Highlights from the Coordinating Research Council 2015 Mobile Source Air Toxics Workshop

Asian Connections: Bolstering Cities’ Role in the Fight Against Air Pollution

Also in this issue:

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FEATURES

Protecting Public Welfare: Assessing Science on NO\textsubscript{x} and SO\textsubscript{x} Effects
by Prakash Doraiswamy, RTI International  Page 4

An overview of the latest science and policy issues that will inform the next review of secondary air quality standards for nitrogen oxides (NO\textsubscript{x}) and sulfur oxides (SO\textsubscript{x}). Topics will include ecosystem impacts; nutrient enrichment; atmospheric modeling of fate, transport, and deposition; and will build upon the subjects discussed at a kickoff workshop organized by the U.S. Environmental Protection Agency in 2014.

Impact of Sulfur Dioxide (SO\textsubscript{2}) and Nitrogen Oxide (NO\textsubscript{x}) Emissions Reductions on Acidic Deposition in the United States
by Christopher M.B. Lehmann and Brian M. Kerschner, National Atmospheric Deposition Program Central Analytical Laboratory, and David A. Gray, Prairie Research Institute, University of Illinois Urbana-Champaign  Page 6

Connecting Nitrogen Deposition and Final Ecosystem Goods and Services for Air Quality Standards Review
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Reactive Nitrogen Monitoring Gaps: Issues, Activities, and Needs
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CONFERENCE HIGHLIGHTS

Highlights from the Coordinating Research Council 2015 Mobile Source Air Toxics Workshop
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Complex times for air policy directors

by Dallas Baker, P.E., BCEE

What interesting times we live in—from an air pollution control perspective that is. Hyper-developing countries such as China are making difficult choices to curb smog precursors and particulate emissions to protect health (much like many U.S. cities were in the early 20th century). Abatement of anthropogenic greenhouse gas continues to be discussed at conferences, in the media, and in governments around the world. Energy production is straining to keep up with long term demand growth projections, with new regulations shaping emission controls and fuel sources. In the U.S., agencies and industry are reacting to no shortage of significant rule changes: National Ambient Air Quality Standard modifications, the Clean Power Plan, the Coal Ash Rule, and Startup Shutdown & Malfunction (SSM), just to name a few. Each rule is complex, controversial and affects economies and governments of every geographic scale.

As environmental professionals keep developing strategies, analyzing policy, advising decision-makers and wondering when the next shoe is to drop, I firmly believe members and stakeholders of the Air & Waste Management Association are positioned well to play a role in influencing the landscape. The A&WMA provides a neutral forum and a conduit for information exchanges between stakeholder groups traditionally unconnected and often opposed from one another. I know of no organization better suited to fulfill this purpose, and I hope to drive forward more opportunities for you to be engaged.

This issue of EM focuses on the process and implications of properly reexamining secondary standards of air quality. Science drives the process, and the implications can be profound. How, when and where we plan expansion of power generation and industry depend on attainment of these national standards. Non-attainment forces us to answer questions such as: What new controls will be required? Is there a sustainable solution to meeting the demands of a growing economy in that area? Our members are asking these questions, and our members are assisting one another in discovering answers.

What does the future hold? In most areas of the United States, ambient air monitoring of ozone and particulates trend well; however most predict more and more regulation will be handed to state agencies already struggling with lean resources. Looking forward, as I talk with senior leaders in state and local agencies, private companies and NGOs, it is becoming essential to develop the technical skills and fundamental understanding of pollution control practices of young staff members as Baby Boomers leave the work force. The Millennial Generation is the fastest growing segment of the work force, while seasoned professionals are looking to hand over significant responsibilities soon. I hope to foster new technical and non-technical professional development programs to assist our members in meeting this critical need. If you have suggestions of what we could develop and the means to deliver it, please let me know at president@awma.org.

As a final note, I want to thank everyone who sponsored and attended the outstanding Annual Conference & Exhibition in Raleigh. Special thanks to Bob Hall and his tireless planning team. Well done! I encourage every EM reader to mark your calendar next June for travel to a world-class destination city: New Orleans, Louisiana, the venue for ACE2016. As they say, Laissez les bons temps rouler!
Each year, A&WMA recognizes deserving individuals or companies for their outstanding accomplishments in the promotion of a clean environment.

These awards were established by the Association to encourage environmental professionals to serve as models for others to emulate and to further A&WMA’s mission and objectives. Please join us in celebrating their remarkable contributions.

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Frank A. Chambers Excellence in Air Pollution Control Award

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Richard I. Stessel Waste Management Award

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Cynthia A. Carter, Jason S. Midgett
Outstanding Young Professional Award

John Koehler, Sc.D., Michael T. Kleinman, Kim L. Marcus, Daniel Weiss
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2015 Scholarship Award Recipients

Wangki Yuen, Milton Feldstein Memorial Scholarship for Air Quality Research

Pooya Shariaty, Dave Benforado Scholarship for Air Pollution Control and Waste Minimization Research

Dhawal Chheda, Richard Stessel Memorial Scholarship for Solid and Hazardous Waste Research

Qingshi Tu, Jacqueline Shields Memorial Scholarship for Waste Management Research and Study

Amanda Pappin, Environmental Management or Policy Research and Study Related to Air Quality

Andrew Abeleira, Air Quality Research and Study

Amini Adib, Sustainability research and Study Related to Air Quality and Waste Management

Jon Powell, Waste Management Research and Study

Nominate Your Peers

Who do you know that deserves special recognition? It’s not too early to be thinking about nominations for A&WMA’s 2016 Honors & Awards. Nominations for all award categories will be due October 30, 2015. For more information, please visit www.awma.org/about-awma/honors-awards/.

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The Clean Air Act (CAA) of 1970 required the U.S. Environmental Protection Agency (EPA) to establish National Ambient Air Quality Standards (NAAQS) for certain widespread pollutants, based on scientific criteria. The NAAQS include both primary standards to protect public health and the secondary standards to protect public welfare (e.g., vegetation, ecosystems, property, soil, water, visibility, and climate).

The Act as amended also requires that EPA review the recent scientific information and update the standards, if necessary, on a five year cycle. The previous review of the oxides of nitrogen (NO\textsubscript{x}) and oxides of sulfur (SO\textsubscript{x}) secondary standards was completed in 2012. The EPA is currently performing the integrated science assessment for NO\textsubscript{x} and SO\textsubscript{x} secondary standards as part of this review cycle. The major route of the secondary...
impact on the environment is through dry and wet deposition of pollutants. In the nearly 45-year time frame, there has been tremendous progress in our understanding and control of the emissions of these pollutants from multiple sources that has translated into reductions in deposition, attesting to the efforts of the EPA. In this issue, we present three articles that provide an overview of some of the science and recommendations to be considered in this review.

**Impact of Sulfur Dioxide (SO\textsubscript{2}) and Nitrogen Oxide (NO\textsubscript{x}) Emissions Reductions on Acidic Deposition in the United States**
The first article by Lehmann et al. (page 6) demonstrates the significant reduction in emissions of SO\textsubscript{2} and NO\textsubscript{x} since the establishment of the NAAQS and the corresponding decrease in deposition as sulfates and nitrates, respectively as indicated by data from the National Atmospheric Deposition Program (NADP). It is obvious that the sulfate deposition has decreased significantly compared to nitrate, increasing the relative importance of nitrogen deposition on ecosystem acidification.

