DRAFT

Fall line Air Quality Study (FAQS)

An outline for assessing urban and regional air pollution, identifying the sources of pollutants and pollutant precursors, and recommending solutions to realized and potential poor air quality in the Augusta, Macon, and Columbus, Georgia metropolitan areas.

Prepared by:

The Fall line Air Quality Study Alliance

List MOU signatories	

Total Project Cost: $3 million
Term: January 1, 2000 – December 31, 2002

October 5, 1999

A. OVERVIEW

The Atlanta metropolitan area has failed to attain state and federal air quality standards since 1979. A 20-year effort to improve air quality in the metro area has not been successful. Now at crisis proportions, Governor Barnes and the General Assembly created the Georgia Regional Transportation Authority (GRTA) in response. GRTA has been granted broad powers to effect change in "nonattainment" areas, and through the Governor's Development Council, other areas of the state.

It now appears that other metropolitan areas in Georgia may be experiencing poor air quality. On some days, concentrations of ground-level ozone in Augusta, Columbus, and Macon approach or exceed the threshold for clean air as defined by state and federal standards[1]. Rather than wait for a "nonattainment" designation before acting to improve air quality, these proactive metropolitan areas desire solutions to their air quality problems before the onset of crises[2]. Unfortunately, information is lacking in these regions regarding the composition of the air, the source of air pollutants and pollutant precursors, and the feasibility, effectiveness, and efficiency of any potential controls.

Ozone, the primary pollutant in the type of smog that most often afflicts Georgia's communities, is produced in the atmosphere via a complex photochemical process involving two types of chemical compounds: volatile organic compounds (VOCs and also often referred to as "hydrocarbons") and nitrogen oxides (NOx). The intense summer sun provides the energy needed to drive these reactions, and if the winds are light, ozone can accumulate rather than disperse.

$$\text{VOCs} + \text{NOx} + \text{sunlight} \rightarrow O_3$$

Nitrogen oxides are a byproduct of the combustion process. As gasoline, diesel fuel, jet fuel, coal, natural gas, wood, or other combustibles are burned, nitrogen oxides are likely produced. Volatile organic compounds may be emitted into the atmosphere as paints, printing agents, fuels, or solvents evaporate or are otherwise released into the air. In the Southeast US, there is also an

[1] The US EPA's National Ambient Air Quality Standard (NAAQS) for ground-level ozone is 0.12 ppmv averaged over 1-hour. Within Georgia but outside of Atlanta, only the Macon area meets the criteria for nonattainment of the 1-hour standard (i.e. four or more days over a three-year period on which 1-hour average ozone concentrations are greater than 0.12 ppmv). Macon reached this milestone on July 27, 1999 when the ozone monitor there registered its fourth violation of the 1-hour standard since 1997. In July of 1997, the US EPA promulgated a more stringent standard of 0.08 ppm averaged over 8-hours and remanded the 1-hour standard for all areas currently meeting it. On May 14, 1999 however, the United States Court of Appeals for the D.C. Circuit ruled that this new standard could not be enforced (*American Trucking Associations, Inc., et al. v. United States Environmental Protection Agency*; Case No. 97-1440). The court ruling aside, Augusta, Columbus, and Macon have all experienced sufficiently frequent violations of the 8-hour standard that, prior to the Court of Appeals ruling, could have warranted a nonattainment designation. If the US EPA successfully appeals the court ruling or corrects the deficiencies identified by the court, these cities could again face nonattainment.

[2] Attached is a signed memorandum of understanding attesting to each community's commitment to proactively address their air quality concerns, as well as a pledge to work with each other and several technical partners to resolve these problems autonomously.

abundance of VOCs that are emitted from natural sources such as many types of trees, crops, and other vegetation.

