AIR QUALITY RESEARCH PROGRAM

Texas Commission on Environmental Quality
Contract Number 582-10-94300
Awarded to The University of Texas at Austin

Quarterly Report

December 1, 2013 through February 28, 2014

Submitted to

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Texas Air Quality Research Program

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Overview

The goals of the State of Texas Air Quality Research Program (AQRP) are:

(i) to support scientific research related to Texas air quality, in the areas of emissions inventory development, atmospheric chemistry, meteorology and air quality modeling,

(ii) to integrate AQRP research with the work of other organizations, and

(iii) to communicate the results of AQRP research to air quality decision-makers and stakeholders.

On April 30, 2010, the Texas Commission on Environmental Quality (TCEQ) contracted with the University of Texas at Austin to administer the AQRP. For the 2010-2011 biennium, the AQRP had approximately $4.9 million in funding available. Following discussions with the TCEQ and an Independent Technical Advisory Committee (ITAC) concerning research priorities, the AQRP released its first request for proposals in May 2010. Forty-five proposals, requesting $12.9 million in research funding were received. After review by the ITAC for technical merit, and by the TCEQ for relevancy to the State's air quality research needs, the results of the reviews were forwarded to the AQRP's Advisory Council, which made final funding decisions in late August 2010. A total of 15 proposals were selected for funding. As of November 30, 2011, all projects have been completed. Final reports on all but one project have been posted to the AQRP website.

In June 2011, the TCEQ renewed the AQRP for the 2012-2013 biennium. Funding of $1,000,000 for the FY 2012 period was awarded in February 2012. An additional $1,000,000 for the FY 2013 period was awarded in June 2012. At the same time an additional $160,000 was awarded for FY 2012, to support funding for two specific air quality projects recommended by the TCEQ. A call for proposals was released in May 2012. Thirty-two proposals, requesting $5 million in research funding were received. The proposals were reviewed by the ITAC and the TCEQ. The Advisory Council selected 14 projects for funding. The 2012 – 2013 research projects were completed on November 30, 2013. The final reports for 10 of the projects have been posted to the AQRP website, while the remaining 4 reports are in the final stages of review.

In June 2013, the TCEQ renewed the AQRP for the 2014-2015 biennium via Amendment 9 of the Grant. At this time the TCEQ also awarded an additional $2,500,000 in FY 2013 funds to the AQRP. 10 % of these funds were allocated for Project Administration, and the remaining funds were allocated to the Research program. Initiated by the renewal, the AQRP developed the FY 2014/2015 research priorities and submitted them to the ITAC for input and to the TCEQ for review.

Funding of $1,000,000 for FY 2014 and $1,000,000 for FY 2015 was awarded via Amendment 10 in October 2013. A call for proposals was released and by the November 22, 2013 due date, 31 proposals requesting $5.8 million in research funding were received. In December and January the ITAC and the TCEQ reviewed the proposals. On February 21, the Advisory Council selected 15 projects for funding. One additional project will be considered by the Advisory Council in March.

BACKGROUND

Section 387.010 of HB 1796 (81st Legislative Session), directs the Texas Commission on Environmental Quality (TCEQ, Commission) to establish the Texas Air Quality Research Program (AQRP).

> Sec. 387.010. AIR QUALITY RESEARCH. (a) The commission shall contract with a nonprofit organization or institution of higher education to establish and administer a program to support research related to air quality.
>
> (b) The board of directors of a nonprofit organization establishing and administering the research program related to air quality under this section may not have more than 11 members, must include two persons with relevant scientific expertise to be nominated by the commission, and may not include more than four county judges selected from counties in the Houston-Galveston-Brazoria and Dallas-Fort Worth nonattainment areas. The two persons with relevant scientific expertise to be nominated by the commission may be employees or officers of the commission, provided that they do not participate in funding decisions affecting the granting of funds by the commission to a nonprofit organization on whose board they serve.
>
> (c) The commission shall provide oversight as appropriate for grants provided under the program established under this section.
>
> (d) A nonprofit organization or institution of higher education shall submit to the commission for approval a budget for the disposition of funds granted under the program established under this section.
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> (e) A nonprofit organization or institution of higher education shall be reimbursed for costs incurred in establishing and administering the research program related to air quality under

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this section. Reimbursable administrative costs of a nonprofit
organization or institution of higher education may not exceed 10
percent of the program budget.
       (f)  A nonprofit organization that receives grants from the
commission under this section is subject to Chapters 551 and 552,
Government Code.
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The University of Texas at Austin was selected by the TCEQ to administer the program. A contract for the administration of the AQRP was established between the TCEQ and the University of Texas at Austin on April 30, 2010 for the 2010-2011 biennium, and was renewed in June 2011 for the 2012-2013 biennium and in June 2013 for the 2014-2015 biennium. Consistent with the provisions in HB 1796, up to 10% of the available funding is to be used for program administration; the remainder (90%) of the available funding is to be used for research projects, individual project management activities, and meeting expenses associated with an Independent Technical Advisory Committee (ITAC).

RESEARCH PROJECT CYCLE

The Research Program is being implemented through a 9 step cycle. The steps in the cycle are described from project concept generation to final project evaluation for a single project cycle.

1.) The project cycle is initiated by developing (in year 1) or updating (in subsequent years) the strategic research priorities. The AQRP Director, in consultation with the ITAC, and the TCEQ, develop research priorities; the research priorities are released along with a Request for Proposals.

2.) Project proposals relevant to the research priorities are solicited. The Request for Proposals can be found at http://aqrp.ceer.utexas.edu/ .

3.) The Independent Technical Advisory Committee (ITAC) performs a scientific and technical evaluation of the proposals.

4.) The project proposals and ITAC recommendations are forwarded to the TCEQ. The TCEQ evaluates the project recommendations from the ITAC and comments on the relevancy of the projects to the State's air quality research needs.

5.) The recommendations from the ITAC and the TCEQ are presented to the Council and the Council selects the proposals to be funded. The Council also provides comments on the strategic research priorities.

6.) All Investigators are notified of the status of their proposals, either funded, not funded, or not funded at this time, but being held for possible reconsideration if funding becomes available.

7.) Funded projects are assigned a Project Manager at UT-Austin and a Project Liaison at TCEQ. The project manager at UT-Austin is responsible for ensuring that project objectives are achieved in a timely manner and that effective communication is maintained among investigators involved in multi-institution projects. The Project Manager has responsibility for documenting progress toward project measures of success for each project. The Project Manager works with the researchers, and the TCEQ, to create an approved work plan for the project.

    The Project Manager also works with the researchers, TCEQ and the Program's Quality Assurance officer to develop an approved Quality Assurance Project Plan (QAPP) for each project. The Project Manager reviews monthly, annual and final reports from the researchers and works with the researchers to address deficiencies.

8.) The AQRP Director and the Project Manager for each project describe progress on the project in the ITAC and Council meetings dedicated to on-going project review.

9.) The project findings are communicated through multiple mechanisms. Final reports are posted to the Program web site; research briefings are developed for the public and air quality decision makers; and a bi-annual research conference/data workshop is held.

Steps 1 – 9 have all been completed for the initial (2010-2011) biennium. Steps 1 – 8 have been completed for the 2012 – 2013 biennium, and step 9 is in progress. A research conference/data workshop was held on November 14, 2013. For the 2014 – 2015 biennium Steps 1 through 5 have been completed. Steps 6 and 7 will begin in March 2014.

RESEARCH PROJECTS

Research Projects for FY 2010-2011 are now completed. All projects have submitted final invoices and those invoices have been paid. The Final Report for each project, with the exception of one, is posted on the AQRP website at http://aqrp.ceer.utexas.edu/projects.cfm.

A summary of the projects approved for funding for FY 2012-2013 follows, along with a description of the Discover AQ field study.

Discover AQ

In September of 2013, the DISCOVER-AQ (Deriving Information on Surface Conditions from Column and Vertically Resolved Observations Relevant to Air Quality) program deployed NASA aircraft to make a series of flights with scientific instruments on board to measure gaseous and particulate pollution in the Houston, Texas area. The purpose, for NASA, of this campaign was to better understand how satellites could be used to monitor air quality for public health and environmental benefit.

To complement the NASA flight-based measurements, and to leverage the extensive measurements being funded by NASA to better understand factors that control air quality in Texas, ground-based air quality measurements were made simultaneously by researchers from collaborating organizations, including research scientists and engineers funded wholly or in part by the AQRP and the TCEQ. Because of the opportunity to leverage NASA measurements, projects related to DISCOVER-AQ were a high priority for the 2012-2013 biennium.

Project 12-004	STATUS: Active - March 1, 2013
	Completed – November 30, 2013

DISCOVER-AQ Ground Sites Infrastructure Support

University of Texas at Austin – Vincent Torres

AQRP Project Manager – Dave Sullivan
TCEQ Project Liaison – Raj Nadkarni

Funding Amount: $1,691,944

Expended Amount: $ TBD

Amount Returned to AQRP: $ TBD

Executive Summary

In the summer of 2013, the DISCOVER-AQ (Deriving Information on Surface Conditions from Column and Vertically Resolved Observations Relevant to Air Quality) program deployed NASA aircraft to make a series of flights with scientific instruments on board to measure gaseous and particulate pollution in the Houston, Texas area. The purpose of this campaign, for NASA, was to improve the use of satellites to monitor air quality for public health and environmental benefit.

To complement the NASA flight-based measurements, and to leverage the extensive measurements being funded by NASA to better understand factors that control air quality in Texas, ground-based air quality measurements were made simultaneously by researchers from collaborating organizations, including research scientists and engineers funded wholly or in part by the AQRP and the TCEQ. Multiple ground sites were expanded or established to accommodate the instrumentation brought to Houston by research collaborators. This project centralized and coordinated the site infrastructure preparation for the ground sites identified for expansion to support DISCOVER-AQ Houston 2013.

The scope of work for this project began with meeting with and/or contacting appropriate DISCOVER-AQ and TCEQ personnel and determining how many and which ground sites will be used for the study. Once sites were determined, assignment of instrumentation to each site followed. Next, to accommodate the instrumentation and the associated support equipment and supplies that were located at the selected ground sites, site improvements were made; site access/use agreements, ground (site pad) preparation, installation of utilities (electrical and communication) and security fencing, and rental of temporary buildings to accommodate instrumentation that must be located in conditioned space were all performed. During the intensive measurements period of the campaign, some limited support was required by the ground-based researchers when problems arose with the site accommodations. At the end of the campaign, each of these sites were decommissioned and restored to their original condition or a condition required by the property owner.

Project Update

All project activities have been completed and final invoices are being paid. The final report is posted on the AQRP website.

Funding of approximately $750,000 is expected to be returned to the AQRP for use in future projects. These funds were a later addition to this project for the purchase of additional instrumentation equipment for use in the Discover AQ field study. This equipment was not purchased because the manufacturer could not deliver the instruments prior to the kickoff of the Discover AQ Study.

Project 13-005 **STATUS: Active – January 15, 2013**

Completed – November 30, 2013

Quantification of industrial emissions of VOCs, NO_2 and SO_2 by SOF and mobile DOAS during DISCOVER AQ

Chalmers University – Johan Mellqvist
University of Houston – Barry Lefer

AQRP Project Manager – Dave Sullivan
TCEQ Project Liaison – John Jolly

Funding Amount: $177,553
($129,047 Chalmers, $48,506 UH)

Expended Amount: $173,975.24
($129,047 Chalmers, $44,928.24 UH)

Amount Returned to AQRP: $3,577.76
($0.00 Chalmers, $3,577.76 UH)

Executive Summary

A measurement study was carried out in the Greater Houston area during September 2013, in close coordination with the NASA DISCOVER-AQ mission in Houston. Column measurements of VOCs, SO_2, NO_2, and formaldehyde were carried out in the Houston Ship channel for future comparison with aircraft and ground based measurements. A secondary objective was to study direct emissions of the above-mentioned species from refineries and petrochemical industries in the area, as a follow-up to older measurements to provide support data for modeling. The primary methods used were SOF (Solar Occultation Flux) and Mobile DOAS (Differential Optical Absorption Spectroscopy).

During the campaign, mobile remote sensing by the SOF method and Mobile DOAS were carried out in the Houston area on twenty days in September 2013 together with frequent balloon launches. During ten of these days, column measurements of SO_2, NO_2, HCHO and VOCs in a box around the Houston Ship channel were carried out synchronized with science flights by the NASA aircrafts. During the rest of the days more focused industrial measurements were carried out. The weather during the campaign was relatively poor with 4 good clear days, 10 moderate days and the rest rather cloudy. For cloudy conditions the spectral retrieval and interpretation of column results from the optical remote sensing techniques is challenging in terms of spectral retrieval and further work is needed.

There were relatively few days available for emission measurements in the project since most focus was put on synchronized column measurements with the NASA DISCOVER-AQ aircrafts.

The data indicates that the overall alkene emissions in the HSC have decreased by 20-30%, that alkane emissions have remained the same and that NO_2 and SO_2 emissions were only slightly lower than for previous years. For Mont Belvieu the alkene emissions appear to have decreased by 30-40%. For Texas City the alkane and SO_2 measurements appear to have decreased considerably while being almost the same for NO_2. In all cases the VOC data are 5-10 times higher than the reported emission values, while for NO_2 and SO_2 the measured values are 5-95% higher, with exception for the SO_2 emissions at Texas City which are 300% higher than reported.

