single trailer trucks dominate the Interstate truck traffic and further indicates that the 2-axle, single unit trucks combined with the 5-axle, 2-unit trucks comprises approximately 90% percent of the truck volume.

Table 3
FHWA Truck Classifications and Georgia Truck Count Percentages[4]

FHWA Classification	Number of Axles	Number of Trailers	Percent of Truck Total at a Typical HPMS Interstate Site
5	2	0	10-20%
6	3	0	3-5%
7	4	0	Less than 1%
8	3-4	1	2-5%
9	5	1	65-75%
10	6+	1	3-5%
11	4-5	2+	3-5%
12	6	2+	Less than 1%
13	7+	2+	Less than 1%

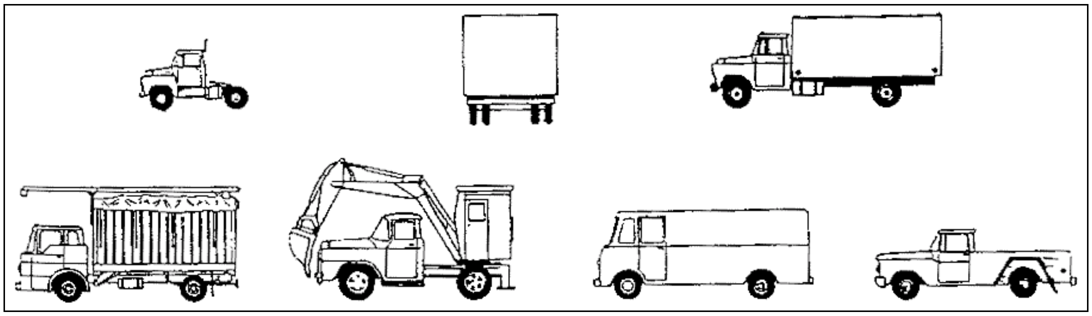
Onroad Truck Classification Scheme

The onroad truck classification scheme that will be used for all field data collection in this research is based upon previous analyses of HPMS, weigh station, and weigh-in-motion data in

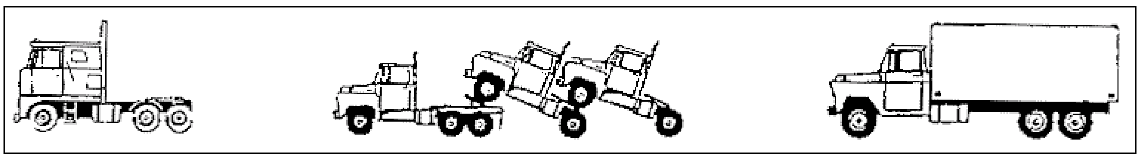
[4] Ahanotu, Dike (1999); Heavy-Duty Vehicle Weight and Horsepower Distributions: Measurement of Class-Specific Temporal and Spatial Variability; Dissertation; Georgia Institute of Technology, Atlanta, GA.

Atlanta.[4] A four-class system, based upon axle-trailer configurations, will be used for all ground counts and field observations. Using the FHWA classification as a base, a modified classification system ensures that all FHWA truck classifications are covered, and that a significant number of each of the vehicle types will be collected in the survey. The four observational classifications are composed of FHWA vehicle classes that were aggregated based upon three criteria: 1) range of gross weights across classes, 2) engine horsepower differences across classes, and 3) ease of classifying during field observations. For example, large single trailer trucks (FHWA Class 9) have very similar weight distributions to the double trailer trucks (based upon a maximum truck weight limit and differences in trailer unit sizes) and similar engine horsepower distributions.[4] Plus, the straight-forward axle/trailer configurations improve the efficiency and accuracy of field data collection. That is, these classifications are easy to identify and less prone to error than attempting to collect data across the classifications employed in the emission rate models. The four observational classes are:

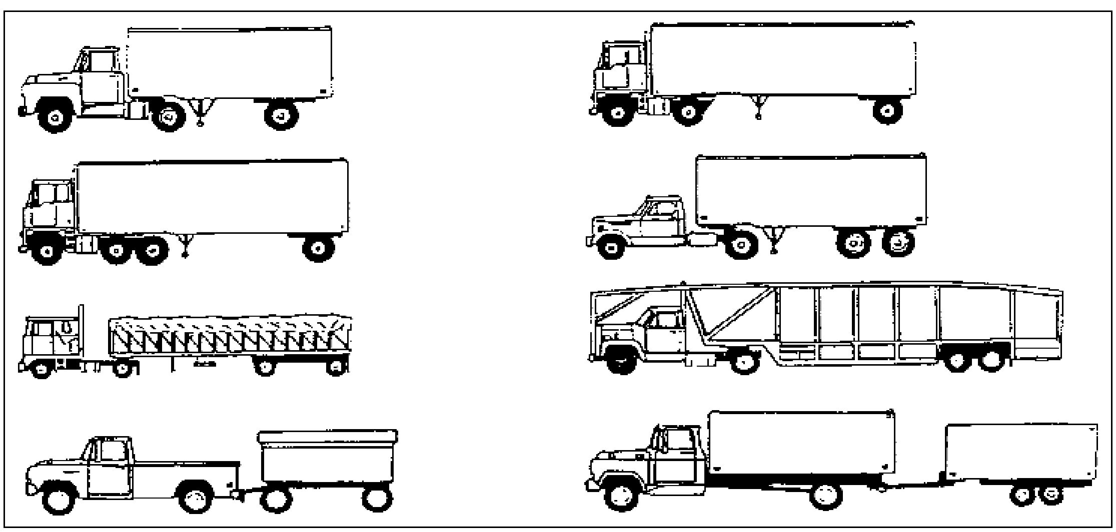
- 2-axle, single unit trucks (Class 5 trucks)
- 3 or more axle, single units trucks (Class 6-7 trucks)
- 3 or 4 axle, truck and single trailer combinations (Class 8 trucks)
- 5 or more axle single trailer trucks, plus double trailer trucks (Class 9-13 trucks)



