Review of Louisville/Jefferson County, KY
Air Pollution Control District
Ambient Air Monitoring Operations

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1.0 Introduction

This report presents the results of a review of the Louisville/Jefferson County, KY Metro Air Pollution Control District (APCD) ambient air monitoring operations (APCD AM). The review team consisted of Mr. Jerry Monnig of Inquest Environmental, Inc., and Mr. David Gemmill of David Gemmill Quality Assurance Consulting, LLC.

The review was performed under contract between Inquest Environmental and the Louisville/Jefferson County Metro Government (Metro Government), under Contract No. 3108. David Gemmill performed the work under a separate contract with Inquest Environmental.

This review was conducted in response to unsatisfactory audit findings from recent Technical Systems Audits (TSAs) of the APCD AM performed by the Kentucky Division for Air Quality (KDAQ) and by the U.S. Environmental Protection Agency (EPA) Region 4. The results from these audits are summarized in Section 2.0 below. Section 3.0 presents the scope and narrative of the review process and the associated accomplishments and Section 4.0 presents the review team's findings and recommendations.

1.1 On-Site Visits

The on-site portion of the review was undertaken on three separate trips to Louisville, as follows:

- September 16-20, 2013: Initial APCD AM office and air monitoring network visit by Mr. Monnig. This trip also included a visit with KDAQ personnel in Frankfort, KY.
- October 1-4, 2013: Principal APCD AM visit by Mr. Monnig and Mr. Gemmill.
- October 28-31, 2013: Follow-up visit by Mr. Monnig.

2.0 Background Information

The KDAQ and EPA Region 4 recently conducted TSAs of two key APCD AM measurement areas, including particulate matter less than 2.5 microns ($PM_{2.5}$) and ozone (O_3). The reports from these TSA's identified a wide variety of significant unsatisfactory audit findings and non-conformance areas. These reports also included recommended corrective actions. These unsatisfactory audit findings may affect the validity and defensibility of the $PM_{2.5}$ and O_3 data collected by the APCD AM since 2009 or perhaps earlier.

2.1 Unsatisfactory Findings from $PM_{2.5}$ TSAs

The KDAQ audit was conducted on April 23 and 26, 2013. This TSA addressed the APCD AM weigh lab operations, 2009-2013 data, and the effectiveness of the APCD AM quality system. The unsatisfactory audit findings may affect all of the APCD AM's manually-derived $PM_{2.5}$, PM_{10}, and $PM_{10-2.5}$ data. The EPA Region 4 TSA was conducted during the period of July 30 through August 1, 2013. This second TSA essentially corroborated the findings of the KDAQ

audit, thus only the KDAQ findings are summarized here. In the sections below the number of each finding corresponds to the same numbered finding in the KDAQ audit report. The review team evaluated the audit reports in detail and concurs with all findings and the associated recommended corrective actions

2.1.1 Weigh Laboratory Operations

These findings have been addressed by outsourcing the weigh laboratory operation (see Section 4.1, item #2).

1. The variations in the laboratory temperature and humidity were not being calculated and reviewed.
2. The control limits programmed into the laboratory Access database for temperature, humidity and microbalance checks were incorrect.
3. Field blank data from January 2012 through February 2013 were outside the acceptable limits.
4. Laboratory blank data from January 2012 through February 2013 were outside the acceptable limits.
5. Filter lot stability testing was not being performed correctly.
6. Microbalance checks were not being performed correctly.
7. In 2012 it was determined that static electricity was causing the erroneous data results and the appropriate corrective actions ensued. In early 2013 it was discovered that the laboratory had improper electrical grounding. However, there was no written record of this troubleshooting and corrective action process. Thus, this chain of events could not be recreated on a temporal basis, and therefore the status of the laboratory could not be correlated with the particulate data.
8. The quarterly verifications of the working weight standards were not documented.
9. The forceps for initial and exposed filters were being stored in the same plastic bag.
10. The sample filters were not being properly inspected using a light table.
11. The filter shipment thermometer was not certified.
12. The field blank filter frequency was insufficient.
13. Trip blank filters were not being utilized.
14. Replicate weighings done by an analyst other than the one who performed the original weighing were not documented.
15. Quarterly performance audits of the microbalance were not being conducted using independent standards.

2.1.2 Data Handling

All of these findings should be addressed by the APCD AM by improvements in their field and quality assurance operations (see Section 4.1, item #3). The review team has conducted training as addressed in Section 4.2, item #7. Continued training of APCD AM personnel is recommended.

1. Multiple regulatory requirements were not being followed: 1) the time frame between the 30-day requirement between the initial weight and sampling date; 2) the 7 day, 9-hour requirement for sample retrieval; 3) the post-sample weigh time; and 4) the particulate sampler's coefficient of variance for flow rate was not being reviewed.
2. There was no documentation of the required manual calculations to verify accuracy of the reported mass concentrations.
3. Interval data files from the $PM_{2.5}$ samplers were not being routinely reviewed.
4. The chain-of-custody forms in use did not match the forms presented in the APCD AM QAPP.
5. The following problems were found in the $PM_{2.5}$, PM_{10}, $PM_{10-2.5}$, and Pb data in AQS: 1) inconsistencies were found in data coding that could not be explained by APCD AM staff members; 2) APCD AM staff could not provide documentation as to why some of the data had been invalidated; 3) the Pb data dates did not correspond to the PM_{10} data dates; and 4) there appeared to be missing data on scheduled sample days with no explanation.
6. There was no independent review of the precision and accuracy data files entered into the P&A Transaction Generator.
7. The APCD AM data handling SOP does not detail any of the procedures undertaken by the QAO during the data validation and certification process.