**Reactive Nitrogen Monitoring Gaps: Issues, Activities, and Needs**
The next article by Schichtel and Walker (page 12) focuses on the components of nitrogen deposition. The article elaborates on the importance of ammonia and organic nitrogen to the total reactive nitrogen budget and the need for improved quantification. While ammonia monitoring has begun as part of the NADP, measurement of organic nitrogen is lacking. The article stresses the need for improved monitoring of these components to reduce the uncertainty in reactive nitrogen deposition budgets.

**Connecting Nitrogen Deposition and Final Ecosystem Goods and Services for Air Quality Standards Review**
The final article by Compton et al. (page 20) explores an approach to connect nitrogen deposition to ecosystem services and their associated economic value that will demonstrate and quantify the impact of nitrogen deposition. They describe a framework that will enable such an evaluation based on the Final Ecosystem Goods and Services (FEGS) concept.

The above articles represent a small fraction of the science that goes into the comprehensive review process that is underway. In addition to atmospheric impacts, there are also impacts on aquatic and terrestrial species, which we hope to cover in a future issue. We thank the authors for their contribution to this issue, and Mr. John Bachmann and Ms. Susan Wierman for their assistance. em
Impact of Sulfur Dioxide (SO$_2$) and Nitrogen Oxide (NO$_x$) Emissions Reductions on ACIDIC DEPOSITION in the United States

by Christopher M.B. Lehmann, Brian M. Kerschner, and David A. Gay

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Background

As extensively described in A&WMA’s 2007 Critical Review on the history of the National Ambient Air Quality Standards (NAAQS), regulations have been promulgated in the United States to address the adverse impacts of air pollution on human health and the environment since the original Clean Air Act (CAA) of 1963. The 1990 CAA Amendments (CAAA) specifically sought to limit the adverse impact of acidic deposition through control of emissions of SO$_2$ and NO$_x$. Title IV of the 1990 CAAA set sulfur dioxide (SO$_2$) emissions limits to reduce 1980-level air emissions by 9.1 teragrams (Tg, 10$^{12}$ g) or 10 million short tons by the year 2000. Title IV also regulated NO$_x$ emissions from stationary sources, and Title II regulated NO$_x$ mobile source emissions. The U.S. EPA’s Acid Rain and related programs established subsequent rules to further limit emissions of SO$_2$ and NO$_x$ from stationary and mobile sources to improve air quality and public health. The current Cross-State Air Pollution Rule (CSAPR) requires 23 central and Midwestern U.S. states to significantly improve air quality by reducing stationary source emissions. Such controls include summertime NO$_x$ reductions to mitigate ozone production and annual SO$_2$ emissions reductions to limit fine particle formation. Phase I of CSAPR will be implemented in 2015.

Trends in Atmospheric Emissions of SO$_2$ and NO$_x$

The U.S. EPA provides air emissions data (1970–2014) through the National Emissions Inventory (NEI). These data show that significant decreases in SO$_2$ and NO$_x$ have occurred from 1970 to present in response to rules and legislation targeting emissions of these species (Figure 1).
SO\textsubscript{2} emissions have decreased from over 25 Tg/yr in 1970 to less than 5 Tg in 2014. NO\textsubscript{x} emissions, originally estimated to be less than SO\textsubscript{2} emissions in 1970 (~24 Tg/yr), exceeded SO\textsubscript{2} emissions by over a 2:1 ratio in 2014 (~11 Tg/yr). Figure 1 includes stationary-source regulatory controls on SO\textsubscript{2} air emissions (red text) and NO\textsubscript{x} air emissions (blue text) at the year of implementation. These regulatory controls include Phases I and II of the 1990 CAAA, and the Clean Air Interstate Rule (CAIR); some of these programs provided incentives for sources to reduce emissions before the compliance dates shown.\textsuperscript{5,8} Additional mobile-source emissions regulations (e.g., Tier I emissions, Tier II emissions, and low-sulfur fuel standards) are not shown in the figure but are detailed elsewhere by the U.S. EPA.\textsuperscript{5,8}

Monitoring of Atmospheric SO\textsubscript{2} and NO\textsubscript{x} Trends
There are several national-level monitoring networks that measure long-term ambient concentrations of criteria air pollutants for compliance with the CAAA including the State and Local Air Monitoring Stations (SLAMS) and the related National Air Monitoring Stations (NAMS) networks.\textsuperscript{9} Monitoring of precipitation (i.e., rain and snow) chemistry also provides an indicator of overall air quality, as precipitation readily scavenges the airborne gases and particles generated by emissions. Dry deposition monitoring of particles and gases, including estimates of their removal fluxes using atmospheric models, provides estimates of total deposition of pollutants and their overall removal from the atmosphere.

The National Atmospheric Deposition Program (NADP) has measured the concentrations of pollutants in precipitation samples since 1978 and related air-quality parameters to characterize the chemical climate of the U.S. and its temporal and spatial trends.\textsuperscript{10} The NADP is a coordinated research project supported by over 150 cooperating agencies which sponsor one or more individual monitoring stations, currently comprising over 139 sites meeting completeness criteria during both time periods. Sites within 100 km of oceans were corrected for sea-salt sulfate concentrations.\textsuperscript{15}

Figure 2. Three-year (1984–1986, 2012–2014) precipitation volume-weighted mean concentrations of SO\textsubscript{4}\textsuperscript{2-} (top) and NO\textsubscript{3}-- (bottom) ions in NADP/NTN precipitation samples as hydrogen ion microequivalents per liter (µeq/L).\textsuperscript{10} Colors between station locations represent an Inverse-Distance-Weighting (IDW) interpolation. All valid samples were included for 139 sites meeting completeness criteria during both time periods. Sites within 100 km of oceans were corrected for sea-salt sulfate concentrations.\textsuperscript{15}
350 locations in the U.S. (and its territories), Canada, Argentina, and Taiwan. The NADP consists of the following five networks:

- **National Trends Network (NTN)** — Established in 1978; weekly concentrations and wet deposition fluxes of sulfate (SO$_4^{2-}$), nitrate (NO$_3^-$), chloride (Cl$^-$), bromide (Br$^-$), ammonium (NH$_4^+$), orthophosphate (PO$_4^{3-}$), calcium (Ca$^{2+}$), magnesium (Mg$^{2+}$), potassium (K$^+$), and sodium (Na$^+$) ions, as well as pH and specific conductivity.

- **Atmospheric Integrated Research Monitoring Network (AIRMoN)** — Established in 1992; event-based measurements of the same species as NTN.

- **Mercury Deposition Network (MDN)** — Established in 1995; weekly concentrations and wet deposition fluxes of mercury.

- **Atmospheric Mercury Network (AMNet)** — Established in 2009; gaseous ambient concentrations of mercury fractions.

- **Ammonia Monitoring Network (AMoN)** — Established in 2010; gaseous ambient concentrations of ammonia.

Dry deposition monitoring in the U.S. is provided by the Clean Air Status and Trends Network (CASTNET). More information on CASTNET is available at http://epa.gov/CASTNET. Together, wet and dry deposition monitoring networks complement the SLAMS and NAMS networks in evaluating overall air pollutant trends in the U.S.