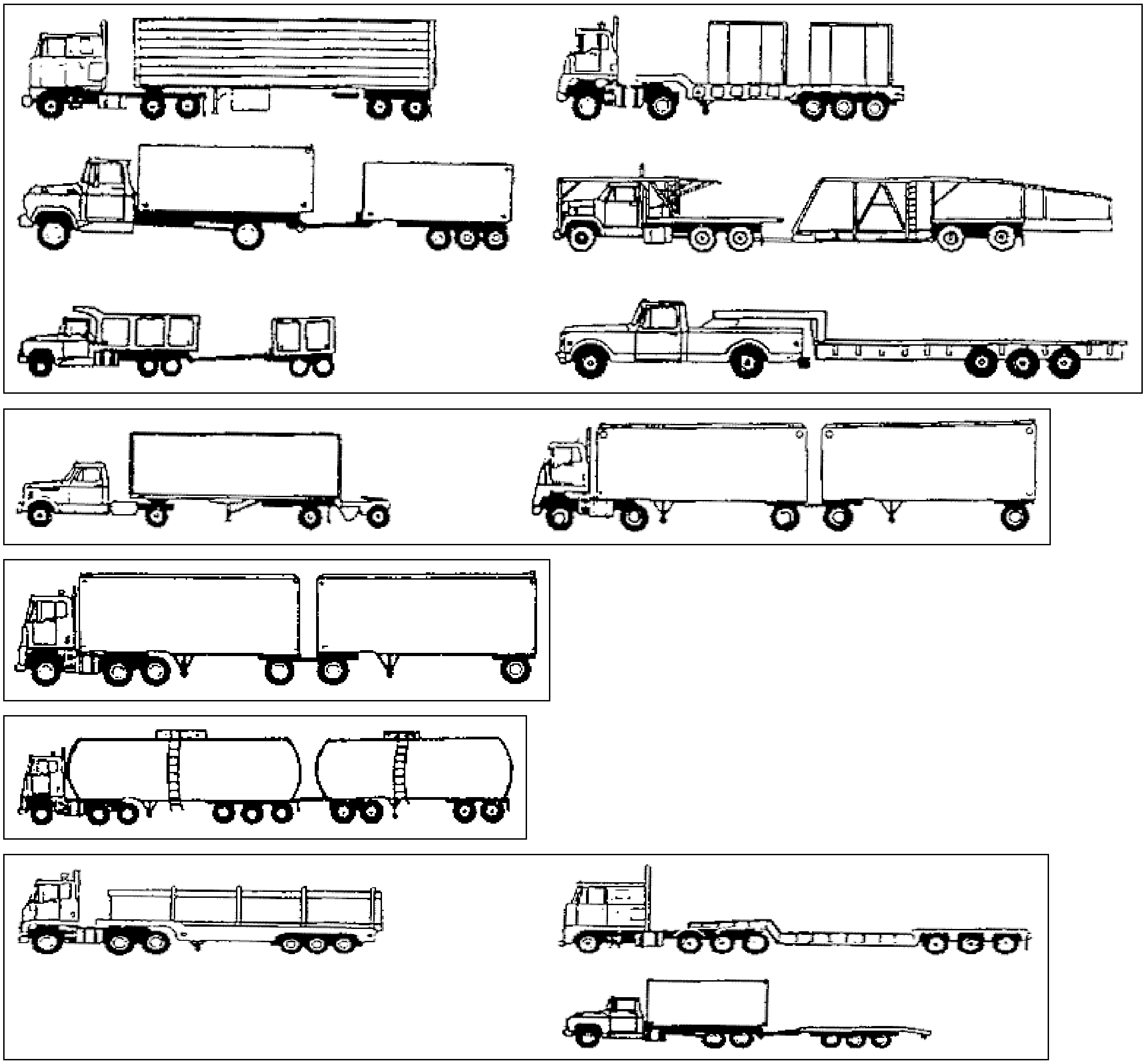
FHWA Class 5, two-axle single unit trucks



FHWA Class 6/7, Single unit trucks with more than two axles



FHWA Class 8: 3-4 axle, 1-trailer vehicles



FHWA Class 9-13: 5+ axles, and/or multiple-trailer trucks

Quantification of Onroad Heavy-Duty Truck Activity

The proposed approach for quantifying the onroad activity of heavy-duty trucks involves a combination of field observation and shipper surveys. The research team will define a regional freeway freight network and will collect onroad heavy-duty truck ground counts on every link on this network. A survey of local shipping operators will provide data on the relative percentage of freeway versus local road activity. Freeway ground counts will be used directly and local road activity will be inferred from the measured freeway activity and relative ratio of local/freeway travel provided by shippers. Observed activity in the survey period will be scaled to summer activity using Commodity Flow Survey relationships.

Truck travel on the metropolitan freeway network consists of major through movements, major movements into and out of freight terminals, and movements entering and departing the network to make local pick ups and deliveries. Through movements are governed by large scale freight commodity flow. Hence, through movements result in significant differences in truck volumes upstream and downstream from major freeway interchanges, as vehicles moving through the system head for other cities and states. Similarly, movements into and out of major freight terminals can yield significant difference in truck travel volumes upstream and downstream from a freeway exit serving major terminal systems. However, goods movement onto and off of the local network system for pickups and deliveries is much more random in nature. In general, truck volumes immediately upstream and downstream from exits serving residential and basic commercial/retail land uses are fairly consistent (inflows and outflows tend to balance). As such, it is not necessary to measure truck traffic volumes between every freeway exit; only upstream and downstream of locations where major changes in truck trip activity are expected to occur. The research team proposes to define a freeway network that consists of links that are defined by the transition points where major truck activity is expected to leave or join the freeway; where freeways meet and at any interchange that serves as an exit to a major freight terminal.

With the exception of highly seasonal freight activity, such as raw agricultural commodity movements and construction materials movements, the majority of commercial freight activity tends to scale with economic productivity and consumption. Seasonal variations in consumption patterns exist, but in general the same consumptive goods are moving through the system on a daily basis, just in different amounts (i.e. fewer movements). The freight terminal network is well established, and truck movements through the network usually exhibit stable operational patterns that tend to scale with overall commodity flow. Hence, it is also reasonable to assume that the freight travel on the network tends to exhibit serial correlation in space and time. That is, even if an upstream freeway link tends to show more truck travel than a downstream freeway link, when the movements are down by 20% on the upstream link they will be down by roughly the same proportion on the downstream link. As such, the research team believes that a general counting approach will not require continuous measurements for all freeway links for extended periods in order to generate the general flow relationships and estimate total system travel for the monitored network.

The researchers are proposing the following sampling and survey plan:

1. Screenline Cordon - The team will establish a screenline cordon around the Atlanta metro area for freeway travel. The team will establish 7 to 9 freeway count stations at the edges of the region (I-75x2, I-85x2, I-20x2, and GA400, and perhaps 675 and 575, depending upon observed extra-regional truck volumes). These stations will isolate the heavy-duty truck traffic coming into and out of the Atlanta region.
2. Screenline Site Review - The team will inspect each screenline site to select observation locations and determine whether unattended video camera monitoring of traffic operations can be implemented.
3. Screenline Count Program - The team will conduct counts/classifications at all screenline stations over a two-week period in the fall. Every station will be monitored for 24 hours on two different days. The sites selected for monitoring each day will be randomized (random site selection with one replacement so that two full days of data are collected for each station).