2.1.3 Quality Assurance

Findings #4 through #10 should be addressed by the APCD AM by improvements in their quality assurance operation (see Section 4.1, item #3). Findings #1 through #3 have been addressed with the outsourcing of the weigh laboratory functions.

1. The weigh laboratory analyst had no knowledge of a revised Weigh Lab SOP, indicating that there was little or no communication between the QAO and the analyst.
2. The weigh laboratory analyst's procedures had never been reviewed by the QAO.
3. The QAO had never conducted a systems audit of the weigh laboratory operation.
4. The APCD AM staff did not appear to have a clear understanding of the data quality objectives for the particulate monitoring network or the requirements in the QAPP.
5. The systems audits of the particulate monitoring network conducted by the QAO consisted only of incomplete checklists and they were not issued to the Air Quality Unit Supervisor for any potential follow-up actions.
6. The quality system documents for particulate measurements demonstrated: 1) inconsistencies in terminology and procedures; 2) no updating for five or more years; and 3) no EPA approval of some of the documents.
7. There appeared to be a significant breakdown in the APCD AM corrective actions process as follows: 1) when weigh laboratory quality control data exceeded acceptance limits, no CAR forms were generated; 2) when CAR forms were generated, they did not indicate that any of the generated corrective actions were completed during the field blank investigation; and 3) the APCD AM QAPP stipulates that any staff that perceives the need for corrective action

shall present the situation to the Air Quality Unit Supervisor within 30 days. In 2012, the supervisor was not notified within 30 days of the need for troubleshooting and corrective actions in the weigh laboratory. The KDAQ recommended shortening this communication time down to 5 days.
8. There is no single individual within the APCD AM to track equipment certifications or verifications and therefore ensure that each standard is within specification.
9. Control charts were not utilized.
10. The APCD AM routinely uploaded data into AQS within its internal deadline of 45 days, but the regulatory deadline is 90 days. The KDAQ recommended allowing staff more time to review the data to minimize data entry errors.

2.2 Unsatisfactory Findings from O_3 TSA

The KDAQ audit was conducted on June 26-27 and July 3, 2013. The audit revealed problems with the following: 1) inadequate and incomplete O_3 transfer standard verification records; 2) problems in general operations; 2) site-specific issues; 3) inadequate logbook documentation; and 4) inadequate quality assurance procedures. Further, there were multiple data handling errors identified in the APCD AM O_3 AQS dataset. As a result of these unsatisfactory audit findings the following actions by APCD AM are required: 1) corrections in the AQS database must be made; 2) the O_3 data must be re-certified; and 3) the APCD AM O_3 monitoring operation must be brought into and maintained in compliance with all appropriate EPA regulations and guideline documents.

As mentioned in the KDAQ audit report, the technical requirements for monitoring O_3 are intricate, thus the findings in the report are lengthy and complex. However, the review team evaluated the audit report in detail and concurs with all findings and the associated recommended corrective actions. The following is a summary of the findings presented at the end of the TSA report. These findings apply to all 2009-2013 APCD AM O_3 data.

1. Several internal performance audits of the monitoring network O_3 analyzers had been conducted using a transfer standard that had not been verified with a higher-level O_3 transfer standard within the required 6 months. The review of verification records for the APCD AM O_3 transfer standards was inconclusive because of poor record keeping and requires further investigation on the part of APCD AM. At a minimum, all 2009-2013 records should be scrutinized.
2. Numerous hours of O_3 data must be invalidated in the AQS database because of procedural deviations and because of routine ambient analyzer calibration data being erroneously uploaded into AQS as ambient data.
3. Qualifier flags must be added to large portions of the APCD AM O_3 dataset to account for procedural deviations and/or exceedances of quality control limits.
4. A review of the agency's 2009-2013 O_3 precision and accuracy dataset is needed.
5. After monitoring equipment is repaired and verified, the results of that work are not routinely

reviewed by an independent party (i.e., quality assurance staff) prior to the equipment being deployed into the field.
6. The quality assurance staff is not continuously tracking O_3 transfer standard verifications to ensure that all regulatory and technical assistance document requirements are being successfully met and maintained over time.
7. The monitoring station operators are not adhering to SOPs. The procedures being performed vary from site to site or technician to technician.
8. Documentation is insufficient.
9. During this audit, the KDAQ auditors spent an excessive amount of time trying to locate records. Thus, the APCD AM's filing/archiving system needs significant improvement.
10. The O_3 monitoring stations are equipped with different instrument types. The stations should be standardized.
11. The current Ozone SOP should be revised. Moreover, additional SOPs should be developed that address equipment acceptance testing and verifications.
12. The APCD AM's quality assurance program is ineffective; questionable data and procedures are being overlooked.
13. The APCD AM staff needs additional training in all aspects of air monitoring: equipment operations, documentation requirements, data review, and ultimately an understanding of the required procedures.

3.0 Scope of Review and Accomplishments

The RFP and the Inquest proposal dated August 29, 2013, provided for the following scope of work:

1. A formal TSA, conducted per the requirements in the EPA guidance document listed in Section 3.1.1 below.
2. Recommendations of new equipment, technology, and software.
3. Cost estimates to purchase/upgrade the recommended systems/network monitoring systems.

After the initial review of the status of the APCD AM and discussions with key Metro Government and APCD personnel, it was determined that it would not be necessary or cost effective to conduct another TSA, particularly since recent TSAs that had been conducted by the KDAQ and EPA Region 4. Therefore, in lieu of a TSA, the scope of work was modified to focus on response to selected unsatisfactory TSA findings listed in Section 2.0 above, and to initiate standardization of the pneumatic and electrical systems in the APCD AM monitoring stations. Accordingly, three on-site visits were undertaken instead of the single visit specified in the Inquest proposal. The modifications to the scope of work suggested by the review team were approved and supported by the Louisville/Jefferson County Metro Government. The consensus was that a flexible, dynamic strategy would provide the most efficient and cost-effective means to assist the APCD AM in initiating the necessary corrective actions and quality improvements to

bring its air monitoring operations into compliance with federal and state regulations and guidelines.