### Impacts

#### Effects of Emissions Regulations on Sulfate (SO$_4^{2-}$) and Nitrate (NO$_3^-$)

**Acidic Wet Deposition**

SO$_2$ and NO$_x$ air emissions are oxidized in the atmosphere, and are wet deposited as acidic SO$_4^{2-}$ and NO$_3^-$ ions in precipitation, respectively. Reductions of U.S. SO$_2$ and NO$_x$ air emissions have had a direct and quantifiable impact on SO$_4^{2-}$ and NO$_3^-$ wet deposition. Three-year precipitation volume-weighted mean concentrations of SO$_4^{2-}$ and NO$_3^-$ ion concentrations as microequivalents per liter (µeq/L) are shown for two time periods (1984–1986 and 2012–2014) in Figure 2. The maps demonstrate that sulfate and nitrate concentrations are decreasing, consistent with emissions reductions (Figure 1). Median SO$_4^{2-}$ concentrations for the 139 stations shown in Figure 2 decreased from 28.6 µeq/L in 1984–1986 to 11.8 µeq/L in the 2012–2014 period, representing a 59% decrease. Median NO$_3^-$ concentrations decreased from 14.7 µeq/L to 11.5 µeq/L during the same period, a decrease of 22%. The NADP provides a time-series animation of SO$_4^{2-}$ and NO$_3^-$ concentrations and wet deposition fluxes at http://nadp.isws.illinois.edu/data/animaps.aspx.

The larger magnitude emissions reduction in SO$_4^{2-}$:

- When evaluating the acidification potential of sulfate and nitrate ions, each molar unit concentration of SO$_4^{2-}$ contributes two hydrogen ion equivalents, and NO$_3^-$ contributes one hydrogen ion equivalent.

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Figure 3. Relative equivalents ratio of SO$_4^{2-}$ to NO$_3^-$ concentrations in NADP/NTN precipitation samples for the three-year periods 1984–1986 (left) and 2012–2014 (right). Colors between station locations represent an Inverse-Distance-Weighting (IDW) interpolation. All valid samples were included for 139 sites meeting completeness criteria during both time periods. Sites within 100 km of oceans were corrected for sea-salt sulfate concentrations.
relative to $\text{NO}_3^-$ is reflected in the shift in the relative equivalents ratio of these two species between the three-year periods 1984–1986 and 2012–2014 (Figure 3). In 1984–1986, the region where the $\text{SO}_4^{2-}$ to $\text{NO}_3^-$ equivalents ratio ($\text{SO}_4^{2-}/\text{NO}_3^-$) was greater than 2:1 represented one-third of the total area of the continental U.S. By 2012–2014, the region represented a very small area of the continental U.S. In contrast, the region where $\text{SO}_4^{2-}/\text{NO}_3^-$ was less than 1:1 represented only a small area along the West Coast in 1984–1986. By the 2012–2014 period, the region where $\text{SO}_4^{2-}/\text{NO}_3^-$ was less than 1:1 represented more than half of the continental U.S., principally in western states. This indicates that $\text{NO}_3^-$ wet deposition exceeds $\text{SO}_4^{2-}$ deposition in much of the continental U.S. for its acidification impacts.

Quantifying Ecosystem Impacts: Total Deposition and Critical Loads

In 2011, the NADP formed the Total Deposition Science Committee (TDEP) to improve estimates of atmospheric deposition through integration of measured and modeled wet, dry, and total deposition of sulfur, nitrogen and other species of concern (e.g., mercury). This committee has produced a series of maps representing the total deposition of sulfur and nitrogen species, available at http://nadp.isws.illinois.edu/committees/tdep/tdepmaps/, as well as published in print. These maps provide estimates on the total loading of sulfur and nitrogen pollutants. Total deposition provides data for ecological assessments, including evaluation of critical loads.

The critical load represents the threshold at which air pollution deposition results in a response in sensitive resources or ecosystems. Critical loads can be developed for various ecosystem responses, including impacts on aquatic systems, spread of invasive species, changes in soil chemistry, and stream acidification. For ecosystems currently experiencing damage from air pollution, critical loads help determine deposition reductions required for ecosystem recovery. In areas where critical loads are not exceeded, the levels inform land management and policy decisions regarding appropriate air quality standards to protect ecosystems. A series of critical loads maps was recently published for the U.S.

Future Directions

Development of $\text{NO}_x/\text{SO}_x$ Secondary Standards

The CAA requires the U.S. EPA to set primary and secondary National Ambient Air Quality Standards (NAAQS) for the six criteria pollutants (including $\text{NO}_x$ and $\text{SO}_x$), and periodically review them. Primary NAAQS are established to protect human health and sensitive populations. Secondary NAAQS protect ecosystems and human welfare. As the U.S. EPA reviews secondary $\text{NO}_x/\text{SO}_x$ NAAQS, the objective is to develop a framework of standards that recognizes the interactions between $\text{NO}_x$ and $\text{SO}_x$ as they deposit to sensitive ecosystems. This is consistent with the CAA’s requirements to protect human health and public welfare, as well as impacts on sensitive ecosystems (e.g., acidic

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deposition). The U.S. EPA is moving towards a multi-pollutant regional approach, recognizing that NAAQS-level controls do not take into account regional variations, including atmospheric and topographic variables as well as the location of sensitive ecosystems.14

References
by Bret A. Schichtel and John T. Walker

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REACTIVE NITROGEN
Monitoring Gaps: Issues, Activities, and Needs
Atmospheric deposition of reactive nitrogen (Nr) can contribute to acidification and nutrient enrichment in aquatic and terrestrial ecosystems. This can lead to reduced fish and insect populations in aquatic systems and their near depletion in highly acidified water bodies. Nutrient enrichment can disrupt the nutrient balance, leading to reduced biodiversity, an increase in invasive species, and increased biological production or eutrophication of fresh and coastal waters. It can also increase susceptibility of vegetation to drought, freezing, and insect infestations. High levels of nutrient enrichment can be toxic to plants. In some cases, these impacts are reducing ecosystem services or the benefits people derive from them (see Compton et al. in this issue).

These negative effects have been well documented in the eastern United States, where the deposition rates have been historically high. However, even in remote, relatively clean environments, aquatic and terrestrial systems are being negatively impacted. In Rocky Mountain National Park (RMNP), the excess Nr deposition has risen to a level of concern such that the U.S. National Park Service, the Region 8 office of the U.S. Environmental Protection Agency, and the Colorado Department of Public Health and Environment formed a Memorandum of Understanding and the Nitrogen Deposition Reduction Plan to reduce Nr in RMNP.

Total Nr is a mix of oxidized and reduced inorganic nitrogen (N) and organic N compounds that are chemically and biologically active in the Earth’s biosphere and atmosphere and are deposited through wet, dry, and occult processes. These compounds arise from a variety of sources, with inorganic oxidized N primarily emitted as nitrogen oxide and dioxide (NOx) from fossil fuel combustion. Atmospheric reactions of NOx result in nitric acid, particulate nitrate, and other compounds. Reduced N arises primarily from ammonia (NH3) gas emissions from agricultural activities, which can react with acidic aerosols, forming ammonium (NH4+) compounds. There are hundreds of organic N compounds, including reduced (e.g., amines) and oxidized (e.g., alkyl nitrates) forms. Sources of organic N are less well known, but increasing evidence shows that biomass burning.
and agriculture\textsuperscript{23} are significant contributors, as are atmospheric reactions of NO\textsubscript{x} with volatile organic compounds.\textsuperscript{24}