During the DISCOVER-AQ campaign a new instrument was brought along to complement the alkane flux measurements with ground concentration measurements of aromatic VOCs, i.e. benzene, toluene, etc. This system is based on an open UV multi-reflection cell connected to a DOAS spectrometer, (MW-DOAS). In addition, a mobile extractive FTIR (meFTIR) was used to measure the concentration of alkanes on the ground. This instrument is based on a closed IR multi-reflection cell connected to a FTIR spectrometer and it has been employed in previous campaigns.

The combination of the MW-DOAS and the meFTIR made it possible to map ratios of the ground concentration of aromatic VOCs and alkanes downwind of industries, allowing aromatic emissions to be inferred by multiplying these ratios with the alkane emission obtained from the SOF measurements. During the campaign side-by-side measurements were carried out with MW-DOAS and a PTR-MS (Aerodyne lab) in the Houston ship channel showing relatively good agreement between the two techniques down to sub-ppb levels.

Project Update

This project is complete and the final report is undergoing revisions.

The final invoice is under review and the project is in the process of being closed.

The project team has not reported any publications or presentations outside of those given to the AQRP.

Project 12-006 **STATUS: Active – February 8, 2013**

Completed – November 30, 2013

Environmental chamber experiments and CMAQ modeling to improve mechanisms to model ozone formation from HRVOCs

University of California - Riverside – Gookyoung Heo
Texas A&M University – Qi Ying

AQRP Project Manager – Elena McDonald-Buller
TCEQ Project Liaison – Ron Thomas

Funding Amount: $146,259
($101,765 UC-R, $44,494 TAMU)

Expended Amount: $143,899.22
($101,765 UC-R, $42,134.22 TAMU)

Amount Returned to AQRP: $2,359.78
($0.00 UC-R, $2,359.78 TAMU)

Executive Summary

Using reliable atmospheric chemical mechanisms in regulatory modeling is necessary to formulate effective and efficient emission controls for managing ozone (O_3) pollution. It is well known that alkenes contribute to O_3 formation in Southeast Texas. Particularly, in Harris County, Texas, seven alkenes (ethene, propene, 1,3-butadiene, 1-butene, isobutene, trans-2-butene, and cis-2-butene) are classified as Highly Reactive Volatile Organic Compounds (HRVOCs), and HRVOC emissions have been regulated. However, condensed chemical mechanisms commonly used for air quality modeling in the U.S. are not optimized to model O_3 formation under atmospheric conditions significantly influenced by highly variable industrial HRVOC emissions that are dominated by a small number of reactive alkenes. Therefore, a chemical mechanism that can be used to simulate O_3 formation from both urban emissions and industrial HRVOC emissions could be developed to more explicitly assess the impact of industrial HRVOC emissions on O_3 formation in Southeast Texas. However, lack of experimental data useful for mechanism evaluation is a critical obstacle to developing reliable mechanisms for the HRVOCs except ethene and propene. In this study, experimental data for mechanism evaluation were generated by using a large indoor environmental chamber at the University of California at Riverside. The new experimental data were used to test the mechanisms, and multiple versions of the SAPRC chemical mechanism were prepared using different methods to represent mechanisms for volatile organic compounds (VOCs). These mechanisms were implemented into the Community Multiscale Air Quality modeling system (CMAQ) and further tested under simulated ambient conditions to examine the effects of using these different mechanisms on O_3 predictions in Southeast Texas.

Environmental chamber experiments were designed and carried out to evaluate and improve the existing mechanisms (i.e., SAPRC's alkene chemistry) for simulating O_3 formation from both urban emissions and industrial HRVOC emissions. The mechanisms for the 5 HRVOCs (1-butene, isobutene, trans-2-butene, cis-2-butene and 1,3-butadiene) and the 5 non-HRVOCs (1-pentene, 1-hexene, trans-2-pentene, cis-2-pentene, 2-methyl-2-butene) were evaluated by using the newly generated experimental data of the 36 reactor runs selected from the 50 environmental chamber reactor runs performed for these 10 alkenes. The model performance was quantified by using two metrics: (1) the maximum ozone, and (2) the NO oxidation and O_3 formation rate. The detailed SAPRC-11 (SAPRC-11D) mechanism reasonably simulated O_3 formation from 7 of the 10 alkenes. The mechanism evaluation results for SAPRC-11D increase our confidence in the mechanisms for 1-butene, 1-pentene, isobutene and cis/trans 2-butene and 2-pentene. On the other hand, the evaluation results also highlight mechanism issues for 1,3-butadiene, 1-hexene and 2-methyl-2-butene. Mechanism improvements were made for 1,3-butadiene and 1-hexene. However, those modifications were not complete enough to implement into CMAQ. Chamber simulations with the Carbon Bond chemical mechanism were also carried out.

Four SAPRC mechanisms with varying levels of VOC lumping were implemented into CMAQ to simulate a summer ozone episode during the 2006 Texas Air Quality Study (TexAQS II):

- SAPRC-11D: the most detailed SAPRC mechanism ever applied in regional air quality simulations that uses approximately 300 explicit VOC species.
- SAPRC-11L: a condensed and fixed-parameter version of SAPRC-11D.
- SAPRC-07L: SAPRC-07 with standard lumping, similar to SAPRC-11L, but with outdated mechanisms for aromatics.
- SAPRC-07T: a "toxics" version of SAPRC-07L with additional explicit VOC species.

Chemically detailed emissions data were generated for SAPRC-11D to inspect consistency *between* the compositions of the lumped alkene species (i.e., OLE1 and OLE2) used in deriving the SAPRC-11L mechanism *and* the emissions inventory data that air quality simulations heavily rely on. For example, the contributions of alkenes such as propene, 1-butene, 1-pentene, 1-hexene, 1,3-butadiene, and 3-methyl-1-butene assumed during the development of SAPRC-11L were compared with those based on the emission inventories.

While the O_3 time series predicted by the four mechanisms using 2-km and 4-km horizontal grid resolutions appeared similar and agreed with observations, statistical analysis of the hourly average and peak hour O_3 concentrations showed that SAPRC-11D yields overall somewhat better (but not greatly better) O_3 performance than SAPRC-11L. The predicted O_3, OH, HO_2 and PAN were significantly different between SAPRC-11D and SAPRC-11L; SAPRC-11D predicted higher O_3 and PAN throughout the domain, higher OH and HO_2 in urban Houston areas and lower OH and HO_2 in areas with less anthropogenic emissions than SAPRC-11L.

Based on the results of this study, we recommend further studies as follows:

- The mechanism for 1,3-butadiene has many similar features to that for isoprene, and knowledge gained during updating the isoprene chemistry should be used to update the 1,3-butadiene chemistry, and vise-versa.
- In regard to lumping methods, the results for propene, 1-butene, 1-pentene and 1-hexene indicate that unbranched C_{3+} terminal alkenes share similar O_3 formation mechanisms but also have non-negligible differences among those 1-alkenes. The results for cis/trans 2-butene and 2-pentene indicate that unbranched internal alkenes share similar ozone formation chemistries. The results for isobutene and 2-methyl-2-butene indicate that lumping branched terminal alkenes (e.g., isobutene) and branched internal alkenes (e.g., 2-methyl-2-butene) with unbranched internal alkenes (e.g., 2-butene and 2-pentene) introduces significant inaccuracies. In re-deriving lumping methods for the tested 10 alkenes, reliable emissions data as well as these mechanism evaluation results should be considered.
- More detailed analyses of the model results, possibly with process analysis, are needed to clearly explain the differences between SAPRC-11D (detailed version) and SAPRC-11L (lumped version).
- Developing a version of SAPRC with an intermediate level of explicitness between SAPRC-11D and SAPRC-11L is needed to reduce the computational cost and better predict/reproduce ozone concentrations in the Houston area.
- Explicitly modeling propene and 1,3-butadiene is potentially useful to improve the accuracy of ozone predictions based on the spatial variability of propene and 1,3-butadiene emissions in the Houston area. Additional testing under ambient conditions is needed.
- Further work is needed on testing and improving mechanisms under Houston ambient conditions while limiting the impact of uncertainties in emissions.

Project Update

This project is complete and the final report is posted on the AQRP web page.

All invoices are paid and the project is in the process of being closed.

The project team has produced the following publications and presentations:

<u>Journal Papers:</u>

Gookyoung Heo, Peng Wang, Qi Ying, Ron Thomas, William P.L. Carter. Using chemically detailed emissions data to test assumptions used in developing chemical mechanisms: a case study for southeast Texas, USA. [To be submitted to Atmospheric Environment in March, 2014]

Peng Wang, Gookyoung Heo, William P.L. Carter, Qi Ying. Comparison of a detailed and a lumped version of SAPRC-11 photochemical mechanism during a summer ozone episode. [To be submitted to Atmospheric Environment in March, 2014]

Gookyoung Heo, Chia-Li Chen, Ping Tang, William P.L. Carter. Evaluation of mechanisms for major terminal and internal alkenes with environmental chamber data. [To be submitted to Atmospheric Environment in April, 2014]

Gookyoung Heo, Shunsuke Nakao, William P.L. Carter. Evaluation of mechanisms for 1,3-butadiene with environmental chamber data. [To be submitted to Atmospheric Environment in April, 2014]

Conference Paper:

Heo, G., Carter, W.P.L., Wang, P., Ying, Q., Thomas, R. (2013). Evaluating and improving atmospheric chemical mechanisms used for modeling ozone formation from alkenes. Presented at the 12th Annual CMAS Conference, Chapel Hill, NC, October 28-30, 2013.

Project 12-011	STATUS: Active – January 17, 2013
	Completed – November 30, 2013

Investigation of Global Modeling and Lightning NOx Emissions as Sources of Regional Background Ozone in Texas

ENVIRON International – Chris Emery

AQRP Project Manager – Elena McDonald- Buller
TCEQ Project Liaison – Jim Smith

Funding Amount: $77,420

Expended Amount: $77,410.16

Amount Returned to AQRP: $9.84

Executive Summary:

The production, transport, and fate of tropospheric ozone are highly dynamic processes with contributions from a multitude of anthropogenic and natural sources spanning spatial scales from local to global. Regional models used for regulatory assessments now routinely address worldwide contributions by deriving chemical boundary conditions from global models. As global models continue to emerge and improve, their contributions to background ozone as represented in regional models need to be evaluated.

The Texas Commission on Environmental Quality (TCEQ) uses the Comprehensive Air quality Model with extensions (CAMx) for research and regulatory photochemical modeling. Two popular global models have been routinely coupled to CAMx to provide chemical boundary conditions for its continental-scale grid system: the Goddard Earth Observing System - Chemistry model (GEOS-Chem); and the Model for OZone and Related chemical Tracers (MOZART-4). A newer global model called AM3 has gained attention lately from recent applications to quantify Asian and stratospheric influences on springtime high surface ozone events in the western US.

We developed boundary condition inputs for CAMx utilizing output from three global models (GEOS-Chem, MOZART, and AM3) and analyzed the sensitivity of simulated ozone in and around Texas to the source of regional boundary conditions. The April-October 2008 CAMx database employed in this study was developed independently and was used in several concurrent AQRP modeling projects. We performed quantitative performance comparisons of the global and CAMx models against available rural ozone measurements throughout the southern US and assessed their ability to provide reasonable boundary conditions for regional downscaling, particularly with respect to state-wide regulatory ozone modeling in Texas.

The surface evaluation focused on the southwest, south-central, and southeast regions of the US surrounding Texas and the Gulf of Mexico. In general, the models' performance tracked each other throughout the 2008 simulation, with very large over prediction biases in the warm seasons (May – October) and lower positive bias in the cool seasons (November - April). Poor global model performance during the summer in the south-central and southeast regions was likely the result of coarse resolution that increases ozone production efficiency. Other factors likely include uncertainties in biogenic emissions and the chemistry of isoprene nitrate, and may include transport of over predicted ozone from the Gulf and Atlantic to coastal states, and a misrepresentation of tropospheric convection that would impact boundary layer venting, photolysis rates, and estimates of nitrogen oxides (NOx) generated by lightning.

All three global models performed the best in the southwest region, where MOZART and AM3 performed particularly well year-round. GEOS-Chem exhibited significantly larger over prediction bias during the warm season, which has been attributed to over estimates of lightning NOx. AM3 performed the best in the spring, which has been attributed to its better representation of stratospheric intrusions.

CAMx fractional bias and error in the south-central and southeast regions tended to be better than all three global models by about 10-20% during the summer months. The similarity in fractional bias and error trends in these two regions among the three CAMx runs indicated a fairly insensitive response to the choice of boundary conditions. Analyses with various statistical performance measures suggest that the rural diurnal ozone wave in these regions was not well simulated, which is more likely related to limitations in the regional model. The use of simple time/space-constant boundary conditions led to only minor differences in statistical performance in the south-central and southeast regions during most months. There was no clearly superior source of boundary conditions according to performance in the south-central and southeast regions.

Conversely, the three CAMx cases performed best year-round in the southwest region, paralleling the respective global model results. The southwest region is highly influenced by deep vertical transport of ozone from the upper troposphere and lower stratosphere to the higher terrain elevations of the inter-mountain west. MOZART, GEOS-Chem, and the associated CAMx runs tended to under estimate ozone in the spring months. AM3 and its associated CAMx run performed better than the other models in the spring, but CAMx bias patterns suggested deleterious effects from coarse vertical resolution toward the top of the modeling domain. The use of simple boundary conditions was clearly invalid for the southwest region, as the influence of higher ozone concentrations in the upper troposphere and lower stratosphere, as provided by the global models, plays a substantial role in the springtime regional surface ozone pattern in the western US. In this case, AM3 provided a superior source of boundary conditions for the southwest region.