The review was performed within the three phases described below.

3.1 Preparation

This phase included: 1) establishing initial contacts with the APCD and KDAQ; 2) reviewing relevant and APCD AM project documentation; 3) reviewing the recent TSAs; and 4) planning and scheduling the on-site visits.

3.1.1 Reference Documents

Implicit in the review process is the review team's familiarity with the documents listed below. These documents form the basis of an ambient air monitoring operation that produces valid and defensible data.

- Code of Federal Regulations, Chapter 40, Part 50 (40 CFR 50) (appropriate appendices)
- 40 CFR 53 (appropriate subparts)
- 40 CFR 58, Appendices A, D, and E
- "Guideline on the Meaning and the Use of Precision and Bias Data Required by 40 CFR 58 Appendix A," Version 1.1, EPA-454/B-07-001, October 2007
- "EPA Guidance on Technical Audits and Related Assessments for Environmental Data Operations," EPA QA/G-7, EPA/600/R-99/080, January 2000
- "Quality Assurance Handbook for Air Pollution Measurement Systems," Volume II: Ambient Air Measurements, EPA-454/B-13-003, May 2013
- "Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV: Meteorological Measurements," EPA-454/B-08-002, March 2008
- "EPA Requirements for Quality Assurance Project Plans," EPA QA/R-5, EPA/240/B-01/003, March 2001
- "Guidance for Preparing Standard Operating Procedures (SOPs)," EPA/240/B-01/004, March 2001
- "Technical Assistance Document: Transfer Standards for the Calibration of Air Monitoring Analyzers for Ozone," EPA-454/B-10-001, November 2010
- "EPA Traceability Protocol for Assay and Certification of Gaseous Calibration Standards" EPA/600R-12/531, May 2012
- "Quality Assurance Guidance Document 2.12: Monitoring $PM_{2.5}$ in Ambient Air Using Designated Reference or Class I Equivalent Methods," November 1998

3.1.2 APCD Documents

The project team reviewed the APCD AM documents that are specific to its ambient air monitoring operations. These documents are listed below.

- "Louisville Metro Air Pollution Control District Quality Management Plan," June 11, 2013
- "Quality Assurance Project Plan for the Louisville Metro Air Pollution Control District Ambient Air Quality Monitoring Program," Version 2, November 2009
- "Quality Assurance Project Plan for the Louisville Metro Air Pollution Control District NCore Ambient Air Quality Monitoring Program," Version 1.0, June 2010
- "Gravimetric Analysis for Measurement of Fine Particulate Matter as $PM_{2.5}$ (Standard Operating Procedure (SOP) Using Mettler MT5 Microbalance in Support of the Federal Reference Method for Measuring $PM_{2.5}$)," (AQ-PMF2), Version 1.4, November 8, 2007
- "Gravimetric Analysis for Measurement of Fine Particulate Matter as PM_{10C}, $PM_{2.5}$, and Pb-PM_{10} (Standard Operating Procedure (SOP) Using Mettler MT5 Microbalance), Version 2.0, July 3, 2013
- "Standard Operating Procedure for Monitoring Particulate Matter in Ambient Air Utilizing Met One BAM Model 1020," Version 1.2, February 14, 2012
- "Standard Operating Procedure for Rupprecht and Patashnick TEOM Model 1400A/B," Revision 4, February 2002
- "Data Handling and Custody, Standard Operating Procedure for Collecting, Processing, and Reporting Ambient Air Quality Data," QA-Data, Version 1.0, February 2009
- "Field Operations for Measurement of Lead as PM10C, Standard Operating Procedure (SOP) Using Rupprecht & Patashnick or TEI Partisol-Plus 2025 RFPS-0498-118," Version 1.2, May 19, 2011
- "Field Operations for Meteorological Measurements Standard Operating Procedure (SOP)," Version 1.1, January 13, 2012
- "Standard Operating Procedure for Nitrogen Oxides Monitoring, Performance Testing Utilizing Thermo Environmental 42C Series NO_x Analyzer," Revision 1.0, June 10, 2002
- "Standard Operating Procedure for Monitoring of Ozone in Ambient Air Utilizing Thermo Environmental Instruments Model 49 Ozone Analyzers," Version 2.0, September 1, 2010
- "Standard Operating Procedure for Sulfur Dioxide in Ambient Air Utilizing Thermo Electron Model 43C SO_2 Analyzer EQSA-0486-060," Version 2.0, May 12, 2011

3.1.3 Recent TSA reports

The project team reviewed the TSA reports listed below. These reports are summarized in Section 2.0 above and identify the problems currently encountered by the APCD AM.

- "Technical Systems Audit of LMAPCD $PM_{2.5}$ Weigh Lab Operations," conducted April 23 and 26, 2013, Kentucky Division for Air Quality, Technical Services Branch
- "Technical Systems Audit of the APCD $PM_{2.5}$ Weigh Laboratory," conducted July 30 – August 1, 2013, EPA Region 4 Science and Ecosystem Support Division
- "Technical Systems Audit for Ozone," conducted June 26-27 and July 3, 2013, Kentucky Division for Air Quality, Technical Services Branch

3.2 On-Site Visits

3.2.1 Initial Visit

The initial visit occurred during the period of September 16-20, 2013. The following tasks were completed:

1. The review team, key members of the APCD staff, and Metro Government became familiarized with one another.
2. Through discussions with key personnel, the functionality of the air monitoring group as an organization was studied.
3. An inspection of the APCD AM seven-station ambient air monitoring network was begun to determine its current status and conformity with the appropriate EPA regulations and guideline documents.
4. The APCD AM office and laboratory facilities were inspected.
5. A debriefing was obtained from the KDAQ personnel in Frankfort, KY who performed the TSAs described in Section 2.0 above. This enabled the review team to avoid duplication of efforts previously undertaken by the KDAQ.