Nr compounds also contribute to ozone and particulate matter, two pollutants regulated by the primary and secondary National Ambient Air Quality Standards (NAAQS). NO\textsubscript{x} and some organic N are precursors to ozone, which can adversely impact human health, vegetation, and crops.\textsuperscript{25} NH\textsubscript{3} reacts with nitric acid (HNO\textsubscript{3}) to form particulate ammonium nitrate, an important contributor to particulate matter (PM).\textsuperscript{26} Elevated PM contributes to health,\textsuperscript{27} visible haze,\textsuperscript{28} and climate issues.\textsuperscript{29,30} Outside of agricultural areas, NH\textsubscript{3} is often the limiting species for particulate ammonium nitrate formation, and reductions in NH\textsubscript{3} could be an effective control strategy to reduce PM.\textsuperscript{31}

In the past, excess Nr deposition was primarily due to inorganic oxidized N,\textsuperscript{32,33} and monitoring networks in the United States focused on these compounds. The importance of oxidized N for deposition, ozone, and PM issues led to regulations and programs to decrease emissions of NO\textsubscript{x}, specifically Title IV of the 1990 U.S. Clean Air Act Amendments Acid Rain Program, the NO\textsubscript{x} SIP (State Implementation Plan) Call for the U.S. Mid-Atlantic states, the U.S. Clean Air Interstate Rule, the U.S. Cross-State Air Pollution Rule, and the primary and secondary NAAQS for oxides of nitrogen and sulfur.\textsuperscript{34} Reduced and organic N compounds remain essentially unregulated.\textsuperscript{21,35}

Air quality regulations have contributed to the nearly 50\% decline in U.S. NO\textsubscript{x} emissions from power plants and mobile and other sources that occurred 1990 and 2010.\textsuperscript{28,36} However, during this same time period, NH\textsubscript{3} emissions increased 11\%, mostly due to increased livestock and agricultural activities.\textsuperscript{36} These divergent trends are altering the composition of the Nr in the atmosphere.\textsuperscript{32} This is reflected in the wet-deposited inorganic oxidized and reduced N measured as nitrate (NO\textsubscript{3}\textsuperscript{-}) and NH\textsubscript{4}\textsuperscript{+} respectively in the National Atmospheric Deposition Program’s (NADP) National Trends Network (NTN) since 1978.\textsuperscript{14,33} As shown in Figure 1, the average contribution of NH\textsubscript{4}\textsuperscript{+} to wet-deposited, inorganic N over the United States was relatively constant from 1980 to 2000 at about 43\%. Around 2000, wet-deposited NO\textsubscript{3}\textsuperscript{-} began to rapidly decrease while NH\textsubscript{4}\textsuperscript{+} increased, and in 2014, 58\% of the wet-deposited N was from NH\textsubscript{4}\textsuperscript{+}. The fractional contribution varies spatially, with higher NH\textsubscript{4}\textsuperscript{+} contributions in the Great Plains to Midwest and lower along the eastern seaboard.\textsuperscript{37} Air quality modeling of projected 2050 emissions suggests that the relative and absolute importance of reduced N will continue to increase.\textsuperscript{29,30}

The changing atmospheric composition is making it increasingly important for regulatory programs, such as the secondary NAAQS for oxides of nitrogen and sulfur, to consider non-oxidized forms of Nr. A primary goal of these regulations is to protect healthy and remediate damaged ecosystems from the adverse impacts of Nr deposition. Without knowledge of atmospheric changes in reduced and organic N, regulators will not know if these compounds are increasing and countering the positive benefits from past and potentially future reductions in NO\textsubscript{x}. In addition, this information would help in understanding why ecosystems may or may not recover as NO\textsubscript{x} is continually decreased.

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{Figure1.png}
\caption{Trends in the annual wet deposition of inorganic nitrogen from NH\textsubscript{4}\textsuperscript{+} and NO\textsubscript{3}\textsuperscript{-} and the fractional contribution of NH\textsubscript{4}\textsuperscript{+} to the total measured inorganic N. The data are aggregated over 225 NADP-NTN monitoring sites in the continental United States with 15 years or more of data.}
\end{figure}
Current U.S. monitoring programs do not measure all of the relevant Nr species, specifically NH₃ dry deposition and wet and dry organic N deposition. In this article, we demonstrate the importance of these unmeasured compounds to the total Nr deposition budgets and review the current activities to close these monitoring gaps. Secondly, remaining monitoring needs and issues are discussed.

**Reactive Nitrogen Deposition Monitoring Gaps**

In the United States, wet deposition is routinely measured by the NADP-NTN, and dry deposition is derived from ambient measurements from the Clean Air Status and Trends Network (CASTNET) monitoring program. NADP-NTN and CASTNET together have made it possible to track long-term changes in atmospheric chemistry and deposition of oxidized N and NH₄⁺, serving as the primary observational datasets underpinning deposition assessments. However, all monitoring programs need to make compromises, balancing costs against spatial, temporal, and species resolutions.

The NADP-NTN measures the wet inorganic, reduced and oxidized dissolved N compounds in weekly samples, but it does not routinely analyze samples for organic N. Important oxidized N compounds (i.e., particulate nitrate (p-NH₃⁻) and HNO₃), as well as particulate ammonium (p-NH₄⁺), are monitored in CASTNET in weekly samples, but gaseous NH₃ and particulate and gaseous organic N are not. These non-monitored nitrogen compounds are only relevant to atmospheric deposition if they are biologically available. The biological importance of NH₃ deposition is well established but is less so for organic N deposition, particularly in terrestrial ecosystems. A number of aquatic studies do indicate that organic N immediately contributes to ecosystem productivity. This suggests that both NH₃ and organic N are likely bioavailable, and inclusion of them in deposition budgets is essential.

As more measurements of atmospheric NH₃ and organic N have become available over the last decade, it has become evident that these missing Nr compounds are significant, accounting for a third or more of total Nr deposition in some sensitive ecosystems. For example, in the measured Nr deposition budgets at RMNP and Grand Teton NP presented in Figure 2, dry NH₃ deposition accounted for 15–30% of the Nr deposition, and the wet organic N deposition accounted for 10–20%. The contribution of dry organic N deposition was not measured. It is notable that reduced N deposition accounted for over 50% of the measured Nr deposition, while the oxidized N accounted for less than a third.

**New Monitoring Activities**

**Ammonia Monitoring**

The lack of long-term NH₃ monitoring has been a significant gap in the U.S. air quality monitoring programs, not only impacting assessment of Nr deposition, but also PM and its physical and optical properties. Some studies and programs have begun to address this issue.

The Ammonia Monitoring Network (AMoN) is the most extensive routine network. AMoN began operating as a new NADP pilot program in 2007 and was officially adopted as a subnetwork in 2010. AMoN uses passive samplers to measure 2-week, integrated NH₃ concentrations and currently has 91 sites throughout the United States, Canada, and

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**Figure 2.** Nitrogen deposition budgets at Rocky Mountain NP (RMNP) for 2009 and the east and west sides of Grand Teton NP (GTNP) during the summer of 2011.
Puerto Rico. These data are well suited for deriving some spatial and seasonal patterns and long-term trends. For example, Figure 3 presents the 2014 annual average concentrations. As shown, NH$_3$ concentrations are highest near intensive agricultural activities, e.g., in northern Utah, and among the lowest in the easternmost states. The eastern United States is a region where acidic ammoniated sulfate still occurs. In general, the NH$_3$ concentrations are seasonally variable, with lows in the winter and highs in the late spring and summer.