A separate ozone performance analysis was conducted for a small set of coastal sites along the Gulf of Mexico that routinely measure very low ozone concentrations entering Texas during on-shore flow conditions. These sites are often influenced by modeled boundary conditions as there are only minor source impacts between the boundaries and the Texas coastline. Over predictions peaked at nearly 100% at two sites during mid-summer, with nearly identical bias among all CAMx and global model runs. There is growing evidence that current modeling systems (global and regional) are missing an important ozone destruction mechanism associated with oceanic halogen emissions, which is potentially far more effective at removing ozone over the Gulf than deposition processes alone.

We compared monthly-mean global and regional model predictions of vertical ozone profiles against ozonesonde measurements at four sites across the US. Simulated profiles over Houston from all models were generally very consistent with the measured profiles and with each other throughout the year, with less variability in the summer months. The largest variability exhibited by each model, and across all models, occurred during the non-summer months in the upper troposphere and stratosphere. All three global models tended to under predict mid-summer tropospheric ozone (particularly in the boundary layer) over Houston, most likely because of their inability to resolve the Houston ozone plume. CAMx tropospheric ozone profiles over Houston exhibited little sensitivity to choice of boundary conditions. CAMx runs matched the ozonesonde data in the boundary layer much better in the mid-summer months than the global models. However, the stratospheric profiles (>12 km) were not well reproduced by CAMx, which were related to coarse layer resolution toward the top of the CAMx domain. Performance issues aloft would mostly impact lower tropospheric ozone over the western US, including west Texas.

Project Update

This project is complete and the final report is posted on the AQRP web site.

All invoices are paid and the project is closed.

No publications or presentations of this work are planned at this time.

Project 12-012 **STATUS: Active - December 19, 2012**

Completed – November 30, 2013

Interactions Between Organic Aerosol and NOy: Influence on Oxidant Production

University of Texas at Austin – Lea H. Ruiz
ENVIRON International – Greg Yarwood

AQRP Project Manager – Dave Sullivan
TCEQ Project Liaison – Mark Estes

Funding Amount: \$148,835
(\$79,461 UT Austin, \$69,374 Environ)

Expended Amount: \$148,546.58
(\$79,173.94 UT Austin, \$69,372.64 Environ)

Amount Returned to AQRP: \$290.42
(\$289.06 UT Austin, \$1.36 Environ)

Executive Summary

In rural areas where emission rates of NO_x ($NO + NO_2$) are relatively low, ozone formation can be sensitive to secondary NO_x sources such as decomposition of organic nitrates (ONs). AQRP project 10-042 provided experimental evidence for NO_x production when ONs degrade by OH reaction and photolysis. Implementing NO_x production from OH reaction with ONs causes regional ozone increases that are large enough to affect model agreement with ozone observations. This implies that ONs are less available to NO_x recycling than previous experiments suggested. This project investigated the hypothesis that uptake of ONs into organic aerosol (OA) reduces the amount of NO_x recycled by ON photolysis and reaction with OH.

The University of Texas at Austin (UT-Austin) conducted laboratory chamber experiments to investigate the formation of organic nitrates (ON) and their gas-particle partitioning from different VOC precursors. Significant concentrations of ON formed from all precursors investigated, and NO_x concentrations decreased during each experiment providing experimental evidence that VOCs act as NO_x sinks and ON sources. A substantial fraction of the ON partitioned to the particle phase, and the gas-particle partitioning of the ON was found to be reversible. UT-Austin also measured ONs in the gas- and particle phase in ambient measurements during DISCOVER-AQ near Houston. Approximately 100 organic nitrogen species were identified in the gas-phase, and they exhibited different diurnal variation. The particle-phase ONs measured near Houston exhibited a strong diurnal cycle with lowest concentrations in the afternoon.

ENVIRON modified the Carbon Bond 6 (CB6) chemical mechanism to differentiate ONs between simple alkyl nitrates (AN) that remain in the gas-phase and multi-functional ONs that can partition into OA. Uptake of multi-functional ONs by organic aerosol (OA) was added to

the Comprehensive Air quality Model with extensions (CAMx). ONs present in aerosols are then assumed to undergo hydrolysis to nitric acid with a lifetime of approximately 6 hours based on laboratory experiments and ambient data. The revised CB6 mechanism is called CB6r2 and regional modeling simulations using CAMx with CB6r2 showed improved performance in simulating ozone and in simulating the partitioning of NO_y between ONs and nitric acid.

Uncertainty in the atmospheric fate of ONs adds substantial uncertainty in modeling regional O_3 and other oxidants. Additional laboratory studies and ambient measurements are needed to better quantify partitioning of ONs to aerosol, forming ANs, and the subsequent chemical fate of ANs. We make the following recommendations for additional environmental chamber experiments and other activities to support improvements in the representation of organic nitrates in chemical transport models:

1. Environmental chamber experiments forming ONs from different precursors and at different relative humidity to quantify the hydrolysis rate of ONs. (The lifetime of 6 hours currently used in CB6r2 is based on limited experimental and ambient data.)

2. Analysis of experimental data to calculate the gas-particle partitioning coefficient of ONs (the gas-particle partitioning currently used in CB6r2 is based on a single peer-reviewed publication). This analysis necessitates quantification of ONs in the gas-phase and the particle-phase, or quantification of total ON formation and the amount of ONs in the gas-phase or particle-phase. A more systematic analysis of the gas-particle partitioning of ONs with varying environmental chamber temperature would support this analysis.

3. Analysis of ambient data to calculate the gas-particle partitioning factor of organic nitrates. This analysis would necessitate quantification of ONs in the gas-phase and the particle phase.

The ON scheme implemented in CB6r2 is simple and generally consistent with available studies and improves the performance of CB6r2 in simulating regional O_3 and NO_y speciation compared to CB6r1. CB6r2 is recommended over preceding versions of CB6 and CB05.

Project Update

This project is complete and the final report is undergoing the last round of revisions.

All invoices have been paid and the project is in the process of being closed.

The project team has produced the following publications and presentations:

- C. Faxon, J. Bean, L. Hildebrandt Ruiz. Evidence of atmospheric chlorine chemistry in Conroe, TX: Regional implications. American Chemical Society Southwest Regional Meeting, November 2013, Waco, TX.
- J. Bean, C. Faxon, L. Hildebrandt Ruiz. Atmospheric processing of pollutants in the Houston Region: First insights from DISCOVER-AQ. American Chemical Society Southwest Regional Meeting, November 2013, Waco, TX.
- L. Hildebrandt Ruiz, J. Bean, G. Yarwood, B. Koo, U. Nopmongcol. Formation and Gas-Particle Partitioning of Organic Nitrates: Influence on Ozone Production. American Association for Aerosol Research Annual Meeting, October 2013, Portland, OR.

Planned publications

- J. Bean, C. Faxon and L. Hildebrandt Ruiz. Manuscript summarizing results from DISCOVER-AQ. Submission planned for late 2014.

Project 12-013 **STATUS: Active – December 14, 2012**

Completed – November 30, 2013

Development of Transformation Rate of SO_2 to Sulfate for the Houston Ship Channel using the TexAQS 2006 Field Study Data

ENVIRON International – Ralph Morris

AQRP Project Manager – Elena McDonald-Buller
TCEQ Project Liaison – Jim Price

Funding Amount: $59,974

Expended Amount: $59,960.93

Amount Returned to AQRP: $13.07

Executive Summary:
In 2010, the US Environmental Protection Agency (EPA) revised the 1-hour sulfur dioxide (SO_2) primary National Ambient Air Quality Standard (NAAQS) to be much more stringent, which can possibly affect attainment status in many areas in the US including the Houston region. Conversion of SO_2 to sulfate in the atmosphere is a complex process involving various chemical species and multiple phases. However, the EPA-recommended approach for modeling 1-hour SO_2 is to use the American Meteorological Society/Environmental Protection Agency Regulatory Model Improvement Committee Model (AERMOD) steady-state Gaussian plume model assuming no chemical transformation of SO_2. This approach may not be adequate under certain atmospheric conditions, such as the highly reactive atmospheric conditions that occur in the Houston Ship Channel.

To address this issue, this study determines a representative SO_2 transformation rate for the Houston Ship Channel area using measurements from the National Oceanic and Atmospheric Administration (NOAA) P-3 aircraft collected during the 2006 Texas Air Quality Study (TexAQS) that can be used with the AERMOD model to simulate 1-hour SO_2 concentrations. The P-3 aircraft research platform provided high time resolution measurement data for SO_2 and sulfate as well as meteorological data such as temperature and wind direction through 16 flights between September 11 and October 12, 2006. We assessed these flight data and selected four flights that pass across the Houston Ship Channel plumes and have relatively small interferences from background and sources outside the ship channel.

The selected flight data was then simulated using a three-dimensional grid model to find what transformation rate best fits the observations. The Comprehensive Air-quality Model with Extensions (CAMx) was used for this grid modeling. Instead of the full gas and aerosol chemistry mechanisms available in CAMx, a special chemistry mechanism that models a pseudo first-order conversion of SO_2 to sulfate is used to mimic AERMOD's treatment of SO_2 transformation (exponential decay).

The model inputs of meteorological conditions and SO_2 emissions over the Houston modeling domain were provided by the Texas Commission on Environmental Quality (TCEQ). Boundary conditions (SO_2 and sulfate) to the modeling grid were extracted from a previous 2006 US modeling results. The model used multiple tracers to distinguish direct contributions of the Ship Channel emissions from those of other nearby sources and regional background. The model results with varying SO_2-to-sulfate conversion rate were then evaluated against the P-3 aircraft measurement data.

To quantify the model performance, we employed the "average excess above background" concentration that is defined as a cumulative concentration difference (total – background) across a Ship Channel plume normalized by the plume width. This quantity was used to avoid the effect of inaccuracies in meteorological model inputs (e.g., wind direction) and regional background (through boundary conditions). More specifically, modeled ratios of sulfate to SO_2 average excess above background concentrations were evaluated against the corresponding observed ratios as this ratio is better suited to evaluate the SO_2-to-sulfate conversion rate within the Houston Ship Channel.

The results showed that the SO_2-to-sulfate conversion rate of 0.04 hr^{-1} (half-life of 17 hours) best fitted the aircraft measurement data for all selected flights. Therefore, we recommend using this conversion rate for transformation of SO_2 in AERMOD modeling to address the new 1-hour SO_2 NAAQS for the Houston Ship Channel sources. Our estimated SO_2 conversion rate in the Houston Ship Channel plumes is higher than previously reported conversion rates in the power plant plumes, which is expected because high NOx concentrations in the power plant plumes would inhibit photochemistry. However, it should be noted that our result is based on a small number of flight data whose ambient conditions are limited to afternoon on late summer days in the region. Thus, caution is needed when applying this conversion rate to a significantly different condition (e.g., winter or nighttime).

Project Update

This project is complete and the final report is posted on the AQRP website.

All invoices are paid and the project is closed.

No publications or presentations of this work are planned at this time.

Project 13-016 **STATUS: Active – November 20, 2012**

Completed – November 30, 2013

Ozonesonde launches from the University of Houston and Smith Point, Texas in Support of DISCOVER AQ

Valparaiso University – Gary Morris
University of Houston – Barry Lefer

AQRP Project Manager – Gary McGaughey
TCEQ Project Liaison – Dave Westenbarger

Funding Amount: $86,667
($66,821 Valparaiso, $19,846 UH)

Expended Amount: $ TBD
($ TBD Valparaiso, $14,101.40 UH)

Amount Returned to AQRP: $ TBD
($ TBD Valparaiso, $5,744.60 UH)

Executive Summary

This project resulted in an intensive and coordinated series of ozonesonde launches during DISCOVER AQ (September 2013) from three sites within and around the Houston-Galveston-Brazoria County Region (HGBR): Smith Point, the University of Houston Main Campus, and Ellington Field. In total 63 ozonesonde flights were conducted during the DISCOVER-AQ period with another 32 during the month of August, just prior to DISCOVER. The data gathered provide insight into the recirculation of ozone over Galveston and Trinity Bays as well as the opportunity to explore regional scale variability in boundary layer and lower free tropospheric ozone around the HGBR.

Due to the unusual meteorology in 2013, the overall data set did not capture as many ozone exceedance events as we had anticipated. In the last decade, the typical year has 4 frontal passages in August and September, with most year's first frontal passage occurring in mid- to late August. In 2013, the first September frontal passage did not occur until 21 September, and the only prior frontal passage was weak and resulted in a stationary boundary just south of Houston around 16 August. Our preliminary analysis of data from the DISCOVER-AQ period has demonstrated the following:

- The wind patterns from 2013 as compared with a climatology developed from the National Centers for Environmental Prediction (NCEP) data from 2004 – 2012 for Houston demonstrate that the first half of September 2013 meteorologically more resembled the climatology from early to mid August than September.
- The ozone profiles from 2013 as compared with a climatology developed from the Tropospheric Ozone Pollution Project (TOPP) data from 2004 – 2012 for Houston also

demonstrate that the first half of September 2013 more resembled the climatology from early to mid August than September.