The week of September 23, 2013, was spent in further document review and assisting the APCD AM in establishing priorities. Quoted costs for the $PM_{2.5}$ laboratory filter outsourcing were obtained and forwarded to the APCD. Alternative organizational structures for an air quality monitoring department were developed and provided. General air quality monitoring organizational positions' roles and responsibilities were assembled and presented.

3.2.2 Principal Visit

The principal visit was undertaken during the period of October 1-4, 2013. The following tasks were completed:

1. The APCD AM organizational structure, lines of authority, responsibilities within the key APCD AM positions, information flow, and the corrective action process were reviewed.
2. Key APCD personnel were interviewed to review the overall effectiveness of the management of the organization.
3. An additional inspection of the APCD AM office and laboratory facilities was conducted.
4. A review of the improvements underway in the APCD AM data collection, validation and reporting process was conducted.
5. The current process of correcting the historical data for $PM_{2.5}$ and O_3 was reviewed.
6. The APCD AM filter weigh room operation that supports the particulate measurements was inspected and evaluated.
7. The improvements underway in the APCD AM documentation and record keeping process were reviewed.
8. An additional debriefing from the KDAQ personnel was obtained.

9. The inspection of the APCD AM seven-station ambient air monitoring network was concluded.
10. The Cannons Lane (NCore) monitoring station pneumatic and electrical systems were updated. This will serve as a model for the updating of the other six monitoring stations.
11. Hands-on training was provided to selected APCD AM staff in areas where deficiencies were discovered including documentation, quality assurance procedures, and quality control activities.

3.2.3 Follow-up Visit

A follow-up visit was undertaken during the period of October 28-31, 2013. The following tasks were completed:

1. Further work was performed on standardizing the Watson Lane and Bates Elementary monitoring stations.
2. The O3 calibrator at the Cannons Lane station received routine maintenance and was re-verified with the APCD AM level 2 O_3 standards.
3. Continued training of APCD AM staff was provided on documentation, quality assurance procedures, and quality control activities.

3.3 Final Report

This final phase involved the assimilation and analysis of the information collected during the review process and documenting the results in this report.

4.0 Recommendations

The findings and recommendations of the review team are presented below. Other recommendations may be presented at a later date. The recommendations presented herein include two principal groups of suggested actions: 1) corrections to the historical data; and 2) initiating improvements to the APCD AM operation to ensure that such unsatisfactory audit results do not recur in the future.

This is a difficult process and it will take an extensive amount of time and resources to implement the recommendations by KDAQ and the review team to bring the APCD AM into compliance in all problem areas.

4.1 Response to TSAs

1. The highest priority should be given to re-validation of the $PM_{2.5}$ and O_3 and data at least as far back as 2009 to the present. This work is in-process by APCD AM quality assurance personnel, and the corrected qualifier codes for both pollutants are being entered into AQS. This task is difficult and tedious because of past poor record keeping. However, the work has been formalized by the quality assurance staff with clear objectives, a timeline, and is well documented. The quality assurance staff is working closely with the air monitoring

supervisor, who devised a coding guide and continues to refine the documentation process. After all the files have been corrected, the data in AQS should be reviewed for accuracy by a different person than the person who performed the corrections. After this review is completed, the APCD AM must request a review of the corrected datasets in AQS from the KDAQ and/or EPA Region 4 and then re-certify the data. This will allow any pending NAAQS designation decisions to move forward, and end the current uncertainties concerning attainment status for $PM_{2.5}$ and O_3.

2. Early on in the review process it was recommended that the weigh laboratory operation be outsourced. The APCD has accepted this recommendation and is establishing a contract with a qualified laboratory. By outsourcing this function, APCD has addressed the group of unsatisfactory audit findings in the $PM_{2.5}$ TSA presented in Section 2.1 above. The new laboratory contractor will have the responsibility of maintaining the required laboratory standards and procedures, as well as providing APCD AM with the necessary data reports and data entry into AQS. Further, since the APCD AM laboratory was processing only about 50 filters per month, this change is cost-effective.

3. Each of the unsatisfactory $PM_{2.5}$ audit findings presented in Section 2.1.2 above must be addressed by a coordinated effort by the quality assurance staff and field operations. The unsatisfactory findings in items #4-10 in Section 2.1.3 above must be addressed by the quality assurance staff.

4.2 Quality Assurance Improvements

1. A critical recurring theme in the TSAs was that the quality assurance component of the data validation and reporting process was deficient. This indicates that the previous Quality Assurance Officer (QAO) was ineffective and that the organization suffers from a weak quality system. The review team asserts that a robust quality assurance system is crucial to the success of any organization conducting compliance ambient air monitoring. The QAO position has been filled by a qualified staff member. The new QAO should implement and maintain an organization-wide, proactive quality system. In addition, the position of QAO within the organization should be changed to directly report to the Executive Director.

2. The QAO should be supported by qualified staff members and be provided sufficient resources to carry out the many responsibilities of this position. A critical problem identified in the O_3 TSA is that several audits of the monitoring network O_3 analyzers were performed using a transfer standard that had not been verified with a higher level O_3 transfer standard within the six months specified by the EPA Technical Assistance Document (listed in Section 3.1.1 above). This led to inadequate accuracy statistics for the annual O_3 datasets, which in turn could lead to an unclassifiable designation for O_3 in the Metropolitan Statistical Area. The quality assurance technician that conducts these audits occupies a critical position that should only be held by a person who is fully qualified. The person who fills this position

should have experience in conducting performance audits, have proficiency in associated technology tools such as Excel, and be familiar with all associated quality assurance regulations and guideline documents.