During the 1980s, Atlanta pursued an ozone control strategy focused on reducing the emissions of man-made VOCs. By the early 1990s, continued exceedance of air quality standards indicated that this strategy was ineffective and concurrent research at the Georgia Institute of Technology suggested that the “VOC only” strategy failed because it did not account for the abundance of VOCs from natural sources. Even if all man-made VOC emissions were eliminated, sufficient natural VOC emissions remained, and combined with the prevalent man-made NOx emissions, could generate ozone concentrations greater than the health-based standards allow. Unfortunately, this became evident only after approximately $1 billion was expended on reducing man-made VOC emissions in the Atlanta area. Since then, strategies for improving Atlanta’s air quality promulgated by the Georgia Environmental Protection Division (EPD) have focused almost exclusively on controlling emissions of NOx. Still the Atlanta area fails to attain air quality standards. This is because 1) controlling emissions of NOx is both difficult and expensive, and 2) it is widely believed that regionally elevated concentrations of ozone exasperate Atlanta’s attempts to mitigate ozone locally.

In Atlanta, recent and ongoing research conducted or funded by the EPD, US EPA, and others seeks to discover the root causes of excessive ozone concentrations and the most effective and efficient methods to decrease this air pollution. As of the summer of 1999, the EPD has established a network of twelve ozone monitors, and four Photochemical Assessment Monitoring Stations (PAMS) in the Atlanta area. The PAMS sites collect data on the concentrations of VOCs, NOx, and meteorology – the key components controlling ozone formation and accumulation. Atlanta has also been the site of several research monitoring campaigns during which many additional monitors were deployed for a short period to gather intensive and more comprehensive data relevant to ozone air quality (Atlanta Ozone Precursor Study, US EPA, 1990; Atlanta Intensive, Southern Oxidants Study, 1992; PM Supersite, Southern Oxidants Study / Southern Center for the Integrated Study of Secondary Air Pollutants, 1999). All these endeavors have been used to analyze and assess Atlanta’s air pollution problem and have contributed to a better understanding of the causes and consequences of poor air quality in the area.

In preparing and revising the State Implementation Plan (SIP) for the Atlanta Ozone Nonattainment Area (1979, 1985, 1987, 1994, 1998, 1999), the EPD has also developed detailed VOC and NOx emission inventories that identify the source and type of ozone precursors and the location and time they are released into the atmosphere. Extensive computer simulations in support of the SIP and other research activities (e.g. the Ozone Transport Assessment Group, 1995-1997, and the Southern Appalachian Mountain Initiative, 1997-1999), have helped regulators and the public better understand the effects of past, present, or proposed changes in emissions resulting from change, growth, technological innovation, and regulation. These studies have also provided regulators a better understanding of Atlanta’s ozone problem in the context of the air quality conditions prevalent across the whole Southeastern US.

Taken collectively, these activities in Atlanta have significantly contributed to the development of strategies to improve air quality in the area. Of primary importance, they directly led to an initial strategy for decreasing ozone concentrations in the late 1970s and 1980s[3]; a major revision of that strategy in the early 1990s as regulators shifted their efforts from controlling VOCs to controlling NOx[4]; and, by 1997, to a recognition of the regional contributions to poor air quality in Atlanta and the development of a strategy to address them[5]. Now as Augusta, Macon, and Columbus face the possibility of being designated nonattainment, it is evident that even the most fundamental of information needed to improve air quality in these communities is lacking. Whereas the single ozone monitors in Augusta and Macon, and two ozone monitors in Columbus are sufficient to identify the presence of excessive pollution, they do not provide sufficient information to diagnose the causes of poor air quality or to guide decision-making that will effectively and efficiently correct the problem[6].

Herein is an outline describing a study for assessing urban and regional air pollution, identifying the sources of pollutants and pollutant precursors, and recommending solutions to realized and potential poor air quality in the Augusta, Macon, and Columbus metropolitan areas. As the three cities lie along Georgia's "fall line" – the line dividing the piedmont region from the coastal plain – this study is hereafter described as the Fall line Air Quality Study (FAQS). The FAQS will primarily address ground-level ozone but ancillary results will also provide better understanding of the mechanisms contributing to other pollutants such as fine particulate matter.