- Weekly mean ozone profiles from TOPP 2004 – 2012 show a strong tilt through the troposphere in early to mid August, with ozone values increasing with altitude. The same climatology shows that by late August and into September, the mean ozone profiles become more vertical. This change in shape corresponds with the resumption of frontal passages making it through the HGBR.
- The event of 25 September was the only exceedance event during DISCOVER-AQ. A series of ozone profiles demonstrates the influence of high ozone from the lower free troposphere arriving in a dry layer behind the cold fronts of 21 and 25 September.
- Data from Smith Point, both ozonesonde and Nittany Atmospheric Trailer and Integrated Validation Experiment (NATIVE) surface data, demonstrate the arrival of the Houston plume over Trinity and Galveston Bays. The weak north synoptic winds brought the plume over the bays where the ozone concentrations intensified, resulting in ozone concentrations > 150 ppbv at NATIVE.
- It is important to place the DISCOVER-AQ data in the context of the longer-term ozone profile and surface monitor data records from the HGBR.

Project Update

This project is complete and the final report is posted on the UT website.

Final invoices are still pending.

The project team has produced the following presentation:

- Gary Morris presented a poster entitled "Tropospheric Ozone Pollution Project (TOPP) Overview: A Context for DISCOVER-AQ Houston 2013" at the DISCOVER-AQ Science Team Meeting on February 27, 2014.

Project 12-018 **STATUS: Active – January 8, 2013**

Completed – November 30, 2013

The Effects of Uncertainties in Fire Emissions Estimates on Predictions of Texas Air Quality

University of Texas at Austin – Elena McDonald-Buller
ENVIRON International – Chris Emery

AQRP Project Manager – Dave Sullivan
TCEQ Project Liaison – Clint Harper

Funding Amount: $106,970
($85,282 UT Austin, $21,688 Environ)

Expended Amount: $106,884.06
($85,197.80 UT Austin, $21,686.26 Environ)

Amount Returned to AQRP: $85.94
($84.20 UT Austin, $1.74 Environ)

Executive Summary

Wildland fires and open burning can be substantial sources of ozone precursors and particulate matter. The influence of fire events on air quality in Texas and other states has been well documented by observational studies. Fire emissions are often transported over multiple spatial scales and can contribute to exceedances of air quality standards. Accurate characterization of these events is necessary for understanding their influence on measured ambient concentrations, providing a weight of evidence for exceptional event exclusions, conducting air quality modeling for planning and attainment demonstrations, and estimating North American Background ozone concentrations used to inform policy decisions regarding the National Ambient Air Quality Standards. More than 80% of Texas was under exceptional drought in 2011, the worst year for wildfires in the state's history. An increase in future drought frequency in the southwestern United States may have complex and profound effects on the occurrence of fires.

This project evaluated the sensitivity of emissions estimates from FINN v.1 (referred to as the FINN default configuration for the purposes of this work) to variability in input parameters and the effects on modeled ozone and particulate matter concentrations using CAMx. The project included four major tasks:

1. Analysis of the climatology of fires in Texas and central and western states, Mexico and Central America, and western Canada between 2002-2012 using the FINN default configuration.

2. Comparison of fire emission estimates between the FINN default and BlueSky/SmartFire modeling frameworks

3. Evaluation of the sensitivity of FINN emissions estimates to emission factors, land cover classification, fuel loading data, and fire detection and area burned estimation

4. Assessment of the effects of FINN sensitivities on air quality using CAMx.

The time period of the CAMx episode spanned from April 1 through October 18, 2008. The analysis focused on the late spring, April and May, and the late summer/early fall, September and October. Fire climatology based on CO emissions estimates indicated that 2008 was close to the 2002-2012 average and varied strongly by region and season reflecting differences in the types of fire events, including prescribed burning, agricultural and crop residue burning, and wildfires.

Comparison of emissions estimates from the FINN default configuration with the Bluesky/SmartFire modeling framework that was used to provide emissions for the CAMx episode indicated that estimates of CO, VOC, and PM2.5 emissions from BlueSky/SmartFire were higher than estimates from FINN; NOx emissions, however, were higher from FINN than BlueSky/SmartFire. SmartFire uses reported area burned and detections from multiple satellite sensors. In contrast, FINN relies only on the MRR product. Overall, this difference generally results in a greater number of fire detections for BlueSky/SmartFire than FINN. A hypothesis is that higher NOx emission factors in FINN may compensate for lower estimates of acreage burned, in particular in the central United States.

Sensitivity studies using FINN were constructed to examine the effects of uncertainty in emissions factors, fuel loading, land cover classification, and fire detection and estimation of area burned according to Table 1.

Table 1. Sensitivity studies performed with FINN*

RUN NAME	LAND COVER	FUEL LOADING	EMISSION FACTOR	FIRE DETECTION/ BURN AREA
DEFAULT	default	default	default	default
GlobCover	GlobCover	default	default	default
NEWEMIS	default	default	NEW	default
HIGHEMIS	default	default	HIGH**	default
LOWEMIS	default	default	LOW**	default
NEWEMIS_TEMPFOR	default	TEMPFOR+	NEW^	default
SmartFire	default	default	default	SmartFire
FCCS	FCCS	FCCS	default	default

*Default refers to inputs/parameters included in Wiedinmyer et al. (2011) for FINN version 1 and described in Section 3 of this report.

**Note that LOWEMIS and HIGHEMIS represented modifications to the NEWEMIS scenario (not the FINN default scenario).

^ This simulation was a version of the NEWEMIS that include additional changes in vegetation assignment (described below).

+ Evergreen forests were assigned corresponding fuel loadings of temperate forest rather than boreal forest as assumed in the default configuration.

The sensitivity studies highlighted the potential variability in predicted fire emissions, which were season and region dependent. Variability in emissions estimates among the sensitivity studies and between the sensitivity studies and the FINN default configuration exceeded a factor of two. Responses were particularly notable for the SmartFire scenarios in the central and southeastern U.S. during the spring and western and southern U.S. during late summer/early fall seasons and the Globcover scenario in Mexico during the spring. Interactions between input parameters were complex and not generalizable across geographic regions. As illustrated for both ozone and PM2.5, because of the intermittent frequency and variability in the spatial and temporal scales of fire events, impacts on percentile concentrations and mean concentrations over extended time periods may be minimal. On local and regional scales, air quality effects can be quite significant during specific fire events.

Project Update

This project is complete and the final report is under review.

All invoices have been paid and the project is in the process of being closed.

No publications or presentations of this work are planned at this time.

Project 13-022 **STATUS: Active – January 29, 2013**

Completed – November 30, 2013

Surface Measurements of PM, VOCs, and Photochemically Relevant Gases in Support of DISCOVER-AQ

Rice University – Robert Griffin
University of Houston – Barry Lefer

AQRP Project Manager – Dave Sullivan
TCEQ Project Liaison – Jocelyn Mellberg

Funding Amount: \$206,815
(\$89,912 Rice, \$116,903 UH)

Expended Amount: \$192,004.33
(\$75,881.86 Rice, \$116,122.47 UH)

Amount Returned to AQRP: \$14,810.67*
(\$14,030.14 Rice*, \$780.53 UH)
*Expected

Executive Summary

The City of Houston, Harris County, and surrounding areas have a long history of air quality issues because of their large population, extensive industrial activity, and subtropical climate. These issues predominantly have been manifested through ozone (O3) mixing ratios that exceed the National Ambient Air Quality Standards (NAAQS) established by the United States Environmental Protection Agency (EPA). However, recent measurements indicate that Harris County barely achieves compliance with the NAAQS that have been established for particulate matter (PM), specifically for particles with diameters less than or equal to 2.5 micrometers (PM2.5).

In recent years, the National Aeronautics and Space Administration (NASA) has placed considerable emphasis on the use of satellite remote sensing in the measurement of species such as O3 and PM that constitute air pollution. However, additional data are needed to aid in the development of methods to distinguish between low-level and high-level concentrations in these column measurements. To that end, NASA has established a program titled Deriving Information on Surface Conditions from Column and Vertically Resolved Observations Relevant to Air Quality (DISCOVER-AQ). DISCOVER-AQ began in summer 2011 with work in the Mid-Atlantic Coast region that featured satellite, airborne, and ground-based sampling; similar work was performed in California in 2012. The DISCOVER-AQ program conducted operations in and near Houston in September 2013.

During the Houston operations of DISCOVER-AQ, there was a need for ground-based measurement support. The project described in this report filled that need by providing quantitative measurements of sub-micron particle size and composition and mixing ratios of volatile organic compounds and other photochemically relevant gases such as O3 and oxides of nitrogen. The instrumentation for these measurements was deployed using the University of Houston mobile air quality laboratory. The measurement protocols on the mobile laboratory

generally followed two modes. First, during DISCOVER-AQ flights, the mobile laboratory operated in the northwest sector of the Houston area to characterize pollutant outflow under southerly flow conditions or inflow under northerly conditions. To the extent possible, the laboratory operated while in motion. Second, during non-flight periods, the laboratory was operated in various areas around Houston to address specific science questions listed in this report. During these periods, the laboratory operated under a combination of mobile and stationary modes.

Project Update:
This project is complete and the final report is posted on the AQRP website.

All invoices have been paid and the project is in the process of being closed.

No publications or presentations of this work are planned at this time.

Project 13-024 **STATUS: Active – February 20, 2013**

Completed – November 30, 2013

Surface Measurement of Trace Gases in Support of DISCOVER-AQ in Houston in Summer 2013

University of Maryland – Xinrong Ren

AQRP Project Manager – Dave Sullivan
TCEQ Project Liaison – Erik Gribbin

Funding Amount: $90,444

Expended Amount: $89,658.88

Amount Returned to AQRP: $785.12

Executive Summary:
In order to improve the interpretation of aircraft and satellite observations to understand near-surface conditions relating to air quality, high-quality surface observations of ozone and particulate matter (PM) precursors are needed, especially in urban environments like Houston. To support the NASA DISCOVER-AQ study in Houston in summer 2013, we made surface measurements of trace gases including ozone (O_3), nitric oxide (NO), nitrogen dioxide (NO_2), total reactive nitrogen (NO_Y), and sulfur dioxide (SO_2). Research-grade instrumentation to measure these traces gases was deployed at the Manvel Croix and Galveston science sites in September 2013.

Data collected in this field study were analyzed with regard to the source regions, i.e., dependence on wind direction. Measurements results show that highest NO_2 levels at the Manvel Croix site were influenced by plumes from downtown Houston and the Houston Ship Channel, although local emissions were also important to elevated NO_2 levels. Trace gases measured at the Galveston site were generally low, but were occasionally influenced by pollution plumes.

These measurements were compared to concurrent aircraft measurements for the periods when the NASA P-3B aircraft conducted spiral profiles over the both sites. The surface trace gas measurements generally agree with the same measurements on the P-3B, although there were more variations in the P-3B data, indicating more spatial variations were observed by the P-3B. At the Galveston site, the observed mean NO_x/NO_Y ratio was 0.58, with a maximum ratio of 0.77 in the early morning and a minimum of 0.46 in the afternoon. Good correlation between NO_Z (= $NO_Y - NO_x$) and O_3 was observed at the Galveston site, suggesting an ozone production efficiency (OPE) of ~16 ppbv when 1 ppbv of NO_x was converted to NOz. This OPE is about a factor of 2 more than what was observed during DISCOVER-AQ 2011 in the Baltimore-Washington area.

Project Update:
This project is complete and the final report is undergoing the last round of revisions.

All invoices have been paid and the project is in the process of being closed.

The project team has produced the following publications and presentations:

- NASA AQAST meeting at Rice University in Houston, TX (Jan. 14-16, 2014), where Xinrong Ren gave a talk titled: "Measurements of trace gases at the Manvel Croix and Galveston sites during DISCOVER-AQ";
- NASA DISCOVER-AQ science meeting at NASA Langley in Hampton, VA, where Winston Luke gave a talk titled: "NOAA/Air Resources Laboratory Surface Observations at Galveston and Manvel-Croix: Summary and Comparison with Aircraft Data".
- A paper is in preparation with the intent to submit to Atmospheric Chemistry and Physics within about 6 months.

Project 12-028 **STATUS: Active – January 29, 2013**

Completed – November 30, 2013

Implementation and evaluation of new HONO mechanisms in a 3-D Chemical Transport Model for Spring 2009 in Houston

University of Houston – Barry Lefer
UCLA – Jochen Stutz
Environ – Greg Yarwood
UNC at Chapel Hill – Will Vizuette

AQRP Project Manager – Elena McDonald-Buller
TCEQ Project Liaison – Doug Boyer

Funding Amount: \$117,269
(\$19,599 UH, \$17,944 UCLA, \$44,496 Environ, \$35,230 UNC)

Expended Amount: \$114,125.46
(\$16,586.51 UH, \$17,709.91 UCLA, \$44,496 Environ, \$35,230 UNC)

Amount Returned to AQRP: \$3,143.54
(\$3,012.49 UH, \$234.09 UCLA*, \$0.00 Environ, \$0.00 UNC)
* Expected

Executive Summary

The major chemical framework of ozone formation has been understood for decades but nevertheless new scientific discoveries continue to emerge and their impact on ozone formation must be properly evaluated. The roles of radical precursors such as nitrous acid (HONO), formaldehyde (HCHO), and highly reactive volatile organic compounds (HRVOCs) in Houston and other Texas cities continue to be the subject of research. Field measurements and modeling studies suggest that HONO can significantly affect the hydrogen oxide radical (HOx) budget in urban Houston. A robust analysis of how HONO formation influences local and regional photochemistry in Houston requires 3-D modeling with a realistic representation of the HONO sources.