4. Developing the Freeway Freight Network – The digitized roadway network serves as the basis for development of the proposed freeway freight network. The research team will identify all major truck terminals in the Atlanta metropolitan region. Freight network nodes will be established on the freeway system anytime two freeways meet and at any interchange that serves as an exit to a major freight terminal. Freight network freeway links will be defined as the links between these freight network nodes.
5. Sampling from the Freeway Freight Network
   a. Ground counts sampling will be conducted on every freight freeway link. Data will be collected in 3-hour time blocks for approximately 12 hours on each link. The sites and time blocks selected for monitoring each day will be randomized. The total number of days of data collection will be a function of the truck traffic variability and level of serial correlation noted during data collection. The team will determine whether additional data collection is required by analyzing traffic volume variability and observed serial correlation between measurements on the same freeways.
   b. Links covered by the ATMS monitoring system will be collected via video data collection at the GDOT traffic management center when lighting conditions permit. Cameras located on the I-75/I-85 corridor inside the perimeter, along the north legs of I-75 and I-85, and the northern arc of I-285 are monitored by GDOT cameras. The research team will coordinate these video data collection days with TMC staff.
   c. Freight freeway network link ground counts will be used directly to represent freeway vehicle activity.
6. Shipper Surveys – The research team will develop a shipper survey in consultation with GRTA staff which will be submitted for approval by the Institutional Review Board (IRB)[5] for human subjects review. The goal of the survey is to collect basic data on daily shipping movements, temporal distributions of tripmaking, and fraction of vehicle activity on freeways versus local roads. Whereas freeway ground counts will be used directly, local road activity will be inferred from the measured freeway activity and relative ratio of local/freeway travel provided by shippers. Shippers will be identified through Dun and Bradstreet and the 1997 US Department of Commerce Economic Census, and vehicle registration data. Example survey questions are provided in Appendix D. As a contingency, each of the top twenty common carriers operating in the Atlanta Area (as identified by the Atlanta Business Chronicle) will be contacted directly by the project team.
7. Terminal Counts – The 1997 Economic Census from the US Department of Commerce will be used to identify freight terminals and major shipping operations in the Atlanta region. These terminals and shippers will be ranked by total daily movements. A random sample of terminals and shippers by shipment volume will be selected for monitoring using tube counters and classifiers, providing estimates of the temporal

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5 Because the surveys involved in this project collect personally-identifiable information, the survey activities must be approved by the IRB. Clinical trials of medicines or survey activities of human behavior often place participants in the research at risk of unintended medical or legal consequences. The IRB process ensures that the research is conducted in such a manner that all potential risks to the participant are fully disclosed and that the participants understand that participation is voluntary and that they may opt out of the research project at any time. Because the survey data will link equipment ownership to individual Atlanta residents, the IRB must approve the survey plan and all materials involved in the data collection process. However, because the surveys do not place the participants at any risk, the survey activity qualifies for an expedited IRB approval process can yield approval of the materials in a two-week period.

distribution (assuming a time lag) of movements on local roads. Intermodal terminal counts will be coordinated with the rail activity monitoring efforts. Selected terminals will be visited by project personnel to evaluate yard activity and idling time.

8. Weigh Station and Commodity Flow Survey Data – The research team will seasonally adjust the monitoring and survey results collected in the fall to summer values based upon the ratio of goods movement between fall and summer. Regional weigh station data and commodity flow survey data will serve this process.

Driver Interviews

Weigh Station Interviews

In 1997-98, extensive weigh station surveys were conducted by Georgia Tech at the Douglas County weigh station[4] which is located approximately 15 miles west of downtown Atlanta on the eastbound side of Interstate-20 which runs east-west through the Atlanta metropolitan area. Similar weigh station surveys will be conducted as part of this project at inbound weigh stations on I-75, I85, and I-20. Trucks will be selected at random for interviews by the field research team. The weight of the trucks selected for the survey will be recorded using the stationary scale at the weigh station. The weigh station officer will be asked to direct the truck into the truck parking lot where the vehicle identification number, body type, FHWA classification, and origin-destination information for each truck can be collected. Body type data will also collected and divided into four categories: dry container, tanker, tow (trucks that pull other vehicles), and flatbed trucks as well as the classification described above. Origin-destination information will be requested verbally from the driver and will be recorded by city, if within the non-attainment area. If delivering within the non-attainment area the drivers will also be asked if the delivery point is a freight terminal or if they are delivering directly to the customer(s). These data will be used to obtain the weight distributions for both the transient fleet and those making local deliveries and to assess the fraction of screenline trucks making local deliveries.

Truck Stop Interviews and Data Collection

Data will be collected from selected major trucking centers listed in Table 4 below:

Table 4
Preliminary List of Truck Stops for Survey Data Collection

Company		Location	County
PETRO		I-285 Exit 51 Bouldercrest Rd	DeKalb
		I-75 Exit 296	Bartow
		I-285 Exit 16, South Atlanta Rd	Fulton
FLYING J		I-75 Exit 201	Henry
		I-20 Exit 19, Hwy 113	Carroll
TA	Atlanta	I-285 Exit 53, Hwy 160	DeKalb
QT	Atlanta	I-20 Exit 49, Industrial Blvd	Fulton
	Doraville	I-85 Exit 96, Pleasantdale Rd	DeKalb
PILOT	Travel Center #331	I-285 Exit 37	DeKalb
	Travel Center #344	I-285 Exit 11	Fulton

At these locations, drivers will be approached randomly (following the same methods previously undertaken by the research team)[4] and asked if they are making a local delivery to the Atlanta non-attainment area. Like the weigh station surveys described above, the interviewer will also record truck data and stated weight (if known). The interview teams will also evaluate idling activity within these major centers as well as total truck volume.

HPMS Data and Other Local Studies

The research team has requested from GDOT staff the entire HPMS data set for the State of Georgia. The electronic database should be received this month.

The research team will examine the data collected by Street Smarts for the Georgia DOT goods movement project and will determine if any of the data are applicable in the above sampling framework. Because the other study was designed to assess the potential impacts of goods movement restrictions, it is unclear at this time how relevant the weigh station, truck stop, and shipper interview data will be to this inventory study. Other sources of data made available during the course of the study will be examined for applicability in the inventory development process.