3. The APCD AM O_3 transfer standard system that supports the O_3 measurements must be brought into full compliance with the EPA Technical Assistance Document.

4. Performance and system audit schedules, and equipment certifications and verifications must be established, tracked, and documented by the QAO. The purchase of data acquisition system (DAS) support modules will automate data validation and enable the QAO to expedite quality reports.

5. The QAO must assume responsibility for tracking the certifications and verifications of all standards used in the monitoring network to ensure that each standard is operated only within the time period in which the standard is valid. The QAO should also initiate timely re-certifications or re-verifications before the certifications or verifications have expired.

6. The APCD AM QAPP requires that the QAO confirm that all staff can perform their respective duties correctly. Related to this topic, the quality assurance staff should develop an internal systems audit process, complete with all critical subject areas and timelines.

7. The review team worked several days with the new quality assurance staff members. They demonstrated proficiency in reviewing the discrepancies in the APCD AM data in AQS and correcting the coding errors identified in the TSAs. Further, they are initiating improvements in the APCD AM data collection, validation and reporting process and in the documentation and record keeping system. It must be assured by management that these staff members have the necessary resources to complete these tasks and to establish and maintain a new quality system. It should be emphasized that this quality system will not simply reside in a department, but it must permeate throughout the entire organization. Additional on-site training, mentoring, and assistance should be provided to the quality assurance staff where needed.

4.3 Organizational Structure and Management

1. Early in the review process it appeared that the organizational structure of the air quality monitoring section was not conducive to the efficient production of reliable and defensible ambient air monitoring data. This problem was particularly acute in the quality assurance section. Communication and the peer review process within the air quality monitoring section appeared to be hindered by a lack of continuity in the organization. Thus it was recommended that the air quality monitoring section be reorganized. An alternative organizational structure, complete with example job descriptions, was presented for consideration; these recommendations are currently under review by the APCD. The review

team also recommends that the responsibilities associated with each position be clearly defined and emphasis should be placed entirely on the qualifications (formal education and related experience) and the communication skills of the prospective employee filling the position. Concurrent with this reorganization, it is essential that clear lines of communication must be designed, established, and maintained throughout the organization.

2. The changes in organizational structure recommended above will not be effective without concurrent changes in the APCD organizational culture. The present APCD AM culture is generally weak, as there appears to be little internal alignment with organizational values, and the work process typically operates through extensive procedures and bureaucracy. However, the culture can be changed, emanating from a commitment from management. The review team recommends gradually aiming towards a stronger organizational culture, where the performance of tasks is (at least in part) motivated by alignment to organizational values. This can be attained by the formulation of a new strategic vision by top management that provides the catalyst, intent, and direction for the change. It will be necessary to identify what current systems, policies, and procedures need to be changed in order to align with this new organizational culture. At the conclusion of this change, each person should be able to describe their job responsibilities as a process and understand the importance of their role in the overall mission of the organization, and the communication within the organization is dynamic and effective.

3. The Metro Government human resource department should coordinate more closely with the APCD to become familiar with the inner workings and mission of the APCD AM. This coordination would help ease and simplify the reorganization process and improve communications between the APCD and the Metro Government.

4. The APCD is located at a facility in which the organization is scattered amongst different areas of several buildings. This precludes contact and communication between staff members and discourages a unified team concept. The Metro Government indicated that the APCD will soon be moving to a new facility. It is recommended that the Metro Government expedite this move and to choose a facility that better accommodates the organizational needs of the APCD AM.

4.4 Formal Documents

1. Key APCD AM managers and staff members should be familiarized with or periodically review the reference documents listed in Section 3.1.1 above.

2. The APCD documents that support the ambient air measurements (see Section 3.1.2 above) generally comply with EPA requirements and guidelines. However, in some cases the documents are over 10 years old and lack internal consistency. Therefore it is recommended that the Quality Management Plan (QMP), the two QAPPs, and all associated SOPs be

reviewed and revised by qualified personnel familiar with the related processes. Additional SOPs should be added, as necessary. It should be noted that all updated and/or new QAPPs and SOPs must be submitted to EPA Region 4 for approval.

3. The QAO should review the new QAPPs and SOPs to ensure internal consistency. The SOPs should then be made available to all air quality personnel, who must clearly understand and follow the SOPs while performing their designated tasks. Training sessions should be held to update staff on changes to SOPs and to ensure that all staff members understand the procedural requirements described in the SOPs, including the need for all staff members to apply the procedures uniformly across the monitoring network. Management should periodically emphasize to staff members the importance of adhering to the procedures presented in the SOPs. However, note comment #4 below.

4. The SOPs, as written, must comply with the EPA guideline document for Standard Operating Procedures (see Section 3.1.1 above). However, while these SOPs are 'approvable for use' they are lengthy, repetitive, and difficult to read. Accordingly, it is recommended that the SOPs be revised to improve their usefulness and readability. As an alternative, abridged versions, of these SOPs could be developed that contain only the necessary essence of the procedure. Such abridged versions should be approved by EPA for training purposes only and included as appendices to the current SOPs.

5. In the QAPPs the specified time from when staff members encounter a technical problem to when the problem must be reported in a Corrective Action Report is 30 days. This period should be shortened. The KDAQ recommended that this time be changed to 5 days; the review team recommends no longer than 5 days with a goal of 3 days.

6. The Data Handling SOP must be updated to include the activities employed by the QAO to validate and certify the monitoring data.

7. The SOPs for particulate measurements must be updated per the outsourcing of weigh room responsibilities and per the TSA finding in Section 2.1.3, item #6 above.