Included in this outline are the approximate costs associated with the FAQS. These costs were estimated under the assumption that the study leverages the capital resources (hardware, software, laboratories, field equipment, and expert personnel) afforded by the Georgia Institute of Technology (Georgia Tech) and more specifically the Center for Urban and Regional Ecology (CURE), the School of Earth and Atmospheric Sciences (EAS), and the School of Civil and Environmental Engineering (CEE). It may be possible as well as practicable that some components of the study draw on in-kind resources, or compensated services provided by others outside of Georgia Tech. In particular, universities, metropolitan planning organizations, and

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[3] State Implementation Plans developed by the Georgia Environmental Protection Division in 1979, 1985, and 1987 pursued an ozone reduction strategy based on decreasing VOC emissions in the metropolitan Atlanta area. Collectively, these three plans sought a 68% decrease in VOC emissions from projected, uncontrolled emissions in 1987.

[4] Findings from the Southern Oxidants Study (*The State of the Southern Oxidants Study: Policy Relevant Findings in Ozone Pollution Research 1988-1994*; April 1994) suggested that ozone concentrations in the South are more sensitive to changes in anthropogenic NOx emissions than anthropogenic VOC emissions. The *1994 SIP for the Atlanta Ozone Nonattainment Area* demonstrated that "no amount of VOC reduction will be enough to show attainment with the ozone air standard."

[5] With the failure of many states to develop a plan for attainment of the 1-hour ozone air quality standard, the US EPA required all states east of the Mississippi River to participate in a two year study called the *Ozone Transport Assessment Group (OTAG)*. Beginning in 1995, "OTAG was charged with assessing the significance of pollutant transport and with recommending control strategies for reducing that transport." The policy outcome of OTAG was the *Regional NOx SIP Call*. Although currently delayed by pending litigation, the *Regional NOx SIP Call* mandates that states significantly decrease emissions of NOx by 2007 in and outside of current nonattainment areas.

[6] The Georgia EPD began monitoring ozone in the Augusta area (Richmond county) in 1989. The sole Macon (Bibb County) monitor was deployed in 1997. Outside of Atlanta, the longest continuous ozone monitoring has been in the Columbus area. The EPD has been operating two monitors in Muscogee county since the early 1980s.

private environmental consulting firms local or external to Augusta, Macon, and Columbus may be able to provide equivalent or superior services at reduced costs. Inclusion of some groups may also be desirable from the perspective of educating, developing, or transferring capabilities to the local communities. Where such benefits are possible, these opportunities should be employed. Nevertheless, for the purpose of identifying costs only, this outline assumes Georgia Tech is the sole executor.

B. THE FALL LINE AIR QUALITY STUDY

The study shall span three years beginning January 2000 and terminating December 2002. It shall consist of four primary components: 1) enhanced monitoring; 2) emission inventory development; 3) scenario modeling; and 4) analysis, assessment, and recommendation. These four activities will be performed concurrently, but staged over four periods beginning with a six-month period of preliminary assessment and study definition. This will be followed by a one-year intensive period for emission inventory development, model validation, pilot field studies in the three metropolitan areas, and analysis. A second year-long intensive will use a more comprehensive field study, scenario modeling, and associated analyses to provide the primary information needed to properly assess the study areas and develop appropriate strategies. A final six-month period will be used to transfer the technologies implemented in the three areas to local or state authorities and develop comprehensive recommendations for improving air quality in the short and long term. Progress reports will be provided at six-month intervals with the final report, complete with recommendations, provided at the conclusion of the fourth period. Each of these four periods is described in more detail below.

Period 1 (January 2000 through June 2000)

The FAQS will kickoff with a six-month concentrated effort to prepare for the first field campaign as well as initiate database development in support of the emissions inventory and air quality modeling activities. During this period, retrospective air quality analyses using existing information from the EPD chemical and National Weather Service meteorological monitoring networks will be completed to aid in designing the field study. The direction of winds coupled with corresponding ozone peaks will help identify the prevailing regions upwind and downwind of the metropolitan areas that will be targeted during the enhanced monitoring initiatives that will begin near the end of this period. This preliminary assessment also may be utilized to develop tentative action plans that may be implemented immediately to help mitigate the potential for future violations of air quality standards.