Municipal and Commercial Bus Operations

Onroad Bus Fleet Characterization

Georgia Tech currently has access to the engine and chassis data for the entire MARTA bus fleet, as well as vehicle maintenance history data. The research team will meet with MARTA to obtain additional information on their internal policies used to assign specific vehicles to routes. The research team will meet with GRTA staff to obtain similar engine/chassis data for integration into the current Georgia Tech database. School buses constitute the largest bus fleets operated in Atlanta. Each County and school district will be surveyed to determine the number of buses operated and the locations of the marshalling yards so that additional information on bus operations can be obtained.

Operators of small commercial bus fleets will be identified through city and county limousine and bus licenses and permits. Many of these operations were previously identified by GRTA in the taxi/transit integration project conducted in 1999. An expanded telephone contact effort will be undertaken to bring these operators and vehicles into the database. The major fleets identified to date are given in Table 5 below.

Table 5
Bus Operations, Numbers of Buses, and Methods for Data Collection

Transit-Oriented Bus Operations	Estimates	Method for Data Collection
MARTA	700	BTS Data/Telephone Contact
Cobb County Transit	90	BTS Data/Telephone Contact
Gwinnett County Transit	20	Route Count/Telephone Contact/Budgetary Data
C-TRAN	15	GRTA
GRTA pilot program (ATL-MAC)	10	GRTA
Greyhound/Trailways	40	Route Count/Telephone Contact/Budgetary Data
Charter Bus Services	100	Route Count/Telephone Contact/Budgetary Data

Table 5 (Continued)
Bus Operations, Numbers of Buses, and Methods for Data Collection

School-Oriented Bus Operations	Estimates	Method for Data Collection
Public School Systems		
Barrow	63	Route Count/Telephone Contact/Budgetary Data
Bartow	183	Route Count/Telephone Contact/Budgetary Data
Carroll	150	Route Count/Telephone Contact/Budgetary Data
Cherokee	236	Route Count/Telephone Contact/Budgetary Data
Clayton	268	Route Count/Telephone Contact/Budgetary Data
Cobb	869	Route Count/Telephone Contact/Budgetary Data
Coweta	136	Route Count/Telephone Contact/Budgetary Data
Dawson	35	Route Count/Telephone Contact/Budgetary Data
DeKalb	972	Route Count/Telephone Contact/Budgetary Data
Douglas	167	Route Count/Telephone Contact/Budgetary Data
Fayette	204	Route Count/Telephone Contact/Budgetary Data
Forsyth	257	Route Count/Telephone Contact/Budgetary Data
Fulton	550	Route Count/Telephone Contact/Budgetary Data
Gwinnett	1042	Route Count/Telephone Contact/Budgetary Data
Hall	250	Route Count/Telephone Contact/Budgetary Data
Henry	270	Route Count/Telephone Contact/Budgetary Data
Newton	131	Route Count/Telephone Contact/Budgetary Data
Paulding	195	Route Count/Telephone Contact/Budgetary Data
Rockdale	180	Route Count/Telephone Contact/Budgetary Data
Spalding	175	Route Count/Telephone Contact/Budgetary Data
Walton	140	Route Count/Telephone Contact/Budgetary Data
Private School Systems		
The Lovett School	16	Route Count/Telephone Contact/Budgetary Data
The Marist School	14	Route Count/Telephone Contact/Budgetary Data
Pace Academy	8	Route Count/Telephone Contact/Budgetary Data
The Walker School	6	Route Count/Telephone Contact/Budgetary Data
The Westminster Schools	5	Route Count/Telephone Contact/Budgetary Data
Woodward Academy	35	Route Count/Telephone Contact/Budgetary Data
University Bus Systems		
Emory University	22	Route Count/Telephone Contact/Budgetary Data
Georgia Tech	18	Route Count/Telephone Contact/Budgetary Data
Georgia State University	24	Route Count/Telephone Contact/Budgetary Data

Bus Traffic Volumes and Operating Conditions

Georgia Tech is currently using the route and scheduling information provided by MARTA. The research team is in the process of integrating the information into the in-house GIS system for modeling purposes. The route information provides spatial and temporal allocation of onroad bus VMT. Similar efforts will be conducted for the GRTA fleet, school bus fleet, and private fleet operations.

Second-by-second operating data are currently being collected by onboard instrumentation installed on four MARTA buses (which will rotate through different bus routes). The data from these buses are going to be used in the MARTA maintenance model and will be used in our inventory effort to establish typical operating profiles for urban and suburban operations. These operating profiles will be adjusted to reflect the nature of school bus and private fleet activities. Traffic counts will be made at major bus maintenance facilities to determine the extent of unscheduled vehicle movements. Teams will also interview maintenance personnel and visit facilities to estimate bus idling operations.

Emission Modeling

The MOBILE6 emission rate model estimates CO, HC, and NOx emission rates from eight heavy-duty diesel truck classes, plus one heavy-duty diesel transit bus class, and one heavy-duty diesel school bus class. Emission rates are provided for diesel, gasoline, and natural gas vehicles. Panel trucks weighing less than 8,500 pounds (such as many telephone and gas company trucks) are considered to be light-duty vehicles. The PART5 model estimates emission rates for four heavy-duty vehicle classes, plus one bus class. Given the emission rate model framework, forging a link between vehicle activity (miles or hours traveled) and the appropriate emission rate necessitates the tracking or mapping of these individual diesel-vehicle classes. The research team will procure the Polk database available for Atlanta vehicles. The Polk database contains EPA classifications as a data element. A sample of the data elements in the Polk database is given in Appendix E. The Polk data will also be used to split the data collected within the four observational classifications into applicable MOBILE6 and PART5 vehicle classifications.

The traffic volumes collected for each of the four truck categories will be mapped to the appropriate MOBILE5a, MOBILE6, and PART model truck classes using basic vehicle type definitions and additional heavy-duty vehicle registration data procured from RL Polk. Appendix F provides the heavy-duty vehicle classes employed in the MOBILE5 and MOBILE6 models. Linkages to MOBILE5a and PART5 classes are relatively easy, but allocating observational counts to MOBILE6 bins becomes a bit more challenging. RL Polk registration data for Georgia will be used to disaggregate traffic counts into the MOBILE subcategories for freeway activity[6] and regional registration data will be used to disaggregate traffic counts into the MOBILE subcategories for local activity, under the assumption that onroad fleet presence is correlated to registration totals. Freeway activity will be disaggregated using national figures, local traffic will be disaggregated using regional registration figures. That is, Class 5 observations will be split into diesel and gasoline fractions based upon the relative registration mix within this class. Similarly, Class 8 trucks will be disaggregated into Class 8a and 8b trucks for MOBILE6 using the registration fractions for these vehicles with GVWR greater than, and less than 60,000 pounds.