In the Spring of 2009, scientists from many institutions collected extensive atmospheric measurements in urban Houston including nitric oxide (NO), nitrogen dioxide (NO_2), reactive nitrogen compounds (NO_Y), HONO, nitric acid (HNO_3), ozone (O_3), carbon monoxide (CO), sulfur dioxide (SO_2), HCHO, hydrogen peroxide (HOOH), hydroxyl radical (OH), hydroperoxy radical (HO_2), oxygenated volatile organic compounds (OVOCs), volatile organic compounds (VOCs), actinic flux, planetary boundary layer (PBL) height, O_3 production rates, and vertical profiles (from 40m to 300m) of NO_2, HONO, O_3, SO_2, and HCHO, during the Study of Houston Atmospheric Radical Precursors (SHARP). The SHARP dataset provides a unique opportunity to examine and improve our understanding of atmospheric HONO formation processes and how they should be implemented in 3-D models such as the Comprehensive Air quality Model with extensions (CAMx). The objective of the study was to develop, implement, and evaluate new

pathways for HONO formation in the CAMx model that is used to develop air quality management strategies for Houston and Texas.

Previous attempts to implement HONO into 3-D CTMs similar to CAMx have employed empirical parameterizations of HONO production. In contrast, this study explicitly modeled heterogeneous formation of HONO using a surface model available in CAMx. The process based approach developed in this study treats both dark (thermal) and light (photo-enhanced) heterogeneous HONO formation on ground level surfaces. This surface model allows the ground to act as a reservoir for deposited species rather than making the assumption that all processes on surfaces occur instantly. The surface model simulates deposition, photochemical degradation and transformation, and volatilization back into the air (re-emission).

Based on literature reviews and analysis of measurements, reactions of NO_2 and HNO_3 at the surface were implemented in the surface model. The study showed that the surface thermal reaction of NO_2 was necessary to explain nighttime measurements during the SHARP study, while during the day, surface photolytic reactions of HNO_3 and NO_2 were necessary to achieve agreement with observations. Because uncertainties exist in our knowledge of the relevant surface parameters, initial estimates of these parameters were refined, using the SHARP observations, to obtain good agreement between observed and modeled HONO:NO_2 ratios and HONO:HNO_3 ratios.

The implementation of these new HONO formation pathways into CAMx shows that explicitly modeling reactions on surfaces (vegetation, soil) can do a good job of reconciling predicted with observed HONO concentrations and HONO:NO_2 ratios. The best HONO agreement with the surface model was obtained for days when the model predicted the observed in-situ NO_2 mixing ratios well. Consequently, greater emphasis was placed on the overall model simulation of the HONO:NO_2 ratio than the absolute HONO agreement. Sensitivity simulations with direct emissions of HONO (as 0.8 % of NOx emissions) did not consistently reconcile predicted with observed HONO concentrations and HONO:NO_2 ratios. When using surface model parameters that are consistent with SHARP observations, the HONO produced was found to have a substantial impact on morning OH but only minor impacts on daytime OH and as much as 4 ppbv on maximum O_3.

Project Update

This project is complete and the final report is undergoing the last round of revisions.

All invoices have been paid and the project is in the process of being closed.

The project team plans to produce the following manuscripts:

- M1: Implementation and Refinement of a Surface Model for HONO formation in a 3-D Chemical Transport Model   Lead Authors: Greg Yarwood and Prakash Karamchandani

- M2. Modeling heterogeneous nitrous acid formation on surfaces with the CAMx photochemical grid model Lead Author: Evan Cuzco

- M3. Heterogenous nitrous acid formation contributions to modeled ozone chemistry and radical sources in Houston Lead Author: Evan Cuzco

Project 12-032 **STATUS: Active – January 25, 2013**

Completed – November 30, 2013

Collect, Analyze, and Archive Filters at two DISCOVER-AQ Houston Focus Areas: Initial Characterization of PM Formation and Emission Environmental Chamber Experiments to Evaluate NOx Sinks and Recycling in Atmospheric Chemical Mechanisms

Baylor University – Rebecca Sheesley

AQRP Project Manager – Dave Sullivan
TCEQ Project Liaison – Fernando Mercado

Funding Amount: \$45,972

Expended Amount: \$43,642.21

Amount Returned to AQRP: \$2,329.79

Executive Summary

This AQRP project is reporting initial elemental carbon (EC), organic carbon (OC) and optical black carbon (BC) characterization of particulate matter (PM) at Moody Tower and Manvel Croix during DISCOVER-AQ Houston Texas 2013. Particulate filter samples were collected over the entire DISCOVER-AQ sampling period at two primary sites and analyzed *off-line for organic and elemental carbon (*OC/EC). *Furthermore, real-time black carbon (BC) optical data was also collected at these two ground-based sites*. The overall research objective was to "**a***ssess ground-level particulate matter formation and emission at two DISCOVER-AQ Houston Focus Areas and compare results to concurrent aircraft measurements made directly above the ground stations."*

Particulate filter sample collections and analysis, as specified under the original project's framework, was successful. The project's sampling efforts were intensified at the two primary sites. PM sampling efforts were expanded to additional DISCOVER-AQ flight sites, Conroe and La Porte, due to the development of research collaborations during the early stages of this project. As a result of this concerted effort, over 300 PM substrates were collected. Fine particulate matter ($PM_{2.5}$) and total suspended particulate matter (TSP) were collected during the entire month of September 2013, concurrent with the DISCOVER-AQ flights by NASA's P-3B and B200 aircraft.

Over the course of the project the $PM_{2.5}$ OC ranged from 0.8 to 10.1 $\mu g\ m^{-3}$ while the TSP OC ranged from 2.6 to 17.4 $\mu g\ m^{-3}$ at Moody Tower. The EC at Moody Tower ranged from 0.2 to 1.2 $\mu g\ m^{-3}$ for $PM_{2.5}$ and from 0.2 to 3.5 $\mu g\ m^{-3}$ for TSP. At Manvel Croix, the $PM_{2.5}$ OC ranged from 1.2 to 7.2 $\mu g\ m^{-3}$ while the TSP OC ranged from 3.0 to 6.7 $\mu g\ m^{-3}$. The EC at Manvel Croix ranged from 0.13 to 2.0 $\mu g\ m^{-3}$ for $PM_{2.5}$ and from 0.1 to 0.7 $\mu g\ m^{-3}$ for TSP. The higher carbon maximums at Manvel Croix for the fine particulate matter occurred during morning rush hour samples. Based on these preliminary results we have identified two PM regimes for further characterization: the week of Sept 9-13 for primary emission characterization and the week of Sept 21-28 for PM formation.

The aethalometer at Moody Tower revealed distinct trends in BC concentrations with peaks from 04:00 to 10:00 CDT for many days, which is coincident with early morning diesel transport and morning rush hour emissions. The preliminary BC calculated from absorbance at 880nm has been regressed against the preliminary EC measured on the daily 24h medium-volume air quartz fiber filter samplers with a 2.5 µm cyclone inlet. The regression line had a slope of 0.46, an r^2 of 0.57 and a p-value < 0.001. However, both data sets need to be finalized. Absorption by other components of particulate matter including windborne dust and iron oxides associated with industrial emissions is possible at this wavelength.

Finally, particulate filters were archived for future PM projects tasked with examining air quality and atmospheric chemistry in the City of Houston and Harris County. Project results, including real-time and off-line measurements, will be promptly disseminated to DISCOVER-AQ investigators. Currently, project PIs are working with the Langley Aerosol Research Group Experiment (LARGE) to compare ground-based measurement with flight-based measurements. LARGE was one of the main research groups focusing on flight-based aerosol measurements for DISCOVER-AQ.

Project Update

This project is complete and the final report is undergoing the last round of revisions.

All invoices have been paid and the project has been closed.

The project team has produced the following publications and presentations:

- Poster at the American Geophysical Union national meeting (Dec 2013) *Initial characterization of surface-based carbonaceous aerosol during DISCOVER-AQ in Houston, TX* Rebecca J. Sheesley, Tate E. Barrett, Subin Yoon, Adelaide Clark and Sascha Usenko
- Poster at the DISCOVER-AQ Science Working Group meeting (Feb 2014) *Initial characterization of surface-based carbonaceous aerosol during DISCOVER-AQ in Houston, TX* Rebecca J. Sheesley, Tate E. Barrett, Subin Yoon, Adelaide Clark and Sascha Usenko
- Manuscript in preparation. Submission planned to Atmospheric Environment in summer 2014. Draft title: "*Initial characterization of surface-based carbonaceous aerosol during DISCOVER-AQ in Houston, TX*."

Project 12-TN1	STATUS: Active – February 21, 2013
	Completed – November 30, 2013

Investigation of surface layer parameterization of the WRF model and its impact on the observed nocturnal wind speed bias

University of Maryland – Daniel Tong
Pius Lee

AQRP Project Manager – Gary McGaughey
TCEQ Project Liaison – Bright Dornblaser

Funding Amount: $64,994

Expended Amount: $64,537.12

Amount Returned to AQRP: $456.88

Executive Summary

This project investigates surface layer parameterization in the Weather Research and Forecasting (WRF) model during the Second Texas Air Quality Study (TexAQS II) period. The parameterization of energy fluxes from the surface layer significantly impacts simulated near-surface winds. Several recent studies on the meteorological features of the regions adjacent to the Gulf of Mexico using the WRF model have identified a frequent nocturnal wind speed over-prediction (e.g., Byun et al., 2008, Lee et al., 2010). Texas Commission on Environmental Quality (TCEQ) scientists also in several recent communications reported that the WRF model tends to over-predict the surface wind speed in eastern Texas in the evening hours, especially in coastal regions such as the Houston-Galveston-Brazoria (HGB) area. We have previously identified that a wind speed bias prevailed more noticeably when there was a high pressure system centered over the Louisiana/Mississippi/Arkansas states that was associated with easterly/southeasterly flow in the lowest hundreds of meters in Southeastern Texas (Lee et al., 2012; Ngan et al., 2013). This project builds on these findings to further examine the incorrect redistribution of kinetic energy from the nighttime residual layer to the surface.

The objectives of this project were three-fold: (1) to understand the sensitivities of the various surface layer (SL) schemes in the WRF model, especially the MM5 option based on the Monin-Obukhov similarity theory routinely used by TCEQ, (2) to investigate the temporal and spatial characteristics of exchange coefficients for heat and momentum of the scheme(s) through diagnosing intermediate variables/parameters in the parameterization schemes so as perhaps to hypothesize how they affect the accompanied planetary boundary layer (PBL) scheme that determines the wind speed, and (3) to relate how atmospheric stability regimes and important surface characteristics that influence sensible and latent heat fluxes contribute to the wind speed biases.

Multiple ten day simulations using the WRF model were performed between June 4 and 13, 2006 --- a period within the TexAQS-II field campaign that repeatedly showed the high wind speed bias problem during the evening hours. The following provides a chronology of major findings:

1. Simulations using a recent upgrade of the MM5 surface layer (SL) similarity scheme (Jiménez et al., 2012) generally showed significant improvement in reducing biases during the nighttime in the modeled friction velocity that is an important input to the PBL parameterization schemes. The upgrade extended the atmospheric stability regime applicability of the MM5 SL scheme by incorporating universal profile functions for vertical gradients of momentum and heat. The improvement expanded coverage for both highly stable and unstable atmospheric conditions, reduced the lower limit of friction velocity scale over land, and provided an option to account for thermal roughness length over land points (Dudhia 2012). We adopted this upgrade because our modeled results for friction velocity showed noticeable improvements although those for surface fluxes did not show as marked improvements.
2. We suggest that the most physically-based upgrades of the Land-Surface-Model (LSM)/SL-Similarity-Scheme/PBL-Model be used to investigate the low-level wind speed bias because these components are tightly coupled as inherited from the MM5 era such that few parameters are compensating for deficiencies of one another. Examples of these parameters are the bulk Richardson number values that define atmospheric regime cut-offs for similarity function parameterization and numerical values of some of the empirically determined parameters based on specific field campaigns. *This decision was supported by evidence of significantly improved governing inputs to the PBL scheme, yet worsened 10 m wind speed biases; considering the SL scheme as a "stand-alone" module was not possible.* In our newly proposed setup, along with the upgrade by Jiménez et al. (2012), we also replaced the MM5 5-layer soil thermal diffusion land surface model (LSM) with the NOAH LSM. NOAH is a physically based LSM that allows soil moisture nudging and easy incorporation of new time-varying input data and physics.
3. *The NOAH LSM and the upgraded-MM5 SL scheme represented the best physically based surface physics option pair tested in this study and improved sensible heat flux biases in the late afternoon over the University of Houston Coastal Center site by as much as 50%.* Also the negative bias of the sensible heat flux during the nighttime was reduced in the simulation that utilized the NOAH LSM. Moreover, the previously modeled abrupt drop in wind speed between 1800 and 1900 CST averaged over all 46 Continuous Air Monitoring Sites (CAMs) in the HGB area was largely removed. However, it is discouraging that the over-estimation of 10 m wind speed was aggravated.
4. *In theory if one achieves significant improvement in the simulation of the sensible heat flux with non-degraded performance for the latent heat and momentum fluxes, one would also conjecture improvement in the predictions of low-level wind speed.* Nonetheless, the model simulations did not support this conjecture. This result suggests that the MM5 5-layer soil thermal diffusion LSM is better tuned for the MM5 SL scheme. *Without re-optimizing the values of the tunable parameters this physics option pair may not improve WRF's performance for the targeted modeled fields.*

5. We further attempted to identify tunable parameters that could be tuned to optimize the model performance with respect to the low-level wind speed prediction. It was concluded that:

   (a) *A formal mathematical approach based on multiple criteria algorithms* such as those by Gupta et al. (1999) should be employed in the simultaneous optimization of the numerical values of those parameters applicable to various seasons and climate conditions of interest, and

   (b) *More frequent utilization of observed soil moisture should be used to nudge the surface heat and/or moisture fluxes towards reality* to allow the LSM-SL option pair to better capture the decoupling of the nocturnal boundary layer and the vertical distribution of wind speeds (Wilczak et al., 2009).