4.5 Monitoring Stations

1. The pneumatic and electrical systems at the Cannons Lane NCore, Watson Lane, and Bates Elementary monitoring stations have been modified per the recommendations in the TSAs. The modifications were made as a step towards the standardization of the air monitoring stations throughout the network and to bring them into better conformance with guidelines. Further, equipment purchases are planned to upgrade key components of the stations including analyzers and calibration equipment. See Table 1 below for a detailed equipment list.

2. The APCD AM should continue to standardize the configurations of and equipment within the monitoring stations. This recommendation is intended to simplify and standardize station operation activities, not because of any questions concerning the validity of the historical data. The new station designs should be documented in a new station operation SOP.

3. The DAS are being updated to include software modules that enable the air quality technicians and the quality assurance staff to further automate the data validation process. The upgraded DAS modules include support for real time telemetry networks and enhanced data collection platforms.

4. Several additional software modules from Agilaire LLC should be purchased and put into use to supplement the DAS. At a minimum, the following software modules should be considered: 1) automated data validation processor; 2) inventory control module; and 3) direct poll licenses for the $PM_{2.5}$ Thermo Model 2025 $PM_{2.5}$ samplers.

5. The APCD AM should obtain the assistance of Agilaire LLC to provide consultation and hardware for the completion of the automation of the DAS over the entire monitoring network costs associated with the automation is not included in the table below.

6. The equipment listed below is recommended for purchase by the APCD AM in order to standardize and update the existing equipment. The equipment purchased for the Cannons Lane monitoring station must comply with specifications for supporting an NCore monitoring station. The estimated cost for items listed in Section 4.5, item 3 and equipment listed below in Table 1 is $264,383.00.

Table 1
Itemized Equipment Cost Summary

Description	Quantity	Cost	Total
Ozone calibrators	2	$10,250.00	$20,500.00
Gas dilution calibrator	2	$10,250.00	$20,500.00
Zero air generators	3	$5,660.00	$16,980.00
Ozone analyzer	1	$7,965.00	$7,965.00
SO2 analyzer	2	$11,655.00	$23,310.00
PM 2.5 FRM	6	$14,000.00	$84,000.00
Direct poll licenses for FRM	1	$5,000.00	$5,000.00
Agilaire inventory module	1	$3,000.00	$3,000.00
Agilaire ADVP module	1	$6,500.00	$6,500.00
NCore trace-level SO2 analyzer	1	$11,655.00	$11,655.00
NCore O3 analyzer	1	$7,965.00	$7,965.00
NCore trace-level NO2 analyzer	1	$11,070.00	$11,070.00
NCore trace-level CO analyzer	1	$13,800.00	$13,800.00
NCore trace-level NOy analyzer	1	$21,888.00	$21,888.00

Description	Quantity	Cost	Total
NCore O3 calibrator	1	$10,250.00	$10,250.00

4.6 Documentation of Tasks

1. Another recurring theme noted in the TSAs is a lack of proper documentation. This has led to uncertainties about the reported data in AQS. All APCD AM maintenance, calibration and verification operations must be meticulously recorded, disseminated, and filed by the technicians performing these tasks. Quality assurance staff and managers must be able to track the performance and maintenance of each analyzer, calibrator, and particulate sampler through an unbroken chain of easily retrievable documentation that describes all the operations that have been performed on the equipment. The APCD AM should therefore include a new records management policy for document control in associated QAPP's and related SOP's. Copies of all maintenance, calibration, verification, and repair documentation should be kept at the monitoring stations and the support laboratory.

   A quality assurance program associated with the collection of ambient air monitoring data must include an effective procedure for demonstrating the integrity of the data per EPA regulations and guideline documents. Data cannot be uploaded into AQS until it has undergone an extensive validation procedure. An important part of this procedure includes reviewing the documentation that supports the instrument that made the measurements, as well as the calibration system that established the accuracy of the instrument. Each step in the sampling and analysis procedure must be carefully documented. There are basically four elements in a comprehensive documentation program:

   1) Data collection - includes measurement preparation and identification of the sample, sample location and sample time. It also includes the conditions during the measurements in the form of data sheets, logbooks and raw data.
   2) Sample and/or measurement result handling - includes evidence that the sample and data were protected from contamination and tampering during transfer between people and from the sampling site to the laboratory and during analysis, transmittal, and storage. This process is documented in chain of custody forms.
   3) Analysis - includes evidence that samples and data were properly stored prior to and after analysis, interpretation and reporting.
   4) Preparation and filing of measurement report(s) - includes evidentiary requirements and retention of records.

Failure to include any one of these elements in the collection and analysis of ambient air monitoring data may render the measurements inadmissible, or may seriously undermine the credibility of any report or decisions based on the monitoring data.

2. A standardized format should be utilized in all field and laboratory notebooks to ensure that

all necessary information is recorded. The format should be designed to clearly identify important conditions during the measurements, i.e., the date and time, location of the measurement station, actions taken, and operating personnel. This information supports the credibility of the data and should not be erased or altered. Everything should be documented thoroughly from data collection through data use. Data usability, for the future as well as the present applications, depends to a significant extent on how well these details are documented. Training with APCD AM personnel concerning laboratory notebooks has been conducted by the review team (see Section 3.2.2, item 11).

3. Currently, APCD AM logbooks are kept for each analyzer within the network. While it is acceptable to maintain equipment logbooks, it is recommended that these logbooks be replaced with equipment maintenance and repair sheets. Each monitoring station should have a dedicated logbook that a record of all activities and documents all operations and procedures performed on all analyzers and calibrators located at that particular monitoring station.