Table 6 presents the data input components for the MOBILE and PART5 emission rate models. The outputs from these models will be used to estimate the emissions resulting from the activity measurements described earlier.

[6] The actual Polk data are required to perform the mapping. Purchase of the national database or southeastern database is beyond the resources available to the project. Statewide distributions will be assumed to reflect freeway fleet characterization in mapping from FHWA class to MOBILE class.

Table 6
Input Data Required for the MOBILE and PART 5 Models

Parameter	MOBILE6.1/ MOBLE5a	PART5
Calendar year	Y	Y
Evaluation Month	Y	
Daily MIN/MAX temperature	Y	
Hourly Temperature	Y	
Altitude (high, low)	Y	Y
Absolute humidity	Y	
Cloud cover index	Y	
Peak Sun time	Y	
Sunrise/Sunset time	Y	
Registration (age) distribution by vehicle class	Y	
Diesel sales fractions by vehicle class and model year	Y	
Annual mileage accumulation by vehicle class	Y	
Distribution of vehicle miles traveled by vehicle class	Y	Y
Distribution of vehicle miles traveled by roadway type	Y	Y
Average speed distribution (by hour, class, and roadway type)	Y	Y
Engine starts per day by vehicle class and distribution by hour	Y	
Fuel characteristics (RVP, sulfur, and oxygenate content)	Y	Y
Facility type (freeway, arterial/collector, local and ramp)	Y	Y
Inspection and maintenance (I/M) program description	Y	Y
Paved silt loading		Y
Annual days of precipitation		Y
Fleet average number of wheels		Y
Fleet average vehicle weight		Y

COST-BENEFIT ANALYSIS

The specific methodology that will be followed in undertaking the cost-benefit analysis will not be certain until initial collection of data on strategy effectiveness and associated costs is well underway. As noted in the proposal, several efforts at conducting such analyses provide some indication of what will be necessary for this task to be accomplished successfully. For example, one of the more useful approaches has been to divide the project cost by the benefit in the State Implementation Plan (SIP) year or design day labeled the One-Year or One-Day Cost-Effectiveness. The usefulness of this latter cost effectiveness calculation has been to determine the total cost needed to meet an attainment goal. Another recent study conducted by the Transportation Research Board examined the effectiveness of the CMAQ program, and in particular, the relative cost effectiveness of road-based strategies versus nonroad-based strategies. Dr. Meyer was a participant in this study and has access to the data that were used in determining cost effectiveness of these measures.

The work program for this task consists of several activities. First, a review of different methodologies for conducting cost-benefit analysis will be conducted by the research team. This review will include both traditional benefit/cost approaches as well as cost effectiveness methodologies. The data requirements for each will be an important aspect of this review. Second, once the different methodologies have been identified, the most appropriate approach for this study will be recommended with very specific requirements for the type of data that will be necessary for each category of strategy being considered. Third, cost data will be obtained from a variety of different sources. For example, project costs can be determined from historic contracts involving nonroad applications, estimated from similar highway projects, or from supplier information. EPA (http://www.epa.gov/otaq/retrofit/overview.htm) and the California Air Resources Board (ARB) have historically been slow to verify innovative technologies, so often the States and local agencies must provide the impetus for assessing the emission reduction potential based on pilot or manufacturers demonstrations. Finally, a cost-benefit analysis will be conducted for the different strategies considered in this study.

Early in the study, a technical memorandum will be produced that reviews the different approaches to cost-benefit analysis found in practice. This memorandum will also recommend a detailed approach for this portion of this study and will be submitted for approval of the sponsors in January 2003. The importance of this activity, occurring early in the study, is that the evaluation criteria, that is, the benefits or costs that will be used in the analysis, informs the rest of the team of what type of information will be necessary to produce for the study results.

While the exact measures to be evaluated will be determined during the development of the technical memorandum, it is possible to describe current thinking as to those measures that are likely to be considered. In general, the emissions reductions strategies can be grouped into four groups. These are: fuels, retrofit/technology, operational modifications, and vehicle inspection/maintenance approaches.

Fuels

Fuel based emissions control strategies that do not depend upon changing the basic fuel type (considered under the retrofit approach) depend upon changing the composition of the fuel to allow it to burn more efficiently. This may involve either removing an impurity (e.g. sulfur) or changing the ratio of the various component compounds present in the fuel (e.g. aromatic compound reduction, bio-diesel, and additives).

Fuel based strategies are generally most effective for centrally or contractor fueled fleets for which the fuel supply can be readily controlled. EPA has already undertaken a national program of sulfur reductions in diesel fuel and thus the options for Atlanta in this area are limited, at least in terms of highway fuels. There may be an opportunity, however, in the use of a reformulated non-road diesel fuel and this approach will be considered in the development of the technical memorandum to evaluate the potential for significant emissions reductions.

Other approaches that will be evaluated include the bio-diesel fuels and fuel additives. Studies to date have not generally shown that bio-diesel is a cost effective emissions control strategy except under unusual circumstances. Nevertheless, technologies continue to evolve and this strategy will be evaluated in terms of its longer-term applicability. There have also been numerous fuel additives that are purported to reduce diesel, and to a lesser extent gasoline, emissions. These range from cetane enhancers to lubricants to “snake-oil” type compounds. In most cases, there is a distinct lack of quantitative and/or independent evaluation of the actual emissions reductions that can be expected from the use of these additives. However, as they tend to be rather inexpensive to implement relatively low percentage reductions in emissions might prove to be cost-effective. During the development of the technical memorandum, the team will attempt to identify a sub-set of additives that appear to have sufficient supporting documentation to evaluate more fully in the subsequent cost-benefit analysis.

Retrofit/Technology

This category covers the broadest range of emissions control approaches ranging from engine replacement/retrofit to add-on control technologies. Engine replacement has previously been shown by several studies to be potentially cost-effective, especially in the case of non-road emissions, and will be evaluated in this study. Conversions (retrofits) to alternative fuels (e.g. CNG or LNG) will also be evaluated although it appears that with the advent of dedicated alternatively fueled engines and vehicles that complete replacement will often be more cost-effective. Cost-benefits for these conversions and/or new vehicle purchases have been extensively documented (e.g. U.S. DOE and EPA) and these documents will be collected and analyzed by the team.