Project Update

This project is complete and the final report is posted on the AQRP website.

All invoices have been paid and the project is in the process of being closed.

The project team presented at the Community Modeling and Analysis System (CMAS) Conference in October 2013.

Presentation:
"A regional chemical reanalysis prototype" Pius Lee , Greg Carmichael, Tianfeng Chai, Rick Saylor, Li Pan, Hyuncheol Kim, Daniel Tong, and Ariel Stein

Poster:
"Preliminary analyses of flight measurements and CMAQ simulation during Southeast Nexus (SENEX) field experiment" Li Pan, Pius Lee , Hyun Cheol Kim, Daniel Tong ,Rick Saylor and Tianfeng Chai

Project 12-TN2	STATUS: Active – February 21, 2013
	Completed – November 30, 2013

Development of IDL-based geospatial data processing framework for meteorology and air quality modeling

University of Maryland – Daniel Tong
HyunCheol Kim

AQRP Project Manager – Gary McGaughey
TCEQ Project Liaison – Bright Dornblaser

Funding Amount: $69,985

Expended Amount: $68,362.27

Amount Returned to AQRP: $1,622.73

Executive Summary

This project investigates basic computational algorithms to handle Geographic Information System (GIS) data and satellite data essential in regional meteorological and chemical modeling. It develops a set of generalized libraries within a geospatial data processing framework aiming to process geospatial data more efficiently and accurately. The tool can process GIS data both in vector format (e.g., ESRI shapefiles) and raster format (e.g., GEOTIFF and IMG) for any given domain. Processing speeds are improved through selective usages of polygon-clipping routines and other algorithms optimized for specific applications. The raster tool is developed utilizing a histogram reverse-indexing method that enables easy access of grouped pixels. It generates statistics of pixel values within each grid cell with improved speed and enhanced control of memory usage. Geospatial data processing tools to determine spatial allocation that use polygon clipping algorithms require huge computational resources to calculate fractional weighting between GIS polygons of the physical space (and/or polylines) and gridded cells of the modeling space. To overcome the speed and computational accuracy issues, an efficient polygon/polyline clipping algorithm is crucial. One key element for faster spatial allocation is to optimize computational iterations in both polygon clipping and map projection calculations.

The project had the following specific objectives: (A) To develop an optimized geospatial data processing tool that can transform raster data format and vector data format to any target domain within the data coverage with vastly shortened processing time and enhanced accuracy. (B) To collect and to process sample GIS and satellite data so that they are readily deployable for modeling studies. Applications include a spatial regridding method for emissions and satellite data. (C) To perform engineering tests to demonstrate the tool's capability in improving routine data processing for meteorological and air quality models. An example test case has been included in the user-guide and users' installation sample testing package.

Project Update

This project is complete and the final report is posted on the AQRP website.

All invoices have been paid and the project is in the process of being closed.

The project team presented at the Community Modeling and Analysis System (CMAS) Conference in October 2013.

Presentations:
"HCHO and NO_2 column comparisons between OMI, GOME-2 and CMAQ during 2013 SENEX campaign (21 slides)" Hyun Cheol Kim, Li Pan, Pius Lee, Rick Saylor, and Daniel Tong

Posters:
Fine-scale comparison of GOME-2, OMI and CMAQ NO_2 columns over Southern California in 2008" Hyun Cheol Kim, Sang-Mi Lee, Fong Ngan, and Pius Lee

FINANCIAL STATUS REPORT

Initial funding for fiscal year 2010 was established at $2,732,071.00. In late May 2010 an amendment was issued increasing the budget by $40,000. Funding for fiscal year 2011 was established at $2,106,071, for a total award of $4,878,142 for the FY 2010/2011 biennium. FY 2010 funds were fully expended in early 2012 and the FY 2011 funds expired on June 30, 2013 with a remaining balance of $0.11.

In February 2012, funding of $1,000,000 was awarded for FY 2012. In June 2012, an additional $160,000 was awarded in FY 2012 funds and $1,000,000 was awarded in FY 2013 funds, for a total of $2,160,000 in funding for the FY 2012/2013 biennium.

In April 2013, the grant was amended to reduce the FY 2012 funds by $133,693.60 and increase the FY 2011 funds by the same amount.

In June 2013, the grant was amended to increase the FY 2013 funds by $2,500,000.

In October 2013, the grant was amended to award FY 2014 funds of $1,000,000 and FY 2015 funds of $1,000,000. The budget for each fiscal year can be found in Appendix C.

For each biennium (and fiscal year) the funds were distributed across several different reporting categories as required under the contract with TCEQ. The reporting categories are:

<u>Program Administration</u> – limited to 10% of the overall funding (per Fiscal Year)
This category includes all staffing, materials and supplies, and equipment needed to administer the overall AQRP. It also includes the costs for the Council meetings.

<u>ITAC</u>
These funds are to cover the costs, largely travel expenses, for the ITAC meetings.

<u>Project Management</u> – limited to 8.5% of the funds allocated for Research Projects
Each research project will be assigned a Project Manager to ensure that project objectives are achieved in a timely manner and that effective communication is maintained among investigators in multi-institution projects. These funds are to support the staffing and performance of project management.

<u>Research Projects</u> / Contractual
These are the funds available to support the research projects that are selected for funding.

Program Administration

Program Administration includes salaries and fringe benefits for those overseeing the program as a whole, as well as, materials and supplies, travel, equipment, and other expenses. This category allows indirect costs in the amount of 10% of salaries and wages.

During the reporting period several staff members were involved, part time, in the administration of the AQRP. Dr. David Allen, Principal Investigator and AQRP Director, is responsible for the overall administration of the AQRP. James Thomas, AQRP Manager, is responsible for assisting Dr. Allen in the program administration. Maria Stanzione, AQRP Grant Manager, with assistance from Rachael Bushn, Melanie Allbritton, and Susan McCoy each provided assistance with program organization and financial management. This included managing the contracting process. Denzil Smith is responsible for the AQRP Web Page development and for data management.

Fringe benefits for the administration of the AQRP were initially budgeted to be 22% of salaries and wages across the term of the project. It should be noted that this was an estimate, and actual fringe benefit expenses have been reported for each month. The fringe benefit amount and percentage fluctuate each month depending on the individuals being paid from the account, their salary, their FTE percentage, the selected benefit package, and other variables. For example, the amount of fringe benefits is greater for a person with family medical insurance versus a person with individual medical insurance. At the end of the project, the overall total of fringe benefit expensed is expected to be at or below 22% of the total salaries and wages. Actual fringe benefit expenses to date are included in the spreadsheets above.

As discussed in previous Quarterly Reports, the AQRP Administration requested and received permission to utilize funds in future fiscal years. This is for all classes of funds including Administration, ITAC, Project Management, and Contractual. As of the writing of this report, the FY 10 and 11 funds have been fully expended. This same procedure will be followed for the FY 12 and 13 funds.

In June 2013, UT-Austin received a Contract Extension for the AQRP. This extension will continue the program through December 29, 2015.

Table 1: AQRP Administration Budget

Administration Budget (includes Council Expenses)
FY 2010/2011

Budget Category		FY10 Budget	FY11 Budget	Total	Expenses	Pending Expenses	Remaining Balance
Personnel/Salary		$202,816.67	$172,702.06	$375,518.73	$375,518.73	$0.00	$0.00
Fringe Benefits		$38,665.65	$33,902.95	$72,568.60	$72,568.60	$0.00	$0.00
Travel		$346.85	$0.00	$346.85	$346.85	$0.00	$0.00
Supplies		$15,096.14	$101.25	$15,197.39	$15,197.39	$0.00	$0.00
Equipment							
Total Direct Costs		$256,925.31	$206,706.26	$463,631.57	$463,631.57	$0.00	$0.00
Authorized Indirect Costs		$20,281.69	$17,270.20	$37,551.89	$37,551.89	$0.00	$0.00
10% of Salaries and Wages							
Total Costs		**$277,207**	**$223,976.46**	**$501,183.46**	**$501,183.46**	**$0.00**	**$0.00**
Fringe Rate		22%	22%		19%		

Administration Budget (includes Council Expenses)
FY 2012/2013

Budget Category		FY12 Budget	FY13 Budget	Total	Expenses	Pending Expenses	Remaining Balance
Personnel/Salary		$74,238.65	$265,040.00	$339,278.65	$135,046.39	$0.00	$204,232.26
Fringe Benefits		$17,068.38	$47,706.00	$64,774.38	$31,912.22	$0.00	$32,862.16
Travel		$339.13	$750.00	$1,089.13	$339.13	$0.00	$750.00
Supplies		$3,560.62	$10,000.00	$13,560.62	$5,324.12	$1.07	$8,235.43
Equipment							
Total Direct Costs		$95,206.78	$323,496.00	$418,702.78	$172,621.86	$1.07	$246,079.85
Authorized Indirect Costs		$7,423.86	$26,504.00	$33,927.86	$13,504.63	$0.00	$20,423.23
10% of Salaries and Wages							
Total Costs		**$102,630.64**	**$350,000.00**	**$452,630.64**	**$186,126.49**	**$1.07**	**$266,503.08**
Fringe Rate		22%	22%		24%		

Administration Budget (includes Council Expenses)
FY 2014/2015

Budget Category		FY14 Budget	FY15 Budget	Total	Expenses	Pending Expenses	Remaining Balance
Personnel/Salary		$70,000.00	$70,000.00	$140,000.00	$0.00	$0.00	$140,000.00
Fringe Benefits		$15,150.00	$15,150.00	$30,300.00	$0.00	$0.00	$30,300.00
Travel		$350.00	$350.00	$700.00	$0.00	$0.00	$700.00
Supplies		$7,500.00	$7,500.00	$15,000.00	$0.00	$0.00	$15,000.00
Equipment							
Total Direct Costs		$93,000.00	$93,000.00	$186,000.00	$0.00	$0.00	$186,000.00
Authorized Indirect Costs		$7,000.00	$7,000.00	$14,000.00	$0.00	$0.00	$14,000.00
10% of Salaries and Wages							
Total Costs		**$100,000.00**	**$100,000.00**	**$200,000.00**	**$0.00**	**$0.00**	**$200,000.00**
Fringe Rate		22%	22%		0%		

ITAC

During December and January the ITAC conducted their review of the proposals submitted in response to the 2014 – 2015 Request for Proposals. In November 2013 each proposal was assigned to 3 different ITAC members for review. On December 17, 2013, the individual reviews were submitted to AQRP and a conference call was held to perform an initial discussion and ranking of the proposals. On January 10, 2014, the ITAC met for a full day to review the proposals for technical merit and provide a ranking to the TCEQ and the Advisory Council. Expenses during this period were for travel for the ITAC members to attend the meeting and lunch provided during the meeting.

Table 2: ITAC Budget

ITAC Budget
FY 2010/2011

Budget Category		FY10 Budget	FY11 Budget	Total Budget	Expenses	Pending Expenses	Remaining Balance
Personnel/Salary							
Fringe Benefits							
Travel		$16,378.86	$6,292.97	$22,671.83	$22,671.83	$0.00	$0.00
Supplies		$1,039.95	$284.67	$1,324.62	$1,324.62	$0.00	$0.00
Total Direct Costs		$17,418.81	$6,577.64	$23,996.45	$23,996.45	$0.00	$0.00
Authorized Indirect Costs							
10% of Salaries and Wages							
Total Costs		**$17,418.81**	**$6,577.64**	**$23,996.45**	**$23,996.45**	**$0.00**	**$0.00**

ITAC Budget
FY 2012/2013

Budget Category		FY12 Budget	FY13 Budget	Total Budget	Expenses	Pending Expenses	Remaining Balance
Personnel/Salary							
Fringe Benefits							
Travel		$10,000.00	$8,000.00	$18,000.00	$5,145.93	$177.38	$12,676.69
Supplies		$500.00	$2,000.00	$2,500.00	$198.86	$33.00	$2,268.14
Total Direct Costs		$10,500.00	$10,000.00	$20,500.00	$5,344.79	$210.38	$14,944.83
Authorized Indirect Costs							
10% of Salaries and Wages							
Total Costs		**$10,500.00**	**$10,000.00**	**$20,500.00**	**$5,344.79**	**$210.38**	**$14,944.83**

ITAC Budget
FY 2014/2015

Budget Category		FY14 Budget	FY15 Budget	Total Budget	Expenses	Pending Expenses	Remaining Balance
Personnel/Salary							
Fringe Benefits							
Travel		$7,000.00	$7,000.00	$14,000.00	$0.00	$0.00	$14,000.00
Supplies		$500.00	$500.00	$1,000.00	$0.00	$0.00	$1,000.00
Total Direct Costs		$7,500.00	$7,500.00	$15,000.00	$0.00	$0.00	$15,000.00
Authorized Indirect Costs							
10% of Salaries and Wages							
Total Costs		**$7,500.00**	**$7,500.00**	**$15,000.00**	**$0.00**	**$0.00**	**$15,000.00**

Project Management

During this reporting period Project Managers reviewed drafts of the final reports and reviewed budget amendment requests as projects drew to a close. This included a thorough review of each project against its Quality Assurance Project Plan (QAPP). Final reports were approved for 10 projects and these are now available on the AQRP web page. Project Managers are currently working with PIs to complete their revisions to the final reports of the 4 remaining projects.