The preliminary assessment will also be used during this first period to determine the appropriate study domain (area of impact), and to identify relevant episodes for evaluation of potential strategies. Once the study domain is defined, it will be possible to begin creating a database of spatial and temporal information relevant to the study areas in general, and the emission inventories in particular. Among others, the database will house information on land use, demographics, vehicle travel, and industrial activity. Beginning in this period and extending into the next, man-made and natural emissions of VOCs and NOx will be derived from this information. These emissions will be disaggregated in time, space, and chemical speciation, but collectively, they constitute a full account or inventory of all emissions relevant to ozone air quality in the study domain.

At this time, training and other technology transfer for the benefit of the study as well as the local communities or study partners will also commence. Depending on need, training will be provided in any of the technical areas related to the field study, emissions inventory development, or air quality modeling.

Period 2 (July 2000 through June 2001)
The first field study initiated in Period 1 will be completed in this term. The goal of this initial field study is to assess the relative contributions of local sources compared to the contributions of sources beyond the metropolitan areas. VOC, NOx, and ozone data collected at locations upwind and downwind of the metropolitan areas should provide sufficient evidence to determine local contributions, with any residual pollutant loads due to regional background or external transport. Due to constraints on time, it is not possible to establish static upwind and downwind monitoring stations for VOCs, NOx, and ozone during the first ozone season (May 2000 – September 2000) in each of the three metropolitan areas. The Southern Center for the Integrated Study of Secondary Air Pollutants (SCISSAP) based at Georgia Tech however, has a fully equipped and functional mobile air quality laboratory for measuring VOCs, NOx, ozone, meteorology, and other pollution related variables. This mobile laboratory will be transported to each of the three metropolitan areas and deployed for 1 to 1.5 months during the ozone season.

Focused on the pollution events observed during the field study, meteorological modeling will commence to recreate the weather conditions, in a computational framework, that occurred during these episodes. Concurrently, the work to create baseline emission inventories for the study domains also will continue from Period 1. Once completed, emissions and meteorology will then be input into an advanced, three-dimensional photochemical transport air quality model to emulate the chemical conditions that were observed during the field study. NOx, VOC, and ozone data collected during the initial field study will be used to validate or otherwise ensure that the model is performing satisfactory (as determined by US EPA guidance for model performance). These simulations may also be used to identify key local and distant contributors to local and regional air quality.

Based on analyses from the first field study, the baseline emission inventory, and baseline modeling activities, a second field study will be designed for implementation the following year.

Period 3 (July 2001 through June 2002)
A second ozone season-long field study will be conducted to augment the data collected the previous year. As meteorological conditions vary from day to day and year to year, it is important to capture the variability in these conditions to determine how they affect pollutant concentrations. In addition and with knowledge gained from the initial study, permanent stations will be established to begin monitoring long-term trends in NOx, VOC, and ozone concentrations, and to provide continuous assessment as the regions change. At the conclusion of the study, all capital and operations related to these permanent stations will be transferred to local partners or the EPD. Georgia Tech will provide training sufficient to operate these stations. The mobile air quality laboratory used exclusively during the first field study will again be

deployed in each of the three metropolitan areas to supplement data from the permanent monitors.

Working with local stakeholders, several future year scenarios will be developed and evaluated using the emissions and air quality modeling system developed and validated in Period 2. In this process, potential changes in either local or distant sources can be examined relative to their impact on local ozone concentrations. Through this process, it may be possible to identify the optimal or least cost strategy that must be implemented in order for the area to meet or maintain the air quality standard. Options related to growth, voluntary or regulatory controls, or technology development and implementation may be explored. These results will be used in the final period to develop recommendations or action plans for the community.