Two-week samples are inadequate for assessing short-term episodes due to changing emissions and meteorology, which limits the data’s use for understanding atmospheric chemistry, performing source apportionment, and estimating dry deposition rates. This is evident from a special monitoring study in which the Interagency Monitoring of Protected Visual Environments (IMPROVE) program fine-particulate sampler was modified to measure 24-hour total NH$_x$ (NH$_3$ + NH$_4^+$) concentrations from which estimates of NH$_3$ concentrations were derived. The samplers were deployed for 17 months at nine IMPROVE sites in the Rocky Mountains, the eastern plains, and at the Bondville, IL, site. There was high variability from one sampling period to the next and from episodes associated with wild fire activity. In addition to a summer peak in concentrations at all sites, NH$_3$ increased in the fall and winter near agricultural areas, potentially due to fertilizer application.

Large temporal variability of NH$_3$ air concentrations occurs on time scales of less than a day. The continuous monitors needed to measure at these scales are still best suited for special studies. However, the Southeastern Aerosol Search and Characterization (SEARCH) network has had two continuous NH$_3$ monitors operating in and around Atlanta, GA, since 2007. These data reveal morning and evening NH$_3$ peaks thought to be due to the interaction of the diurnal mixing layer height and emissions. This contrasts with after-

Figure 3. Annual 2014 average ammonia (NH$_3$) concentrations from the AMoN network.
noon peaks in NH$_3$ concentrations measured in Grand Teton$^{22}$ and Rocky Mountain NPs, which are not understood.

**Organic N Deposition**

Ambient organic N is found in the gas and particle phases and is the result of emissions from soil, biomass burning, marine, agricultural, and other sources and their atmospheric reactions. These emissions and reactions result in a diverse matrix of compounds that include amines, amino acids, urea, nitrophenols, alkyl amides, and organic nitrates. The myriad of organic N compounds make them challenging to measure in the atmosphere, and currently, the best information for developing deposition budgets comes from measuring total water-soluble organic N in wet deposition samples. In a recent review of global measurements, Jickells et al.$^{49}$ reported that, on average, water-soluble organic N represents $\approx 25\%$ of total N in precipitation samples. In the United States, annual averages ranged from 2.6% to 33% in the few published measurements.$^{51,52,50}$ Global datasets also indicate that the contribution of water-soluble organic N to total N in atmospheric aerosol$^{49}$ may be significant. However, given the low deposition velocity of PM and the efficient wet removal mechanisms, dry particulate organic N deposition may only play a minor role in total N deposition.$^{41}$ Less is known about the importance of gas-phase organic N to total N deposition. Recent measurements indicate that organic nitrates may contribute up to 25% of the oxidized dry deposition flux in some environments.$^{53,54}$ Furthermore, elevated concentrations of reduced organic N observed during biomass burning events (e.g., Prenni et al.$^{22}$) may lead to episodic dry deposition of organic N that may be significant to the annual N deposition budget. Clearly, more effort is needed to better understand the processes and importance of organic N and its deposition, as well as the development of measurement methods suitable for routine networks.

A number of aquatic studies do indicate that organic N immediately contributes to ecosystem productivity.$^{39,40}$ This suggests that both NH$_3$ and organic N are likely bioavailable, and inclusion of them in deposition budgets is essential.
The AMoN network provides invaluable information for understanding spatial and seasonal patterns of NH₃ in the United States, and with continued operation, long-term trends can be assessed.

**Reactive Nitrogen Monitoring Needs**

Available NH₃ and organic N measurements illustrate the regional nature of these pollutants and the potential for significant contributions to the total Nr deposition budget across the United States. At present, these represent the highest priorities for routine monitoring in order to decrease uncertainty in Nr deposition budgets. Of these compounds, our understanding of organic N and its deposition rates, sources, and atmospheric chemistry is the poorest. This information gap will remain until the spatial and temporal variability of organic N deposition is better characterized and more information is gathered regarding important sources. The most tractable approach to better characterization of organic N wet deposition at the national scale would be measuring organic N in wet deposition samples within the NADP-NTN infrastructure. However, without adaptation of NADP-NTN methods to include sample preservation in the field, the use of the network for routine sampling of dissolved organic N at the national scale is not feasible.55

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The AMoN network provides invaluable information for understanding spatial and seasonal patterns of NH$_3$ in the United States, and with continued operation, long-term trends can be assessed. However, complementary higher-temporal-resolution information is needed to improve deposition estimates and further evaluate tools used to develop total deposition budgets. Ideally, continuous information is needed to improve deposition estimates and long-term trends can be assessed. How monitoring would be used, but the uncertainties and expense of current methods makes this impractical for national-scale routine networks. At a minimum, twenty-four-hour concentrations are needed to enhance current air quality and deposition model processes and estimate source contributions. Twenty-four-hour samples are collected on a once-every-third-day schedule at five sites within the SEARCH network. Such daily sampling could be expanded by leveraging existing monitoring programs such as the IMPROVE and Chemical Speciation Network (CSN) fine particulate networks to measure total NHx from which estimates of NH$_3$ can be derived. 

by Jana E. Compton, Dixon H. Landers and Daniel J. Sobota

Connecting Nitrogen Deposition and Final Ecosystem GOODS and SERVICES for Air Quality Standards Review
Nitrogen (N) emission to air and subsequent deposition to land and water can affect terrestrial and aquatic ecosystems directly by changing their chemistry and indirectly by changing their structure and function through chains of events that affect plant or microbial community composition, fire susceptibility, and soil properties. Key changes in ecosystem structure and function can result in impacts that are important to the public, including negative effects on recreation, drinking water, timber production, wildlife viewing, hunting, climate stability, fire risk and human "non-use" values associated with the existence of intact, natural ecosystems. Figure 1 illustrates how these adverse effects occur along the N cascade and then connect to ecosystem services and human beneficiaries. Daily (1997) defined ecosystem services as the “conditions and processes through which natural ecosystems and species therein sustain and fulfill human life or have the potential to do so in the future.” While this definition is a useful starting point for discussion, recent work is expanding our ability to quantify ecosystem services in a way that can be used for policy and regulatory endpoints that benefit people.

The prior secondary NAAQS review process began to explore the potential for incorporating the concept of ecosystem services to represent public welfare impacts (U.S. EPA 2008). The science connecting ecological research, in terms of the ecosystem service supply, to human demands for and impacts on ecosystem services is relatively new. While the concept of ecosystem services includes many of the public welfare issues described in the CAA statute, some authors have pointed out that there are few examples of scientifically defensible accounting frameworks that have linked ecosystem services to decision-making (Daily et al. 2009; Jordan et al. 2010). Emerging work is beginning to develop more precise and useful concepts and definitions regarding ecosystem services. Boyd and Banzaf (2007) defined Final Ecosystem Goods and Services (FEGS) as those components of nature, directly enjoyed, consumed or used to yield human well-being. There has been an effort to identify the mechanistic links between N and ecosystem services (Compton et al. 2011; Rea et al. 2013; Jones et al. 2013), and to develop approaches to economically value the impacts of N on ecosystem services (van Grinsven et al. 2013; Sobota et al. 2015). Developing a framework that makes the connections between N deposition and FEGS explicit can inform our regulators by clearly illustrating the impacts of N deposition on important issues for public welfare. Here we describe the FEGS concept and how it can be applied to the air quality standards review process, and provide some examples of some of the currently quantifiable damages to ecosystem services from N deposition in the U.S.
Application of the FEGS framework to policy and decision-making

During the initiation of EPA’s Ecosystem Service Research Program in 2008, research and policy staff began to explore the use of the ecosystem services concept for cost/benefit analysis and other regulatory needs. This required a system for defining and classifying ecosystem services that was: 1) relatively complete; 2) minimally duplicative; 3) linked to beneficiaries; and which 4) facilitated metric identification. At the time, commonly cited definitions and uses for ecosystem services stemming from the Millennium Assessment (MA 2005) were found to be inadequate for many of the applications that EPA envisioned for ecosystem services. One of the major issues was that identifying what to measure as an ecosystem service was a difficult problem (Nahlik et al. 2012). Additionally, for useful accounting, the overlap or double-counting among various ecosystem services needed to be eliminated or minimized. Double-counting occurs when ecosystem processes, structure and function are combined in some ecosystem service and there is no way to efficiently and accurately separate them. To value ecosystem services (and perform cost-benefit and cost-effectiveness analyses), inform policy and management decisions that are relevant to human wellbeing, and effectively communicate, it is imperative to identify ecosystem services that are connected directly to what people value. Therefore, determining the connection between ecosystem services and value is as equally important as identifying their relationship with nature.