Likewise, the use of add-on controls has been extensively studied elsewhere and the team will collect and analyze these other reports as well as collecting supporting information from the control system manufacturers. This area is almost certainly the hardest to fully define at this early stage of the project. There are more than 75 add-on emissions-control systems either currently marketed or under development for diesel engines alone and only a fraction of these can be fully analyzed. To aid in selecting the specific controls to be analyzed, the team will confer with experts from EPA’s Office of Transportation and Air Quality (OTAQ) to identify the most promising and generally applicable technologies in this area. It is anticipated that most, if not all, of the technologies to be evaluated are currently a part of EPA’s Voluntary Diesel Retrofit Program or EPA’s Environmental Technology Verification Program. At least one, and perhaps two, examples in each of the three major sub-categories or retrofit technologies (i.e. add-on oxidation catalysts or particle traps, engine control based systems (e.g. emissions gas recirculation (EGR)), and selective catalytic reduction (SCR) technologies) will be analyzed.

Inspection/Maintenance

Currently Atlanta has a vehicle inspection program of light duty gasoline vehicles only. However, a number of other jurisdictions (e.g. Maryland) have adopted an opacity test for heavy-duty vehicles that has proven at least somewhat effective at identifying high particulate emitting vehicles. The California Air Resources Board (CARB) is currently analyzing means of testing heavy-duty vehicles on dynamometers for other pollutants. The team will analyze the cost-effectiveness of implementing an opacity program for heavy-duty diesel vehicles in Atlanta and will examine all relevant results from CARB regarding their dynamometer-testing program although it is not clear that these results will be available in time for inclusion in the cost-benefit analysis to be performed in this study. The team will also analyze the potential applicability of an opacity-testing program to non-road engines.

Operational Controls

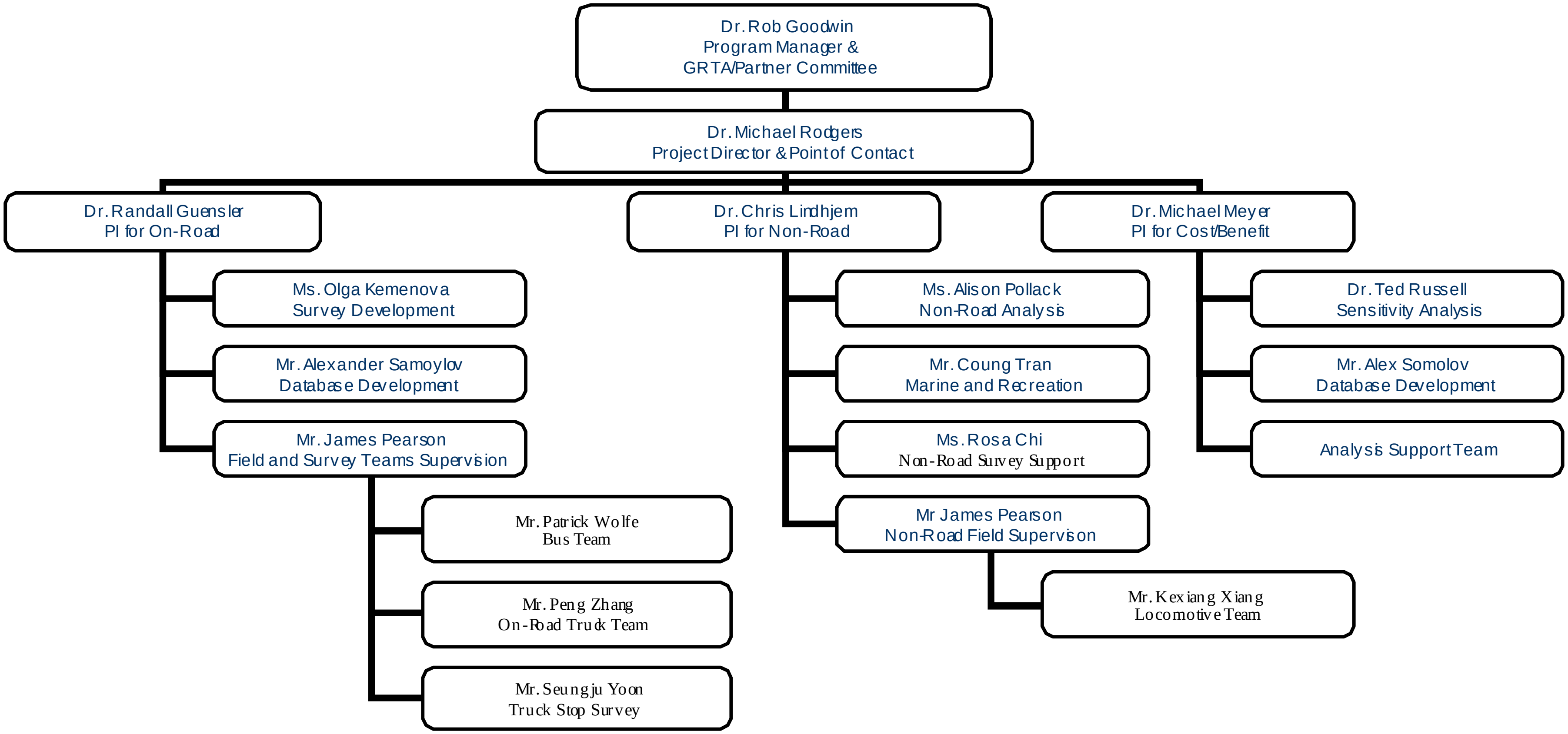
Unlike the other approaches, operational controls seek to reduce emissions producing activities rather than engine emission factors. As such, they are inherently harder to verify and thus have historically received less attention in terms of control strategies. Since in the case of heavy-duty vehicles there operations are directly related to their economic productivity actual use of the vehicles is relatively “efficient” in an economic sense and thus operational control strategies for these vehicles are most likely aimed at reducing idling emissions while these vehicles wait to perform their primary missions.

These idling reduction strategies to be evaluated can be roughly divided into two categories. These are: 1) yard, terminal, and site operations and 2) truck stop and rest area idling. In terms of the former, the team has tentatively identified three classes of facilities that meet the criteria of both involving significant idling activity and being able to implement an idling control strategy. The facilities selected for further analysis are: 1) School and Municipal Bus Yards, 2) Freight Terminals, and 3) Intermodal Terminals. In terms of the latter, “on-road”, idling controls, the team will analyze the existing EPA pilot programs to evaluate whether of not this is likely to be an effective program in the Atlanta area. Unfortunately, the current measurement program does not contemplate any summer measurements of truck stop idling and thus is unlikely to be directly applicable. Both of these sources will be more fully discussed in the technical memorandum.