Period 4 (July 2002 through December 2002)
In this final six months, training will be completed, and all monitoring stations, emissions inventories, and air quality models will be transferred to local partners or the EPD. With guidance by the local stakeholders, final unique recommendations for meeting or maintaining air quality standards will be developed for Augusta, Macon, and Columbus and presented to each community for possible implementation.

C. MANAGEMENT

As the results and recommendations of the Fall line Air Quality Study will have far reaching impacts, it is important that all stakeholders are informed, represented, and accepting of the study. To ensure this, project oversight shall be provided by a Coordinating Council consisting of representatives from the Augusta, Macon, and Columbus metropolitan areas, the Georgia Environmental Protection Division, the Georgia Regional Transportation Authority, the United States Environmental Protection Agency Region IV, and other stakeholders such as representatives from business and industry, environmental advocacy groups, and concerned citizens.

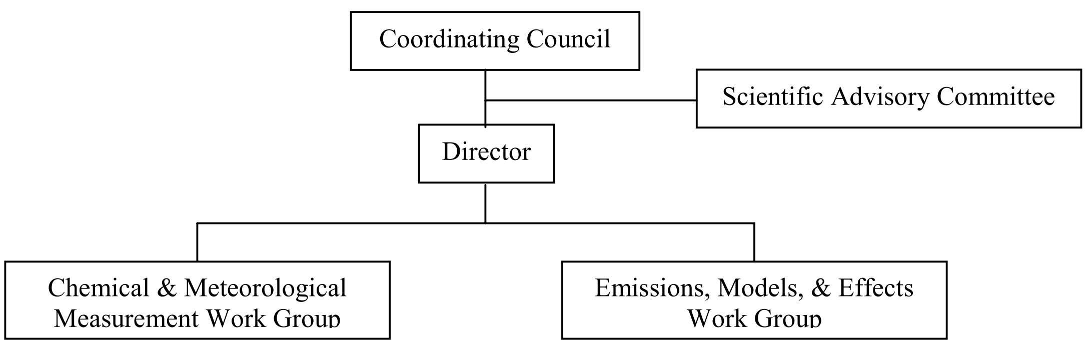
The Coordinating Council shall also seek advice from an independent Scientific Advisory Committee. This committee shall consist of university, government, and industry scientists and engineers with expertise in monitoring, emission inventories, and air quality modeling.

Implementation of the FAQS itself shall be guided by a Director that will coordinate the activities of the Chemical and Meteorological Measurement group and the Emissions, Models, and Effects group.[7] The Director shall also be responsible for organizing and coordinating activities within and between the Coordinating Council, the Scientific Advisory Committee, and the technical work groups. Finally the Director shall work with all FAQS participants to interpret and communicate all technical results and develop comprehensive air quality policy recommendations for the Augusta, Macon, and Columbus metropolitan areas.

This management structure is illustrated in Figure 1. It is patterned after the management structure utilized in the highly successful Southern Oxidants Study. The important features of this broad-based approach include:

- Stakeholders select the policy-relevant research themes and priorities;
- The project utilizes the existing advanced instrumentation and expertise residing in the government, university, and private communities in general, and in Georgia Tech in particular; and
- The FAQS provides opportunities for education and technology transfer within the university setting as well as between Georgia Tech and local, state, and regional constituents

Figure 1. Organization of the FAQS.



[7] At Georgia Tech, Dr. Michael Chang of the Center for Urban and Regional Ecology (CURE) will manage at the project level. Professor C.S. Kiang will serve as senior advisor. CURE will also direct policy development (e.g. recommendations for controls) and implementation guidance (e.g. forecasting / smog alert programs).

The Air Resources Engineering Center (AREC), coordinated by Professor Ted Russell, will develop the emission inventories and relevant air quality models, and execute all simulations exploring the consequences of different scenarios (working in collaboration with each metro area to develop the scenarios), and analyze the results and associated data.

The Southern Center for the Integrated Study of Secondary Air Pollutants (SCISSAP), coordinated by Professor William Chameides, will execute the pollutant monitoring and diagnostic analysis component of this project.