EPA staff proceeded to develop a new classification scheme based on the Final Ecosystem Goods
and Services perspective championed by Boyd and Banzaf (2007). This approach was published as a report and sets of FEGS tables that may be manipulated online based on the needs of a user (Landers and Nahlik, 2013). Each FEGS is identified in the EPA classification system (FEGS-CS) by a unique six digit number that represents the environment from which it was derived (e.g. lake, forest, grassland, created greenspace) and to whom it is a service. By defining who the specific beneficiary of this specific FEGS from nature may be, FEGS function as the hand-off from the natural to social sciences.

The FEGS concept can be used to distinguish the production function that is mainly ecological in nature from the other inputs that are mainly economic (Figure 2). The ability to define and identify FEGS and the specific biophysical components of goods and services that are derived principally from nature may be, FEGS function as the hand-off from the natural to social sciences.

The FEGS-CS is a good way to link potential beneficiaries of air quality to human well-being directly through human health impacts relevant to the primary NAAQS, or indirectly through the N cascade, where air-mediated impacts such as deposition of acids and N cause changes in the environment that people care about. The FEGS-CS can be used to directly identify specific beneficiaries and to hypothesize what it is that they appreciate or value in the environment that is altered by acidic deposition and/or nutrient deposition. Many of these impacts have links to timber production, recreation, water quality and climate stability that benefit foresters, recreationists, residential land owners and all humans (Figure 1). Making these connections quantitatively requires interdisciplinary thinking and systems research described in the next section.

Determining the connection between ecosystem services and value is as equally important as identifying their relationship with nature.

Figure 2. Connections between the environment, beneficiaries and ecological production functions, and economic production functions that lead to human well-being and economic values.
Measuring damages to ecosystem services from N deposition

There are a number of pathways for effects of N deposition on ecosystem services and beneficiaries (Figure 1). These impacts can be broadly categorized into effects on air quality, climate and UV regulation, and effects on terrestrial, freshwater, groundwater and coastal systems. Nitrogen deposition intersects with climate regulation in a number of ways, directly by increasing the production of the important greenhouse gas nitrous oxide ($\text{N}_2\text{O}$), and indirectly through impacts on net carbon storage in plants and soils (Liu and Greaver 2010). NOx also causes ozone formation, which impact production in crop and natural ecosystems; however in a regulatory sense this effect is covered through the ozone NAAQS, and is thus excluded from this discussion.

In terms of the impacts on ecosystem services, it is important to focus on the internal components of Figure 1. Nitrogen deposition can alter the structure and function of terrestrial ecosystems through eutrophication and acidification. Eutrophication can alter the internal N cycle of terrestrial ecosystems, which in turn can result in changes in species composition, altered organic matter storage, increased herbivory, increased N leaching, increased fire risk and changes in net carbon storage (Fenn et al. 2003; Rao et al. 2010; Jones et al. 2014). Acidification in terrestrial ecosystems can alter soil pH, organic matter dynamics, metal dynamics, forest growth and species composition. These impacts can change climate stability and water quality, and can feed into changes in aquatic ecosystems via effects on pH and cycling of metals (Greaver et al. 2012).

Impacts on the terrestrial landscape could connect to multiple beneficiaries. For example, foresters could be affected where species composition or forest production is altered by acidification or nutrient enrichment; recreational users could be affected by reductions in visibility or changes in the habitat that alters wildlife viewing or hiking aesthetic qualities (Banzhaf et al. 2006). Recent work in Europe revealed significant economic benefits of N reductions on recreation (Jones et al. 2014).
Impacts on freshwater and coastal ecosystems can be difficult to directly connect to N deposition because often N inputs to these systems come from various sources other than deposition. Also, in many cases a complete set of potential beneficiaries is undefined and therefore unknown. Based on previous work mapping of N inputs to watershed units (HUC8), we estimated the contribution of N deposition to total N inputs to these watershed units in the U.S. (Figure 3a). Across most of the U.S., at least
20% of the anthropogenic N inputs to those watershed units come from deposition; the exception is the midwestern and western U.S. where agricultural activities dominate N inputs (Figure 3b). In forested areas at least 20% and sometimes more than 40% of the N comes from deposition, representing an important input of N to the landscape. In streams and lakes where atmospheric N is a dominant source of N loading to the landscape, N deposition altered stream species composition, N concentrations, organic matter dynamics and denitrification (Baron et al. 2006; Elser et al. 2009). Given that N deposition is an important component of total loading to watersheds across the U.S. (Figure 3), approaches that link impairment of waters to N loading by source is a key research need.

In order to inform the use of the ecosystem services concepts in the current NOxSO2 secondary NAAQS review process and to develop greater connectivity between clean air and nature’s benefits, EPA and the National Park Service (NPS) convened a workshop on Air Quality and Ecosystem Services (AQES) in February 2015. The AQES workshop convened a diverse group of 27 scientists and environmental policy makers from EPA, NPS, USGS, USFS and university and private entities in order to identify linkages between existing critical loads for atmospheric deposition and FEGS. Critical loads represent the point at which ecosystem processes and characteristics begin to be impaired (http://nadp.sws.uiuc.edu/lib/brochures/criticalloads.pdf). When critical loads are exceeded by current atmospheric deposition, human welfare benefits may be altered, and in some cases impairment of ecosystem services may occur. A critical load does not, however, provide a measure of impairment of ecosystem services or of economic value to the people concerned by the impairment (beneficiaries). The workshop explored a process to link biological indicators to the ecological conditions that support or lead to FEGS. This group adopted the Final Ecosystem Goods and Services Classification System/FEGS-CS as their starting point for connecting thresholds of N and sulfur loading. Subsequently, we identified metrics and beneficiaries to characterize change in specific final ecosystem goods and services that occur when critical loads are exceeded. Final products of the workshop will include a report and journal articles.

Figure 3. Nitrogen inputs to the landscape (Sobota et al. 2013). Watershed units are 8-digit hydrologic unit codes.
3a) Dominant anthropogenic N sources to the U.S. landscape.
3b) Percentage of anthropogenic N inputs to the U.S. landscape derived from deposition.
Summary
There has been an increased effort to document changes in ecosystem structure and function in response to changing N deposition, and a picture is beginning to develop that connects the specific effects to beneficiaries of these changes in the ecosystem (Chestnut and Mills 2005; Banzhaf et al. 2006; Evans et al. 2008; Compton et al. 2011). In spite of this renewed interest, the 2011 NAPAP assessment concluded that current information about response of ecosystem services related to changes in N and sulfur deposition was insufficient to examine in a comparable way to human health and cost information (Burns et al. 2011). Making these linkages will require more ecological and economic research that allows adequate assessment of monetary benefits to ecosystem services of changes in N and sulfur deposition. Using a FEGS framework in addressing these questions will allow researchers to make these connections to the beneficiaries and ultimately to economic valuation. More study is needed at local and regional scales to identify the specific damages and benefits associated with N and S emissions and deposition. And as more studies are completed, they can be placed into the FEGS-CS systems-level framework for identifying beneficiaries in order to economically value the effects of N deposition on ecosystem services.