APPENDIX A: PROJECT SCHEDULE

ACTIVITIES	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN
Finalize Study Plan	■							
Prepare and Assemble Surveys	■	■						
IRB Approval Process		■						
Direct Contacts w/ Large Owners		■	■					
Survey Database Development		■	■					
Monthly Meetings		■	■	■	■	■	■	■
Mail Survey			■					
Survey Data Entry and Analysis			■	■	■			
Locomotives								
Screenline Site Selection		■						
Screenline Counts			■	■				
Intermodal Terminal Inven.		■						
Terminal Counts			■	■				
Switching Yard Studies			■	■				
On-Road Truck Activity								
Screenline Site Selection	■	■						
Screenline Counts				■	■	■		
Driver Survey Development		■	■					
Driver Interviews					■	■		
Bus Operations	■	■	■	■				
Database Analysis						■	■	
Data Collection Report/Approval						■	■	
Eval. of Cost/Benefit Approach		■	■	■				
Cost/Benefit Technical Memo				■	■			
Cost/Benefit Analysis						■	■	■
Draft Emissions Inventory							■	■
Final Inventory and Report								■

APPENDIX B: ORGANIZATION CHART



APPENDIX C: EQUIPMENT USE SURVEY EXAMPLE QUESTIONS

Company Name: ___________________________________
Contact:___________________________________
Address: __________________________________
Phone #:___________________________________
Fax #:___________________________________
D & B Revenue $:___________________________________
D & B Number of Employees:________________________

Company Annual Fuel Consumption

Does your company own any heavy-duty vehicles? **Y** or **N**
Does your company own any nonroad equipment? **Y** or **N**
How is equipment refueled? (Circle one or explain): ___________________________

Owner-fueled   Site Fueled by Outside Supplier   Highway Fuel Pumps
Owner Capacity: _______

Diesel – Highway (undyed gallons): _____________________
Diesel – Nonroad (red dyed gallons): ____________________
Gasoline (used in nonroad equipment): _________________
If ***highway fuel*** is used in nonroad engines, does the firm receive a tax credit? **Y** or **N**

Circle the counties where you operate this equipment?

Barrow	Bartow	Carroll	Cherokee	Clayton	Cobb
Coweta	Dawson	DeKalb	Douglas	Fayette	Forsyth
Fulton	Gordon	Gwinnett	Hall	Henry	Newton
Paulding	Rockdale	Spalding	Walton	**All of Them**	

How many other counties?

Does your company rent non-road equipment? **Y** or **N**
If so, from whom? ________________

Typical Daily and Workweek Schedule for equipment? ___________________
(example; 7am – 4pm, M – F; ½ day Saturday mornings)

Equipment Profiles

For each individual piece of mobile equipment owned (NOT LEASED), please enter as much information as possible.

Equipment Type	Engine Rated HP (make and model, if HP is unknown) and model year	Gasoline (G) or Diesel (D) (LPG) or (CNG)	Estimated or Measured Hours of Use (hrs/week or annual)	Estimated or Measured Weeks of Use (weeks/yr)	Engine Model Year and (Service Start Date) ∗	Cumulative Hours on Engine (Estimated Life	Typical Engine Fuel Use (Gallons∗∗)
EXAMPLE: Backhoe/loader	70 hp, Case 5.80L, 1988	D	10 hours/wk	30 wks/year	1988 (June '88)	3560 (20,000)	36 Gal. for 30 Hrs.

∗ especially important if the engine is newer than the equipment

∗∗ please indicate the fuel consumption in gallons by one of the following: hourly, daily, weekly, monthly or annually.

APPENDIX D: ONROAD SURVEY CONTENT EXAMPLE

Example Questions that may be Included in the On-road Vehicle Use Survey

1) Company Name ____
2) Address ____
3) Contact Name ____
4) Contact Phone Number______________________________________
5) Fax Number ____
6) D&B Revenue $ ____
7) D&B Number of Employees __________________________________

Which of the following categories best describes the type of your company? (Circle the best response)

1. trucking company
2. truck terminal
3. truck stop
4. commercial maintenance facility
5. municipal transportation services _________________________________
   (please specify the type of services)
6. utility services____
   (please specify the type of services your company provides)
7. delivery services
8. other ____
   (please specify)

Does your company own any heavy-duty vehicles? **Y** or **N**

Does your company rent any heavy-duty vehicles? **Y** or **N**
If so from whom?______________________

Which of the following refueling options are typically used by your company? (Check all that apply).

____- Highway Fuel Pumps
____- Outside Supplier
____- Own Supply (if this option checked, please indicate the Site Capacity________)
If known, please indicate sulfur content of fuel used_________________.
____- Other ____
(please explain)

Q4. In which of the following counties do the company's vehicles usually operate? (Check all that apply).

____Barrow	____Bartow	____Carroll	____Cherokee	____Clayton	____ Cobb
____Coweta	____Dawson	____DeKalb	____Douglas	____Fayette	____Forsyth
____Fulton	____Gordon	____Gwinnett	____Hall	____Henry	____Newton
____Paulding	____Rockdale	____Spalding	____Walton	____**All of them**	

Q5. Using visual materials provided with this survey identify how many vehicles from each group your company operates.

1st group ________________ 3rd group____________________
2nd group________________ 4th group____________________

For each group of vehicles identified in previous question please estimate the following:

Q6. An average number of miles traveled per vehicle per year:

1st group ____________ miles/year 3rd group____________ miles/year
2nd group____________ miles/year 4th group____________ miles/year

Q7. An average percentage of miles each vehicle traveled in 21 county area:

1st group _______________ % 3rd group__________________ %
2nd group_______________% 4th group__________________ %

Q8. An average percentage of freeway miles each vehicle driven *inside* 21 county region:

1st group _______________% 3rd group___________________%
2nd group_______________% 4th group___________________%

Q9. An average percentage of non-freeway miles each vehicle driven *inside* 21 county region:

1st group _______________ % 3rd group__________________ %
2nd group_______________ % 4th group__________________ %

Now we will ask you to provide us with information on each and every heavy-duty vehicle your company owns. Please enter as much information as possible into table attached.