Cooperation among these three centers is a natural outcome of their organization within Georgia Tech in the Institute for Sustainable Technology and Development.

D. DELIVERABLES
Biannual progress reports will be provided. Meetings for the Coordinating Council and Scientific Advisory Committee will be scheduled at their request, but no less than biannually. Other milestones and deliverables are described as follows.

Jan 2000	Project Kickoff / Organizational Meeting Selection of Coordinating Council and Scientific Advisory Committees
Apr 2000	Initial Field Study Design Completed
May 2000	Initial Field Study Begins
Jun 2000	Six-month Progress Report Preliminary Assessment Completed
Sep 2000	Initial Field Study Completed
Dec 2000	Six-month Progress Report Baseline Emission Inventories Completed
Apr 2001	Field Study #2 Design Completed
May 2001	Field Study #2 Begins Permanent Monitoring Stations Functional
Jun 2001	Six-month Progress Report Analysis of Initial Field Study Completed
Sep 2001	Field Study #2 Completed
Dec 2001	Six-month Progress Report Baseline Modeling and Validation Completed Scenario Emissions Inventories Completed
Jun 2002	Six-month Progress Report Analysis of Field Study #2 Completed Scenario Modeling Completed
Dec 2002	Final Report Study Results and Policy Recommendations Transfer of Monitoring Station Operations Transfer of Emission Inventories and Models Project Completed

E. COSTS OF THE STUDY

Costs associated with the Fall line Air Quality Study assume Georgia Tech as executor. These costs do not reflect matching real or in-kind funds that may be provided by local stakeholders, or services that may be reasonably provided by sources external to Georgia Tech. Costs described below do however, reflect the contribution from Georgia Tech to the project through the use of the Southern Center for the Study of Secondary Air Pollutants (SCISSAP) mobile air quality lab. This contribution is valued in excess of $1 million.

Period 1 (January 2000 through June 2000)

Database Development	$75,000
Retrospective air quality analysis	
Land use	
Regional statistics	
Preliminary Emissions Inventory Development	$90,000
Air Quality Model Setup	$90,000
Episode election	
Domain selection	
Field Study Design	$100,000
Equipment (includes SCISSAP mobile laboratory)	$1,125,000
Training	$20,000
Total Period 1	$1,500,000

Period 2 (July 2000 through June 2001)

Model Development and Validation	$300,000
Initial Field Study	$500,000
Analysis & Field Study #2 Design	$200,000
Total Period 2	$1,000,000

Period 3 (July 2001 through June 2002)

Scenario Development and Simulation	$300,000
Permanent Monitoring Network Design, Training and Technology Transfer	$200,000
Field Study #2	$400,000
Analysis	$100,000
Total Period 3	$1,000,000

Period 4 (July 2002 through December 2002)

Technology Transfer	$150,000
Recommendations and Action Plan Development	$325,000
Final Report	$25,000
Total Period 4	$500,000

Total (January 2000 through December 2002)

Period 1	$1,500,000
Period 2	$1,000,000
Period 3	$1,000,000
Period 4	$500,000
Subtotal Periods 1 – 4	$4,000,000
Georgia Tech Contribution (SCISSAP mobile laboratory)	($1,000,000)
Total Project Cost	$3,000,000

F. LEGACY OF THE FAQS

At the conclusion of the Fall line Air Quality Study, Augusta, Macon, and Columbus will be provided with sufficient information to begin making the difficult decisions necessary to meet or maintain state and federal air quality standards. Where poor air quality is identified by the FAQS to result from factors beyond the political jurisdiction of these metropolitan areas, EPD or the US EPA will be provided with information necessary to address these externalities. Further, as political, environmental, or economic conditions change in the future, each community will have sufficient skills and computational tools to evaluate and modify alternate action plans. Finally each community will possess a basic monitoring system capable of assessing regional and local air quality conditions, and tracking progress in meeting and maintaining air quality standards.