References

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Highlights from the Coordinating Research Council 2015

Mobile Source AIR TOXICS Workshop

by Susan Collet, S. Kent Hoekman, Eileen McCauley, and Timothy J. Wallington

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The 2015 Coordinating Research Council (CRC) Mobile Source Air Toxics (MSAT) Workshop was held February 17-19 at the California Air Resources Board (CARB) headquarters in Sacramento, CA. This was the seventh in a biennial series of CRC MSAT workshops which started in 2002. The purpose of the workshop was to bring together interested parties to review the status and current knowledge regarding mobile source air toxics. The overarching themes of the 2015 workshop were the ongoing trend of reduced vehicle emissions and improving air quality in urban areas in the U.S. One plenary and six technical sessions covered regulatory aspects, vehicle emissions, air quality and exposure measurements, atmospheric and air quality modeling, and accountability. The workshop featured 36 oral presentations and 7 posters with over 90 participants. The agenda, workshop proceedings, and presentations are available on the CRC website at www.crcao.org. Highlights from the sessions are summarized below.

**Plenary Session**
The plenary session began with a presentation on ambient trends of MSAT in California. The introduction of cleaner fuels and vehicle emission controls have substantially reduced benzene, 1,3-butadiene, and diesel particulate matter (DPM) emissions. These reductions, achieved since the 1980s, are especially impressive when population growth, and increased vehicle miles traveled (VMT) are considered (Figure 1). NMHC measurements described in the second talk provided insights into MSAT concentrations in urban centers in Saudi Arabia, Pakistan and Singapore. This confirmed that MSAT need to be considered in some urban areas. The third presentation, using a method to predict the burden of disease, found that air pollution remains a significant global cause of health burden in some developing countries. The final talk focussed on revisions to risk assessment methodologies that utilize improved exposure estimates and better account for differences between children and adults.

**Regulatory Aspects**
Large reductions in vehicle emissions have been achieved over the past few decades and ambient concentrations are projected to continue to decrease in the future. However, revised risk assessment factors proposed by the California Office of Environmental Health Hazard Assessment (OEHHA) indicate that risks from air toxics are higher than previously estimated. Implementation of OEHHA’s revised cancer risk factors will increase cancer risk estimates in MATES IV by about a factor of 2.7. This does not negate the fact that emissions and risk have declined in California by more than 50 percent since 2005. In southern California, DPM exposure has been substantially reduced, but is still the largest contributor to air toxics risk, especially near ports and transportation corridors. CARB officials discussed a goal of transforming the freight sector to have zero emissions everywhere possible and near zero emissions with renewable fuels everywhere else. Fuel property effects on air quality are an important focus. Near-roadway monitoring, health effects, mitigation and outreach continue to be important components of EPA’s MSAT reduction program, which predicts an 80% reduction in MSAT by 2030 (Figure 2). Environment Canada is coordinating with the U.S. EPA where possible on emission regulations and modeling.

**Emission Measurements**
Emissions characteristics were analyzed for gasoline direct injection (GDI) and port fuel injected (PFI) vehicles using ethanol and iso-butanol blends, and modern heavy duty (HD) trucks operating on diesel and biodiesel. Driving cycle and temperature strongly affected organic carbon (OC) and semi-volatile organic compound (SVOC) emissions. GDI vehicles showed reductions for most...
trace elements and metals when using fuels having higher alcohol levels, while PFI- flex fuel vehicles (FFVs) showed mixed results. When using biodiesel blends, modern diesel trucks had reduced emissions of aromatics, but not carbonyls, as compared to older HD diesel trucks.

The effect of particulate matter (PM) emitted by various light-duty vehicle engine technologies and fuels on a biological (cell-based) reactive oxygen species (ROS) assay was explored. The ROS per mile was greatest for diesel/biodiesel. Ethanol affects tailpipe emissions from FFVs via two mechanisms; fuel chemistry and engine calibration. Fuel chemistry explains increased ethanol, acetaldehyde, formaldehyde, and \( \text{CH}_4 \) emissions. Engine calibration effects are manufacturer and model specific. Emissions from modern vehicles are very low and are not adversely affected by increased ethanol fuel content over the range for which the vehicles are designed to operate.

**Air Quality and Exposure Measurements of MSAT**

The 4th Multiple Air Toxics Exposure Study (MATES IV) in the South Coast Air Basin concluded that the cancer risk has decreased more than 50% since the 2005 MATES III Study. This is because diesel PM emissions have been reduced significantly and exposure to these emissions dominates overall cancer risk. Additionally, risk from all air toxics continues to decline, with the possible exception of ultrafine particles. Airports are being studied as complex three-dimensional sources of air pollution that can affect large parts of urban areas. Studies in California are evaluating the effectiveness of high-performance air filtration systems in reducing vehicle-related air toxics inside homes, schools, and school bus cabins. Significant reductions of both particles and air toxics have been demonstrated, depending on the air cleaning system, the specific specie(s), and the filter type.

**Atmospheric Modeling and Measurements of MSAT Chemistry and Physics**

Tools to estimate MSAT include EPA’s mobile source emissions model, Motor Vehicle Emission Simulator (MOVES 2014) which includes chemical mechanism species for the first time, and the National Air Toxic Assessment (NATA) which provides characterization of air toxics across the U.S. for most hazardous air pollutants (HAPs) plus diesel particulate matter. A new NATA framework is
being implemented that merges two types of grid modeling platforms to generate fine scale ambient concentrations. EPA is in the process of updating toxics emissions from non-road equipment. A new tool, Path-Integral Method (PIM), was used to allocate the anthropogenic increment of aldehydes to sources. Environment Canada is using a regional air quality model to determine mobile source contributions to PAH in urban air.

Acrolein is toxic, highly reactive, and challenging to measure reliably in ambient air. Further work identifying the sources and natural background level of acrolein will improve understanding of the contribution of man-made sources such as vehicle emissions. Super ultra-low (SULEV) and partial zero emission vehicle (PZEV) exhaust showed little, or no, secondary organic aerosol (SOA) formation in chamber experiments with low ozone levels but substantial SOA formation in Potential Aerosol Mass (PAM) flow reactor experiments employing high ozone levels.

**Air Quality and Exposure Modeling of MSAT**

An evaluation of the potential and constraints of carbon-neutral electricity and vehicle fuel (i.e., hydrogen, ethanol and/or biogas) supply was conducted based upon the regional renewable bio-resources in California. Results suggest that while the greenhouse gas benefits of biopower and bio-fuel production are comparable, local air quality impacts may be minimized if biofuels are favored over combustion-based bio-power production. For many pollutants, the VOC profiles associated with increasing fractions of ethanol are predicted to decrease concentrations. However, many factors other than VOC speciation affect air quality. Acetaldehyde concentrations increase with increasing ethanol, but the incremental change might be small relative to total acetaldehyde burden. In the Houston, Texas area, measurement data revealed that episodes of very high emission spikes of 1,3-butadiene occur. The CMAQ model often under predicts 1,3-butadiene mixing ratios for sites exposed to sporadic releases from industrial facilities. These releases are not fully accounted for in the emission inventory. Cyclist’s route choice can have a significant impact on their air pollution exposure. Lung function results indicate that elevated pollutant exposure may not have acute negative effects on healthy cyclists, but further research is necessary to determine effects on a more diverse population.