4.7 Training

1. Another problem mentioned in the TSAs is in the knowledge of selected APCD AM staff members. Personnel assigned to ambient air monitoring activities are expected to have the education, work experience, and specialized training required for their positions. Records on personnel qualifications and training should be maintained and accessible during audit and review activities. Appropriate training should be available to staff members that correspond to their duties. Such training may consist of classroom lectures, workshops, web-based courses, teleconferences, vendor provided training, and on-the-job training. APCD AM has attended workshops conducted by KDAQ to provide training on the fundamental guidelines of ambient air quality monitoring. KDAQ has been supportive in the effort to provide such training as can be provided with their limited resources. On-site training has been provided by the review team during its visits to APCD. Additional hands-on training at the APCD facility and the air monitoring stations would be beneficial to the staff and is strongly recommended.

APPENDIX A – SUMMARY

"Technical Systems Audit of LMAPCD $PM_{2.5}$ Weigh Lab Operations," conducted April 23 and 26, 2013, Kentucky Division for Air Quality, Technical Services Branch		
Findings	**Recommendations**	**Status**
Weigh Lab Operations 1. The variations in the laboratory temperature and humidity were not being calculated and reviewed. 2. The control limits programmed into the laboratory Access database for temperature, humidity and microbalance checks were incorrect. 3. Field blank data from January 2012 through February 2013 were outside the acceptable limits. 4. Laboratory blank data from January 2012 through February 2013 were outside the acceptable limits. 5. Filter lot stability testing was not being performed correctly. 6. Microbalance checks were not being performed correctly. 7. In 2012 it was determined that static electricity was causing the erroneous data results and the appropriate corrective actions ensued. In early 2013 it was discovered that the laboratory had improper electrical grounding. However, there was no written record of this troubleshooting and corrective action process. Thus, this chain of events could not be recreated on a temporal basis, and therefore the status of the laboratory could not be correlated with the particulate data. 8. The quarterly verifications of the working weight standards were not documented.	Outsource the weigh lab operations	Weigh lab bids have been evaluated and a recommendation made. Metro working on a contract now.

"Technical Systems Audit of LMAPCD $PM_{2.5}$ Weigh Lab Operations," conducted April 23 and 26, 2013, Kentucky Division for Air Quality, Technical Services Branch		
Findings	**Recommendations**	**Status**
9. The forceps for initial and exposed filters were being stored in the same plastic bag. 10. The sample filters were not being properly inspected using a light table. 11. The filter shipment thermometer was not certified. 12. The field blank filter frequency was insufficient. 13. Trip blank filters were not being utilized. 14. Replicate weighings done by an analyst other than the one who performed the original weighing were not documented. 15. Quarterly performance audits of the microbalance were not being conducted using independent standards.		
Data Handling 1. Multiple regulatory requirements were not being followed: 1) the time frame between the 30-day requirement between the initial weight and sampling date; 2) the 7 day, 9-hour requirement for sample retrieval; 3) the post-sample weigh time; and 4) the particulate sampler's coefficient of variance for flow rate was not being reviewed. 2. There was no documentation of the required manual calculations to verify accuracy of the reported mass concentrations. 3. Interval data files from the $PM_{2.5}$ samplers were not being routinely reviewed.	1. The highest priority should be given to re-validation of the PM2.5 and data at least as far back as 2009 to the present. 2. Each of the unsatisfactory PM2.5 audit findings presented must be addressed by a coordinated effort by the quality assurance staff and field operations. 3. Initiate improvements in the APCD AM data collection, validation and reporting process and in the documentation and record keeping system.	1. Working to complete 2009-2011 review. 2. Most findings will be resolved by lab outsourcing. The contract lab will provide tracking / documentation for items 1-3. Contract lab will provide forms for #4. #5 has been addressed

"Technical Systems Audit of LMAPCD $PM_{2.5}$ Weigh Lab Operations," conducted April 23 and 26, 2013, Kentucky Division for Air Quality, Technical Services Branch		
Findings	**Recommendations**	**Status**
4. The chain-of-custody forms in use did not match the forms presented in the APCD AM QAPP. 5. The following problems were found in the $PM_{2.5}$, PM_{10}, $PM_{10-2.5}$, and Pb data in AQS: 1) inconsistencies were found in data coding that could not be explained by APCD AM staff members; 2) APCD AM staff could not provide documentation as to why some of the data had been invalidated; 3) the Pb data dates did not correspond to the PM_{10} data dates; and 4) there appeared to be missing data on scheduled sample days with no explanation. 6. There was no independent review of the precision and accuracy data files entered into the P&A Transaction Generator. 7. The APCD AM data handling SOP does not detail any of the procedures undertaken by the QAO during the data validation and certification process.	4. On-site training, mentoring, and assistance should be provided to the staff where needed.	by development of a uniform coding manual, addition of final supervisor review of AQS data (Pb dates and missing data are part). 3. Improvement in data handling in progress, documentation and record keeping will be aided by purchase of DAS modules. 4. #6 has been resolved. P&A independently reviewed monthly. 5. #7 will be future implementation. Extensive review of data handling with new DAS is necessary.
Quality Assurance 1. The weigh laboratory analyst had no knowledge of a revised Weigh Lab	1. Findings #1 through #3 have been addressed with the	1. See above for lab contract