Example Table that may be used to Collect Heavy-Duty Vehicles Profiles

Vehicle Make & Model	Vehicle Group (1-4)	Gasoline /Diesel (G/D)	Year of Purchase	Engine Manuf.	Engine Model or Displacement	Engine Model Year	Engine Service Start Date	Estimated/ Measured Activity (miles/yr)	Typical Engine Fuel Use in (miles/gallon)

APPENDIX E: R.L. POLK DATABASE ELEMENTS

Polk
Automotive Intelligence™

Categories and Parameters for TIPNet

- **Geography Categories**
  - US / Canada
  - State / Province
  - County
  - ZIP Base (First Three Positions)
  - ZIP / Postal Code
  - DMS (Designated Market Area)
  - MSA (Metropolitan Statistical Area)
- **Vehicle Categories**
  - Make
  - Series
  - Model
  - Vehicle Company Name
  - Vehicle Detail
    - Brakes
    - Cab Configuration
    - CID (Cubic Inch Displacement)
    - Cylinders
    - Engine Manufacture
    - Engine Model
    - Engine Type
    - Front Axle
    - Fuel Type
    - Liters
    - Rear Axle
    - Vehicle Type
    - VIN
    - VIN GVW
    - Wheels
    - Year Model
- **Owner Profile Categories**
  - Registration
    - Name
    - Address
    - Local Fleet Size
    - National Fleet Size
    - Carrier Type
    - Vocation
  - Parent Headquarter
    - Name
    - Address
    - Local Fleet Size
    - National Fleet Size
    - Carrier Type
    - Vocation
  - Name and ZIP Change Indicator
  - Name and ZIP Change Date
- **Display Fields Available**
  - Brakes
  - Cab Configuration
  - CID
  - Cylinders
  - DMA
  - Engine Manufacture
  - Engine Model
  - Engine Type
  - Front Axle
  - Fuel
  - Liters
  - Make
  - Make Code
  - Model
  - Model Code
  - MSA
  - Name Change Indicator
  - Name/ZIP Change Date
  - New Count Field

- Parent Headquarters:
  (STATE RESTRICTIONS)
    - Address
    - Carrier Type
    - City
    - County
    - Local Fleet Size
    - Name
    - National Fleet Size
    - State/Province Abbrev.
    - Telephone Number
    - Vocation
    - ZIP/Postal Code

- Plant Location
- Ranking
- Rear Axle
- Registration:
  (STATE RESTRICTIONS)
    - Address
    - Carrier Type
    - City
    - County
    - Local Fleet Size
    - Name
    - National Fleet Size
    - State/Province Abbrev.
    - Telephone Number
    - Vocation
    - ZIP/Postal Code

- Report Month
- Report Year
- Secondary Local Fleet Size
- Secondary Name
- Secondary National Fleet Size
- Secondary Telephone Number
- Series
- Series Code
- Vehicle Company Name
- Vehicle Type
- VIN
- VIN GVW
- Wheels
- Year Model
- ZIP Change Indicator
-

APPENDIX F: VEHICLE CLASSIFICATIONS FOR EMISSION RATE MODELS

No	MOBILE6.1	MOBILE5a	PART5	Description
1	LDGV	LDGV	LDGV	Light-Duty Gasoline Vehicles (Passenger Cars)
2	LDGT1	LDGT1	LDGT1	Light-Duty Gasoline Trucks 1 (0-6,000 lbs. GVWR, 0-3,750 lbs. LVW)
3	LDGT2	LDGT1	LDGT1	Light-Duty Gasoline Trucks 2 (0-6,001 lbs. GVWR, 3,751-5750 lbs. LVW)
4	LDGT3	LDGT2	LDGT2	Light-Duty Gasoline Trucks 3 (6,001-8500 lbs. GVWR, 0-5750 lbs. ALVW)
5	LDGT4	LDGT2	LDGT2	Light-Duty Gasoline Trucks 4 (6,001-8500 lbs. GVWR, 5,751 and greater lbs. ALVW)
6	HDGV2b	HDGV	HDGV	Class 2b Heavy-Duty Gasoline Vehicles (8501-10,000 lbs. GVWR)
7	HDGV3	HDGV	HDGV	Class 3 Heavy-Duty Gasoline Vehicles (10,001-14,000 lbs. GVWR)
8	HDGV4	HDGV	HDGV	Class 4 Heavy-Duty Gasoline Vehicles (14,001-16,000 lbs. GVWR)
9	HDGV5	HDGV	HDGV	Class 5 Heavy-Duty Gasoline Vehicles (16,001-19,500 lbs. GVWR)
10	HDGV6	HDGV	HDGV	Class 6 Heavy-Duty Gasoline Vehicles (19,501-26,000 lbs. GVWR)
11	HDGV7	HDGV	HDGV	Class 7 Heavy-Duty Gasoline Vehicles (26,001-33,000 lbs. GVWR)
12	HDGV8a	HDGV	HDGV	Class 8a Heavy-Duty Gasoline Vehicles (33,001-60,000 lbs. GVWR)
13	HDGV8b	HDGV	HDGV	Class 8b Heavy-Duty Gasoline Vehicles (>60,000 lbs. GVWR)
14	LDDV	LDDV	LDDV	Light-Duty Diesel Vehicles (Passenger Cars)
15	LDDT12	LDDT	LDDT	Light-Duty Diesel Trucks 1and 2 (0-6,000 lbs. GVWR)
16	HDDV2b	HDDV	2BHDDV	Class 2b Heavy-Duty Diesel Vehicles (8501-10,000 lbs. GVWR)
17	HDDV3	HDDV	LHDDV	Class 3 Heavy-Duty Diesel Vehicles (10,001-14,000 lbs. GVWR)
18	HDDV4	HDDV	LHDDV	Class 4 Heavy-Duty Diesel Vehicles (14,001-16,000 lbs. GVWR)
19	HDDV5	HDDV	MHDDV	Class 5 Heavy-Duty Diesel Vehicles (16,001-19,500 lbs. GVWR)
20	HDDV6	HDDV	MHDDV	Class 6 Heavy-Duty Diesel Vehicles (19,501-26,000 lbs. GVWR)
21	HDDV7	HDDV	MHDDV	Class 7 Heavy-Duty Diesel Vehicles (26,001-33,000 lbs. GVWR)
22	HDDV8a	HDDV	HHDDV	Class 8a Heavy-Duty Diesel Vehicles (33,001-60,000 lbs. GVWR)
23	HDDV8b	HDDV	HHDDV	Class 8b Heavy-Duty Diesel Vehicles (>60,000 lbs. GVWR)
24	MC	MC	MC	Motorcycles (Gasoline)
25	HDGB	HDGV	BUSES	Gasoline Buses (School, Transit and Urban)
26	HDDBT	HDDV	BUSES	Diesel Transit and Urban Buses
27	HDDBS	HDDV	BUSES	Diesel School Buses
28	LDDT34	LDDT	LDDT	Light-Duty Diesel Trucks 3 and 4 (6,001-8,500 lbs. GVWR)