Table 3: Project Management Budget

Project Management Budget
FY 2010/2011

Budget Category		FY10 Budget	FY11 Budget	Total Budget	Expenses	Pending Expenses	Remaining Balance
Personnel/Salary		$145,337.70	$121,326.64	$266,664.34	$266,664.34	$0.00	$0.00
Fringe Benefits		$28,967.49	$23,102.60	$52,070.09	$52,070.26	$0.00	($0.17)
Travel							
Supplies		$778.30	$207.98	$986.28	$986.22	$0.00	$0.06.00
Total Direct Costs		$175,083.49	$144,637.22	$319,720.71	$319,720.82	$0.00	($0.11)
Authorized Indirect Costs		$14,533.77	$12,132.66	$26,666.43	$26,666.32	$0.00	$0.11
10% of Salaries and Wages							
Total Costs		**$189,617.26**	**$156,769.88**	**$346,387.14**	**$346,387.14**	**$0.00**	**$0.00**

Project Management Budget
FY 2012/2013

Budget Category		FY12 Budget	FY13 Budget	Total Budget	Expenses	Pending Expenses	Remaining Balance
Personnel/Salary		$53,385.00	$152,000.00	$205,385.00	$83,641.05	$0.00	$121,743.95
Fringe Benefits		$10,984.28	$31,800.00	$42,784.28	$16,741.36	$0.00	$26,042.92
Travel		$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Supplies		$967.98	$6,000.00	$6,967.98	$967.98	$0.00	$6,000.00
Total Direct Costs		$65,337.26	$189,800.00	$255,137.26	$101,350.39	$0.00	$153,786.87
Authorized Indirect Costs		$5,338.50	$15,200.00	$20,538.50	$8,364.10	$0.00	$12,174.40
10% of Salaries and Wages							
Total Costs		**$70,675.76**	**$205,000.00**	**$275,675.76**	**$109,714.49**	**$0.00**	**$165,961.27**

Project Management Budget
FY 2014/2015

Budget Category		FY14 Budget	FY15 Budget	Total Budget	Expenses	Pending Expenses	Remaining Balance
Personnel/Salary		$52,000.00	$52,000.00	$104,000.00	$0.00	$0.00	$104,000.00
Fringe Benefits		$9,300.00	$9,300.00	$18,600.00	$0.00	$0.00	$18,600.00
Travel							
Supplies		$1,000.00	$1,000.00	$2,000.00	$0.00	$0.00	$2,000.00
Total Direct Costs		$62,300.00	$62,300.00	$124,600.00	$0.00	$0.00	$124,600.00
Authorized Indirect Costs		$5,200.00	$5,200.00	$10,400.00	$0.00	$0.00	$10,400.00
10% of Salaries and Wages							
Total Costs		**$67,500.00**	**$67,500.00**	**$135,000.00**	**$0.00**	**$0.00**	**$135,000.00**

Research Projects

FY 2010-2011

The FY 2010 Research/Contractual budget was originally funded at $2,286,000. After all transfers, it was increased by $1,827.93. The FY 2011 Research/Contractual budget was originally funded at $1,736,063. After all transfers, it was increased by $377.62, plus an additional $116,000 from FY 2012 funds that were changed to FY 2011 funds. This is an overall net increase of $13,205.55 to the Research/Contractual funds (and net reduction in Project Management/ITAC funds). ($105,000 in FY 2012 research funds were transferred to FY 2011, the remaining $11,000 were transfers from Project Management funds.)

All FY 2010 Research Project funding was fully expensed before the expiration of FY 2010 funds in June 2012. The FY 2011 Research Project funding that remained after all FY 2011 research projects were completed was alloc5ated to FY 2012-2013 projects. This included the funds that were reallocated from FY 2012 to FY 2011. The funds were allocated to project 13-016 Valparaiso and project 13-004 Discover AQ Infrastructure. Both projects utilized their FY 2011 funds (project 13-004 $116,000 and project 13-016 $20,168.90) by June 30, 2013. A remaining balance of $0.11 was returned to TCEQ.

Table 4 on the following 2 pages illustrates the 2010-2011 Research Projects, including the funding awarded to each project and the total expenses reported on each project through the expiration of the FY 2011 funds on June 30, 2013.

FY 2012-2013

The FY 2012 Research/Contractual budget was originally funded at $815,000. Transfers to date have increased the budget by $27,500. The FY 2013 Research Contractual budget was originally funded at $835,000. In June 2013, Amendment 9 increased this budget by $2,100,000. (The remaining $400,000 was allocated to Admin and Project Management.) $1,402,744 of these funds were allocated to Project 13-004 to allow for the purchase of additional infrastructure equipment and expand the number of Discover-AQ sites. The funds that have not yet been allocated to research projects will be allocated from the next RFP.

Table 5 illustrates the 2012-2013 Research Projects, including the funding awarded to each project and the total expenses reported on each project as of November 30, 2013.

FY 2014-2015

The FY 2014 and 2015 Research/Contractual budgets were originally funded at $825,000 each. Research projects selected from the RFP that closed on November 22, 2013 are expected to be awarded in March 2014.

Table 4: 2010/2011 Contractual Expenses

Contractual Expenses

FY 10 Contractual Funding		$2,286,000		
FY 10 Contractual Funding Transfers		$1,827.93		
FY 10 Total Contractual Funding		**$2,287,827.93**		
Project Number		Amount Awarded (Budget)	Cumulative Expenditures	Remaining Balance
10-008	Rice University	$128,851	$126,622.32	$2,228.68
10-008	Environ International	$49,945	$49,944.78	$0.22
10-009	UT-Austin	$591,332	$591,306.66	$25.34
10-021	UT-Austin	$248,786	$248,786.41	-$0.41
10-022	Lamar University	$150,000	$132,790.80	$17,209.20
10-032	University of Houston	$176,314	$176,314	$0
10-032	University of New Hampshire	$23,054	$18,850.65	$4,203.35
10-032	UCLA	$49,284	$47,171.32	$2,112.68
10-034	University of Houston	$195,054	$186,657.54	$8,396.46
10-042	Environ International	$237,481	$237,479.31	$1.69
10-045	UCLA	$149,773	$142,930.28	$6,842.72
10-045	UNC - Chapel Hill	$33,281	$33,281	$0
10-045	Aerodyne Research Inc.	$164,988	$164,988.10	-$0.10
10-045	Washington State University	$50,000	$50,000	$0
10-DFW	UT-Austin	$37,857	$37,689.42	$167.58
FY 10 Total Contractual Funding Awarded		$2,286,000		
FY 10 Contractual Funding Expended (Init. Projects)			$2,244,812.59	
FY 10 Contractual Funds Remaining Unspent after Project Completion				$41,187.41
FY 10 Additional Projects				
	Data Storage	$7,015.34	$7,015.34	$0
10-SOS	State of the Science	$36,000.00	$36,000.00	$0
FY 10 Contractual Funds Expended to Date*			$2,287,827.93	
FY 10 Contractual Funds Remaining to be Spent				$0

FY 11 Contractual Funding		**$1,736,063.00**		
FY 11 Contractual Funding Transfers		**$116,377.62**		
FY 11 Total Contractual Funding		**$1,852,440.62**		
Project Number		Amount Awarded (Budget)	Cumulative Expenditures	Remaining Balance
10-006	Chalmers University of Tech	$262,179	$262,179	$0
10-006	University of Houston	$222,483	$217,949.11	$4,533.89
10-015	Environ International	$201,280	$201,278.63	$1.37
10-020	Environ International	$202,498	$202,493.48	$4.52
10-024	Rice University	$225,662	$223,769.99	$1,892.01
10-024	University of New Hampshire	$70,747	$70,719.78	$27.22
10-024	University of Michigan	$64,414	$60,597.51	$3,816.49
10-024	University of Houston	$98,134	$88,914.46	$9,219.54
10-029	Texas A&M University	$80,108	$78,276.97	$1,831.03
10-044	University of Houston	$279,642	$277,846.38	$1,795.62
11-DFW	UT-Austin	$50,952	$29,261.75	$21,690.25
FY 11 Total Contractual Funding Awarded		$1,758,099		
FY 11 Contractual Funds Expended (Init. Projects)			$1,713,287.06	
FY 11 Contractual Funds Remaining Unspent after Project Completion				$44,811.94
FY 11 Additional Projects				
	Data Storage	$2,984.66	$2,984.66	$0.00
	12-016 Valparaiso	$20,168.90	$0.00	$21,168.90
	12-004 Discover AQ Infrastructure	$116,000.00	$115,999.89	$0.11
FY 11 Contractual Funds Expended to Date*			$1,852,440.51	
FY 11 Contractual Funds Remaining to be Spent				$0.11
Total Contractual Funding		$4,022,063.00		
Total Contractual Funding Transfers		$118,205.55		
Total Contractual Funding Available		$4,140,268.55		
Total Contractual Funds Expended to Date			$4,140,268.44	
Total Contractual Funds Remaining				$0.11

Table 5. 2012/2013 Contractual Expenses

Contractual Expenses

FY 12 Contractual Funding	$815,000
FY 12 Contractual Funding Transfers	$27,500
FY 12 Total Contractual Funding	**$842,500**

Project Number		Amount Awarded (Budget)	Cumulative Expenditures	Remaining Balance
12-004	UT-Austin (Torres)	$4,820	$4,819.65	$0.35
12-006	UC-Riverside	$101,765	$101,765.00	$0.00
12-006	TAMU/TEES	$44,494	$42,134.22	$2,359.78
12-011	Environ International	$77,420	$77,410.16	$9.84
12-012	UT-Austin (Hildebrandt)	$79,463	$79,173.94	$289.06
12-012	Environ International	$69,374	$69,372.64	$1.36
12-013	Environ International	$59,974	$59,960.93	$13.07
12-018	UT-Austin (McDonald-Buller)	$85,282	$85,197.80	$84.20
12-018	Environ International	$21,688	$21,686.26	$1.74
12-028	University of Houston	$19,599	$16,586.51	$3,012.49
12-028	UCLA	$17,944	$17,812.95	$131.05
12-028	Environ International	$44,496	$44,496.00	$0.00
12-028	UNC - Chapel Hill	$35,230	$35,230.00	$0.00
12-032	Baylor	$45,972	$43,642.21	$2,329.79
12-TN1	Maryland	$64,994	$64,537.12	$456.88
12-TN2	Maryland	$69,985	$68,362.27	$1,622.73
FY 12 Total Contractual Funding Awarded		$842,500		
FY 12 Contractual Funds Remaining to be Awarded		$0		
FY 12 Contractual Funds Expended to Date			$832,187.66	
FY 12 Contractual Funds Remaining to be Spent				$10,312.34

FY 13 Contractual Funding		$835,000		
FY 13 Contractual Funding Transfers		$2,100,000		
FY 13 Total Contractual Funding		**$2,935,000**		
Project Number		Amount Awarded (Budget)	Cumulative Expenditures	Remaining Balance
13-004	UT-Austin (Torres)	$1,571,124	$819,551.26	$751,572.74
13-005	Chalmers University of Tech	$129,047	$65,698.11	$63,348.89
13-005	University of Houston	$48,506	$44,928.24	$3,577.76
13-016	Valparaiso	$46,652	$38,413.66	$8,238.44
13-016	University of Houston	$19,846	$14,101.40	$5,744.60
13-022	Rice University	$89,912	$75,881.86	$14,030.14
13-022	University of Houston	$116,903	$116,122.47	$780.53
13-024	Maryland	$90,444	$85,185.44	$5,258.56
FY 13 Total Contractual Funding Awarded		$2,112,434		
FY 13 Contractual Funding Remaining to be Awarded		$822,566		
FY 13 Contractual Funds Expended to Date			$1,259,882.44	
FY 13 Contractual Funds Remaining to be Spent				$1,675,117.56
Total Contractual Funding		$3,777,500		
Total Contractual Funding Awarded		$2,954,934		
Total Contractual Funding Remaining to be Awarded		$822,566		
Total Contractual Funds Expended to Date			$2,092,070.10	
Total Contractual Funds Remaining to be Spent				$1,685,429.90

Summary

The expenditure of FY 2012 funds is proceeding as anticipated. It is expected that all FY 2012 funds, including Research/Contractual funds, will be fully expended by April 30, 2014. In December 2013, the AQRP Administration received an extension of the end date of the FY 2012 funds from 12/29/13 to 4/30/14 to facilitate the final expenditures. This will also require budget transfers from the ITAC to the Project Management budget.

Once all FY 2012/2013 projects have been fully invoiced, a total of approximately $1,600,000 is expected to remain in FY 2013 project funds. Approximately half of these funds will remain from Project 13-004, which was reduced in scope due to timing issues related to the purchase of infrastructure equipment.

This will leave approximately $1,600,000 in FY 2013 funds and $825,000 in FY 2014 and FY 2015 funds, respectively, for a total of approximately $3,250,000 in the Research/Contractual budget. Project Management funds remaining from FY 13 may be transferred to the Research/Contractual budget as well. This will be determined in the next quarter.

Appendix A

Financial Reports by Fiscal Year

FY 2010 and 2011

(Expenditures reported as of August 31, 2013.)