"Technical Systems Audit of LMAPCD $PM_{2.5}$ Weigh Lab Operations," conducted April 23 and 26, 2013, Kentucky Division for Air Quality, Technical Services Branch		
Findings	**Recommendations**	**Status**
SOP, indicating that there was little or no communication between the QAO and the analyst. 2. The weigh laboratory analyst's procedures had never been reviewed by the QAO. 3. The QAO had never conducted a systems audit of the weigh laboratory operation. 4. The APCD AM staff did not appear to have a clear understanding of the data quality objectives for the particulate monitoring network or the requirements in the QAPP. 5. The systems audits of the particulate monitoring network conducted by the QAO consisted only of incomplete checklists and they were not issued to the Air Quality Unit Supervisor for any potential follow-up actions. 6. The quality system documents for particulate measurements demonstrated: 1) inconsistencies in terminology and procedures; 2) no updating for five or more years; and 3) no EPA approval of some of the documents. 7. There appeared to be a significant breakdown in the APCD AM corrective actions process as follows: 1) when weigh laboratory quality control data exceeded acceptance limits, no CAR forms were generated; 2) when CAR forms were generated, they did not indicate that any of the generated corrective actions were completed during the field blank investigation; and 3) the APCD AM	outsourcing of the weigh lab outsourcing. 2. Findings #4 through #10 should be addressed by the APCD AM by improvements in their quality assurance operation. 3. A critical recurring theme in the TSAs was that the quality assurance component of the data validation and reporting process was deficient. The review team asserts that a robust quality assurance system is crucial to the success of any organization conducting compliance ambient air monitoring. The QAO position has been filled by a qualified staff member. The new QAO should implement and maintain an organization-wide, proactive quality system. In addition, the position of QAO within the organization should be changed to directly report to the Executive Director. 4. Update formal documents. 5. Reorganization of air quality monitoring section.	status. 2. The items in this section are more complex systematic issues that will take time to develop. Critical issue is the development of QA and data sections that will operate with cooperation. 3. Top priority to update PM documents once lab contract is complete.

"Technical Systems Audit of LMAPCD $PM_{2.5}$ Weigh Lab Operations," conducted April 23 and 26, 2013, Kentucky Division for Air Quality, Technical Services Branch		
Findings	**Recommendations**	**Status**
QAPP stipulates that any staff that perceives the need for corrective action shall present the situation to the Air Quality Unit Supervisor within 30 days. In 2012, the supervisor was not notified within 30 days of the need for troubleshooting and corrective actions in the weigh laboratory. The KDAQ recommended shortening this communication time down to 5 days. 8. There is no single individual within the APCD AM to track equipment certifications or verifications and therefore ensure that each standard is within specification. 9. Control charts were not utilized. 10. The APCD AM routinely uploaded data into AQS within its internal deadline of 45 days, but the regulatory deadline is 90 days. The KDAQ recommended allowing staff more time to review the data to minimize data entry errors.		

"Technical Systems Audit of the APCD $PM_{2.5}$ Weigh Laboratory," conducted July 30 – August 1, 2013, EPA Region 4 Science and Ecosystem Support Division		
Findings	**Recommendations**	**Status**
Corroborated the findings of "Technical Systems Audit of LMAPCD $PM_{2.5}$ Weigh Lab Operations," conducted April 23 and 26, 2013, Kentucky Division for Air Quality, Technical Services Branch	Refer to "Recommendations" for "Technical Systems Audit of LMAPCD $PM_{2.5}$ Weigh Lab Operations," conducted April 23 and 26, 2013, Kentucky Division for Air Quality, Technical Services Branch, listed above	In-progress

"Technical Systems Audit for Ozone," conducted June 26-27 and July 3, 2013, Kentucky Division for Air Quality, Technical Services Branch		
Findings	**Recommendations**	**Status**
1. Several internal performance audits of the monitoring network O_3 analyzers had been conducted using a transfer standard that had not been verified with a higher-level O_3 transfer standard within the required 6 months. The review of verification records for the APCD AM O_3 transfer standards was inconclusive because of poor record keeping and requires further investigation on the part of APCD AM. At a minimum, all 2009-2013 records should be scrutinized. 2. Numerous hours of O_3 data must be invalidated in the AQS database because of procedural deviations and because of routine ambient analyzer calibration data being erroneously uploaded into AQS as ambient data. 3. Qualifier flags must be added to large portions of the APCD AM O_3 dataset to account for procedural deviations and/or exceedances of quality control limits. 4. A review of the agency's 2009-2013 O_3 precision and accuracy dataset is needed. 5. After monitoring equipment is repaired and verified, the results of that work are not routinely reviewed by an independent party (i.e., quality assurance staff) prior to the equipment being deployed into the field. 6. The quality assurance staff is not continuously tracking O_3 transfer	1. Corrections in the AQS database must be made. 2. The O3 data must be re-certified. 3. The APCD AM O3 monitoring operation must be brought into and maintained in compliance with all appropriate EPA regulations and guideline documents. 4. Reorganization of air quality monitoring section. 5. Upgrade key components of the air quality monitoring stations. 6. Update formal documents. 7. On-site training, mentoring, and assistance should be provided to the staff where needed.	1. Ongoing review. Findings 2-4 have been addressed and completed. 2. Will work on this during 2013 data cert process. Expect input from EPA. 3. Certification and verification of ozone calibrators has been reassigned to in-house QA personnel. Forms, tracking, and documentation of these activities are being improved. Findings #5-9 will be addressed in this process. 4. Ozone SOP update process is in progress. SOPs will be created for

standard verifications to ensure that all regulatory and technical assistance document requirements are being successfully met and maintained over time. 7. The monitoring station operators are not adhering to SOPs. The procedures being performed vary from site to site or technician to technician. 8. Documentation is insufficient. 9. During this audit, the KDAQ auditors spent an excessive amount of time trying to locate records. Thus, the APCD AM's filing/archiving system needs significant improvement. 10. The O_3 monitoring stations are equipped with different instrument types. The stations should be standardized. 11. The current Ozone SOP should be revised. Moreover, additional SOPs should be developed that address equipment acceptance testing and verifications. 12. The APCD AM's quality assurance program is ineffective; questionable data and procedures are being overlooked. 13. The APCD AM staff needs additional training in all aspects of air monitoring: equipment operations, documentation requirements, data review, and ultimately an understanding of the required procedures.		cert/verification process. 5. Training is in progress. Several sessions of training completed at DAQ regarding analyzer repair and ozone/dilution calibrator certification and verification.