Administration Budget (includes Council Expenses)

FY 2010

Budget Category		FY10 Budget	Cumulative Expenditures	Pending Expenditures	Remaining Balance
Personnel/Salary		$202,816.67	$202,816.67	$0.00	$0.00
Fringe Benefits		$38,665.65	$38,665.65	$0.00	$0.00
Travel		$346.85	$346.85	$0.00	$0.00
Supplies		$15,096.14	$15,096.14	$0.00	$0.00
Equipment					
Other					
Contractual					
Total Direct Costs		$256,925.31	$256,925.31	$0.00	$0.00
Authorized Indirect Costs		$20,281.69	$20,281.69	$0.00	$0.00
10% of Salaries and Wages					
Total Costs		**$277,207.00**	**$277,207.00**	**$0.00**	**$0.00**

Administration Budget (includes Council Expenses)

FY 2011

Budget Category		FY11 Budget	Cumulative Expenditures	Pending Expenditures	Remaining Balance
Personnel/Salary		$172,702.06	$172,702.06	$0.00	$0.00
Fringe Benefits		$33,902.95	$33,902.95	$0.00	$0.00
Travel					
Supplies		$101.25	$101.25	$0.00	$0.00
Equipment					
Other					
Contractual					
Total Direct Costs		$206,706.26	$206,706.26	$0.00	$0.00
Authorized Indirect Costs		$17,270.20	$17,270.20	$0.00	$0.00
10% of Salaries and Wages					
Total Costs		**$223,976.46**	**$223,976.46**	**$0.00**	**$0.00**

ITAC Budget
FY 2010

Budget Category		FY10 Budget	Cumulative Expenditures	Pending Expenditures	Remaining Balance
Personnel/Salary					
Fringe Benefits					
Travel		$16,378.86	$16,378.86	$0.00	$0.00
Supplies		$1,039.95	$1,039.95	$0.00	$0.00
Equipment					
Other					
Total Direct Costs		$17,418.81	$17,418.81	$0.00	$0.00
Authorized Indirect Costs					
10% of Salaries and Wages					
Total Costs		**$17,418.81**	**$17,418.81**	**$0.00**	**$0.00**

ITAC Budget
FY 2011

Budget Category		FY11 Budget	Cumulative Expenditures	Pending Expenditures	Remaining Balance
Personnel/Salary					
Fringe Benefits					
Travel		$6,292.97	$6,292.97	$0.00	$0.00
Supplies		$284.67	$284.67	$0.00	$0.00
Equipment					
Other					
Total Direct Costs		$6,577.64	$6,577.64	$0.00	$0.00
Authorized Indirect Costs					
10% of Salaries and Wages					
Total Costs		**$6,577.64**	**$6,577.64**	**$0.00**	**$0.00**

Project Management Budget
FY 2010

Budget Category		FY10 Budget	Cumulative Expenditures	Pending Expenditures	Remaining Balance
Personnel/Salary		$145,337.70	$145,337.70	$0.00	$0.00
Fringe Benefits		$28,967.49	$28,967.49	$0.00	$0.00
Travel					
Supplies		$778.30	$778.30	$0.00	$0.00
Equipment					
Other					
Total Direct Costs		$175,083.49	$175,083.49	$0.00	$0.00
Authorized Indirect Costs		$14,533.77	$14,533.77	$0.00	$0.00
10% of Salaries and Wages					
Total Costs		**$189,617.26**	**$189,617.26**	$0.00	$0.00

Project Management Budget
FY 2011

Budget Category		FY11 Budget	Cumulative Expenditures	Pending Expenditures	Remaining Balance
Personnel/Salary		$121,326.64	$121,326.64	$0.00	$0.00
Fringe Benefits		$23,102.60	$23,102.77	$0.00	($0.17)
Travel					
Supplies		$207.98	$207.92	$0.00	$0.06
Equipment					
Other					
Total Direct Costs		$144,637.22	$144,637.33	$0.00	($0.11)
Authorized Indirect Costs		$12,132.66	$12,132.55	$0.00	$0.11
10% of Salaries and Wages					
Total Costs		**$156,769.88**	**$156,769.88**	$0.00	**$0.00**

AQRP Budget
FY 2010

Budget Category		FY10 Budget	Cumulative Expenditures	Pending Expenditures	Remaining Balance
Personnel/Salary		$202,816.67	$202,816.67	$0.00	$0.00
Fringe Benefits		$38,665.65	$38,665.65	$0.00	$0.00
Travel		$346.85	$346.85	$0.00	$0.00
Supplies		$15,096.14	$15,096.14	$0.00	$0.00
Equipment					
Other					
Contractual		$2,287,827.93	$2,287,827.93	$0.00	$0.00
ITAC		$17,418.81	$17,418.81	$0.00	$0.00
Project Management		$189,617.26	$189,617.26	$0.00	$0.00
Total Direct Costs		$2,751,789.31	$2,751,789.31	$0.00	$0.00
Authorized Indirect Costs		$20,281.69	$20,281.69	$0.00	$0.00
10% of Salaries and Wages					
Total Costs		**$2,772,071.00**	**$2,772,071.00**	**$0.00**	**$0.00**

AQRP Budget

FY 2011

Budget Category		FY11 Budget	Cumulative Expenditures	Pending Expenditures	Remaining Balance
Personnel/Salary		$172,702.06	$172,702.06	$0.00	$0.00
Fringe Benefits		$33,902.95	$33,902.95	$0.00	$0.00
Travel					
Supplies		$101.25	$101.25	$0.00	$0.00
Equipment					
Other					
Contractual		$1,852,440.62	$1,852,440.51	$0.00	$0.11
ITAC		$6,577.64	$6,577.64	$0.00	($0.00)
Project Management		$156,769.88	$156,769.88	$0.00	$0.00
Total Direct Costs		$2,222,494.40	$2,222,494.29	$0.00	$0.11
Authorized Indirect Costs		$17,270.20	$17,270.20	$0.00	$0.00
10% of Salaries and Wages					
Total Costs		**$2,239,764.60**	**$2,239,764.49**	**$0.00**	**$0.11**

Appendix B

Financial Reports by Fiscal Year

FY 2012 and 2013

(Expenditures reported as of February 28, 2014.)

Administration Budget (includes Council Expenses)

FY 2012

Budget Category		FY12 Budget	Cumulative Expenditures	Pending Expenditures	Remaining Balance
Personnel/Salary		$74,238.65	$74,238.65	$0.00	$0.00
Fringe Benefits		$17,068.38	$17,068.38	$0.00	$0.00
Travel		$339.13	$339.13	$0.00	$0.00
Supplies		$3,560.62	$3,559.55	$1.07	$0.00
Equipment					
Other					
Contractual					
Total Direct Costs		$95,206.78	$95,205.71	$1.07	$0.00
Authorized Indirect Costs		$7,423.86	$7,423.86	$0.00	$0.00
10% of Salaries and Wages					
Total Costs		**$102,630.64**	**$102,629.57**	**$1.07**	**$0.00**

Administration Budget (includes Council Expenses)

FY 2013

Budget Category		FY13 Budget	Cumulative Expenditures	Pending Expenditures	Remaining Balance
Personnel/Salary		$265,040.00	$60,807.74	$0.00	$204,232.26
Fringe Benefits		$47,706.00	$14,843.84	$0.00	$32,862.16
Travel		$750.00	$0.00	$0.00	$750.00
Supplies		$10,000.00	$1,764.57	$0.00	$8,235.43
Equipment					
Other					
Contractual					
Total Direct Costs		$323,496.00	$77,416.15	$0.00	$246,079.85
Authorized Indirect Costs		$26,504.00	$6,080.77	$0.00	$20,423.23
10% of Salaries and Wages					
Total Costs		**$350,000.00**	**$83,496.92**	**$0.00**	**$266,503.08**

ITAC Budget
FY 2012

Budget Category		FY12 Budget	Cumulative Expenditures	Pending Expenditures	Remaining Balance
Personnel/Salary					
Fringe Benefits					
Travel		$10,000.00	$5,145.93	$177.38	$4,676.69
Supplies		$500.00	$198.86	$33.00	$268.14
Equipment					
Other					
Contractual					
Total Direct Costs		$10,500.00	$5,344.79	$210.38	$4,944.83
Authorized Indirect Costs					
10% of Salaries and Wages					
Total Costs		**$10,500.00**	**$5,344.79**	**$210.38**	**$4,944.83**

ITAC Budget
FY 2013

Budget Category		FY13 Budget	Cumulative Expenditures	Pending Expenditures	Remaining Balance
Personnel/Salary					
Fringe Benefits					
Travel		$8,000.00	$0.00	$0.00	$8,000.00
Supplies		$2,000.00	$0.00	$0.00	$2,000.00
Equipment					
Other					
Contractual					
Total Direct Costs		$10,000.00	$0.00	$0.00	$10,000.00
Authorized Indirect Costs					
10% of Salaries and Wages					
Total Costs		**$10,000.00**	**$0.00**	**$0.00**	**$10,000.00**

Project Management Budget
FY 2012

Budget Category		FY12 Budget	Cumulative Expenditures	Pending Expenditures	Remaining Balance
Personnel/Salary		$53,385.00	$53,384.46	$0.00	$0.54
Fringe Benefits		$10,984.28	$10,991.04	$0.00	($6.76)
Travel		$0.00	$0.00	$0.00	$0.00
Supplies		$967.98	$967.98	$0.00	$0.00
Equipment					
Other					
Contractual					
Total Direct Costs		$65,337.26	$65,343.48	$0.00	($6.22)
Authorized Indirect Costs		$5,338.50	$5,338.44	$0.00	$0.06
10% of Salaries and Wages					
Total Costs		**$70,675.76**	**$70,681.92**	**$0.00**	**($6.16)**

Project Management Budget
FY 2013

Budget Category		FY13 Budget	Cumulative Expenditures	Pending Expenditures	Remaining Balance
Personnel/Salary		$152,000.00	$30,256.59	$0.00	$121,743.41
Fringe Benefits		$31,800.00	$5,750.32	$0.00	$26,049.68
Travel					
Supplies		$6,000.00	$0.00	$0.00	$6,000.00
Equipment					
Other					
Contractual					
Total Direct Costs		$189,800.00	$36,006.91	$0.00	$153,793.09
Authorized Indirect Costs		$15,200.00	$3,025.66	$0.00	$12,174.34
10% of Salaries and Wages					
Total Costs		**$205,000.00**	**$39,032.57**	**$0.00**	**$165,967.43**

AQRP Budget

FY 2012

Budget Category		**FY12 Budget**	**Cumulative Expenditures**	**Pending Expenditures**	**Remaining Balance**
Personnel/Salary		$74,238.65	$74,238.65	$0.00	$0.00
Fringe Benefits		$17,068.38	$17,068.38	$0.00	$0.00
Travel		$339.13	$339.13	$0.00	$0.00
Supplies		$3,560.62	$3,559.55	$1.07	$0.00
Equipment		$0.00	$0.00	$0.00	$0.00
Other		$0.00	$0.00	$0.00	$0.00
Contractual		$842,500.00	$832,187.66	$0.00	$10,312.34
ITAC		$10,500.00	$5,344.79	$210.38	$4,944.83
Project Management		$70,675.76	$70,681.92	$0.00	($6.16)
Total Direct Costs		$1,018,882.54	$1,003,420.08	$211.45	$15,251.01
Authorized Indirect Costs		$7,423.86	$7,423.86	$0.00	$0.00
10% of Salaries and Wages					
Total Costs		**$1,026,306.40**	**$1,010,843.94**	**$211.45**	**$15,251.01**

AQRP Budget

FY 2013

Budget Category		**FY13 Budget**	**Cumulative Expenditures**	**Pending Expenditures**	**Remaining Balance**
Personnel/Salary		$265,040.00	$60,807.74	$0.00	$204,232.26
Fringe Benefits		$47,706.00	$14,843.84	$0.00	$32,862.16
Travel		$750.00	$0.00	$0.00	$750.00
Supplies		$10,000.00	$1,764.57	$0.00	$8,235.43
Equipment		$0.00	$0.00	$0.00	$0.00
Other		$0.00	$0.00	$0.00	$0.00
Contractual		$2,935,000.00	$1,264,355.88	$0.00	$1,670,644.12
ITAC		$10,000.00	$0.00	$0.00	$10,000.00
Project Management		$205,000.00	$39,032.57	$0.00	$165,967.43
Total Direct Costs		$3,473,496.00	$1,380,804.60	$0.00	$2,092,691.40
Authorized Indirect Costs		$26,504.00	$6,080.77	$0.00	$20,423.23
10% of Salaries and Wages					
Total Costs		**$3,500,000.00**	**$1,386,885.37**	**$0.00**	**$2,113,114.63**

Appendix C

Budgets by Fiscal Year

FY 2014 and 2015

Authorized Expense Budget - FY14		
Budget Category		**FY14**
Personnel/Salary		$70,000.00
Fringe Benefits		$15,150.00
Travel		$350.00
Supplies		$7,500.00
Equipment		
Contractual		$825,000.00
Project Management		$67,500.00
ITAC		$7,500.00
Total Direct Costs		$993,000.00
Authorized Indirect Costs		$7,000.00
10% of Salaries and Wages		
Total Costs		$1,000,000.00
Fringe Rate		22%
Indirect Rate		10% of salaries and wages

No expenditures to date.

Authorized Expense Budget - FY15		
Budget Category		**FY15**
Personnel/Salary		$70,000.00
Fringe Benefits		$15,150.00
Travel		$350.00
Supplies		$7,500.00
Equipment		
Contractual		$825,000.00
Project Management		$67,500.00
ITAC		$7,500.00
Total Direct Costs		$993,000.00
Authorized Indirect Costs		$7,000.00
10% of Salaries and Wages		
Total Costs		$1,000,000.00
Fringe Rate		22%
Indirect Rate		10% of salaries and wages

No expenditures to date.