**Accountability**

The effectiveness of past, current, and future emission controls can be established by long-term,
consistent monitoring. The observed reductions of elemental carbon (EC), organic carbon (OC), and non-polar OC species represent an important improvement in air quality in the southeastern U.S. that can be attributed to PM$_{2.5}$ controls. Likewise, on-road measurement of emissions from heavy-duty diesel engines shows the emission impact of drayage truck regulation in Oakland, California. Between November 2009 and March 2013, fleet-average emission factors for port trucks found BC decreased by 76%, NO$_x$ decreased by 53%, with NO$_2$ increasing from 3 to 18% of total NO$_x$ emissions.

EPA used CMAQ to model trends in mobile source pollutants, with better agreement between observed and simulated long-term trends of toluene and NO$_x$ compared to xylene, CO, and elemental carbon. Analysis of weekday/weekend trends suggests the need for refinement of weekday/weekend allocations during emissions processing.

Because traditional air quality models have uncertainties and biases, using a variety of methods (observation-driven, model-based and hybrids) can improve estimates of exposure. Using long-term time series increases the ability to identify emissions trends and control impacts, and allows simulating daily concentrations to capture the impact of emissions controls. Hybrid methods can provide daily source impacts for acute time series studies.

Summary

There is an ongoing trend of reduced vehicle emissions and improving air quality in urban areas in the U.S. Cleaner fuels and vehicle emission controls have reduced the emissions and ambient concentrations of MSAT substantially over the past several decades despite a substantial increase in miles traveled. The trend of decreased emissions is expected to continue as older vehicles in the on-road fleet are replaced with newer vehicles with more modern emission controls.
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Advancing Ways to Clean Up Drinking Water Systems

EPA researchers and partners have built the nation’s first field-scale “Water Security Test Bed”
EPA is the federal agency responsible for working with water utilities to improve protection of systems from contamination and to clean up systems that become contaminated. Purposeful or inadvertent contamination of distribution systems can result in large amounts of infrastructure and water that must be cleaned. Contamination incidents can be caused by, for example, natural disasters such as Superstorm Sandy or by individuals hoping to cause harm.

Advancing the science and engineering of decontaminating pipe systems and safely disposing of high-volumes of contaminated water are high priorities for the EPA. To help address these science gaps, Agency homeland security researchers have developed the first-of-its-scale Water Security Test Bed (WSTB).

The first phase of the test bed, constructed at the Department of Energy’s (DOE) Idaho National Laboratory, replicates a section of a typical municipal drinking water piping system with roughly 445 feet of pipe and two fire hydrants laid out in an “L” shape using 40-year-old, eight-inch cement mortar lined, ductile iron pipes, excavated after twenty years of use for water conveyance. Researchers built the WSTB above ground for easy access during experiments, and to facilitate fast leak detection.

Over the next several years, EPA and partner researchers will conduct experiments using simulants of various biological, chemical, and radioactive materials that simulate high toxic versions of these agents. At this “full” sized system, researchers will demonstrate approaches to contamination detection, sensor and model testing, infrastructure decontamination, water treatment and cyber testing developed at lab and pilot scale.

Treatments tested may include chlorination and flushing protocols, use of advanced oxidative processes, or perhaps emptying and fumigating the pipes. The research team plans to connect the test bed to a building with a room set up like a typical residential bathroom to investigate how users of the facility might be exposed to contaminants in water through typical uses of showering and flushing. The team will also study the potential exposure of humans to this contaminated water.

EPA is opening up the test bed research capability to additional potential collaborators such as agencies within the DOE, Department of Defense, the Department of Homeland Security, universities, water utilities, and foundations interested in water security research. EPA is also considering partners’ needs as they build out the test bed to include service connections and other types of pipe commonly found throughout water distribution systems.

“Idaho National Laboratory’s partnership with EPA in developing America’s first Water Security Test Bed will continue the Agency’s legacy of protecting and safeguarding the nation’s drinking water and infrastructure.” — Michael Carpenter, Project Lead, Idaho National Laboratory.

“Idaho National Laboratory’s partnership with EPA in developing America’s first Water Security Test Bed will continue the Agency’s legacy of protecting and safeguarding the nation’s drinking water and infrastructure,” says Michael Carpenter, Project Lead and Relationship Manager at Idaho National Laboratory. em

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Bolstering Cities’ Role in the Fight Against Air Pollution

Cities are on the front lines in the fight against air pollution and climate change. However, managing air pollution and greenhouse gas emissions are complex tasks requiring long-term commitment, technical know-how and multi-stakeholder actions at various levels. The Cities Clean Air Partnership (CCAP)—a Clean Air Asia initiative launched in August 2014—establishes a comprehensive platform for cities to cooperate and take incremental steps in reducing air pollution from critical sources. It asserts that city-level action is the foundation for addressing the challenge of air pollution and its impacts on public health.

Air pollution knows no boundaries. About 7 million premature deaths in 2012 were attributed to air pollution — making it the world’s largest single environmental health risk that is responsible for one in eight deaths around the world. Developing Asia is the most affected region, with 3.3 million deaths linked to indoor air pollution and 2.6 million deaths related to outdoor air pollution. According to the World Health Organization, the impacts of air pollution to health are now more evident with new data that reveal stronger links between air pollution exposure (indoor and outdoor) and both cardiovascular and respiratory diseases. A rapid rise in Asian cities’ urbanization rate, motorized transport, and energy use all contribute to increased levels of air pollution. Cities hold a pivotal role in reversing current trends.
The Cities Clean Air Partnership (CCAP) is an initiative led by Clean Air Asia with initial support from the International Environmental Partnership to drive action and curb air pollution, including short-lived climate pollutants, through city-level interventions. CCAP provides a framework of cooperation open to more cities and partners.

The core element of CCAP lies in its city certification program which creates potential game-changing gains for air quality across the region. This city certification program is being designed to keep cities moving incrementally towards clean air targets. It will provide incentives, direct support, and technical assistance, and an eco-label for cities taking significant actions.

“The initiative is gaining traction with more cities and partners from national governments, environmental institutes, and other stakeholders actively signing up to CCAP since we launched in August 2014,” said Clean Air Asia Executive Director Bjarne Pedersen.

Similar to certification systems such as the Leadership in Energy and Environmental Design (LEEDS) certification that pushes for the improvement of buildings towards green practices, or the Energy Star Rating for energy efficiency and conservation, CCAP will give cities working towards air quality targets incentives for their efforts in bringing down pollution.

In November 2014, a high-level discussion on the CCAP initiative was organized at the Better Air Quality Conference in Sri Lanka. Key city associations and international air quality and climate experts agreed that the CCAP city certification framework should be transparent, participatory, and evidence-based. The panelists and technical experts all recognized and supported the potential of city certification to drive measurable and replicable air quality improvements and co-benefits through city-level actions.

Cities will be able to communicate achievements made towards their air quality management goals.

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a. International Environmental Partnership is an environmental collaboration program established by the United States Environmental Protection Agency (US EPA) and Environmental Protection Administration Taiwan (EPAT) aimed at assisting environmental agencies and organizations around the globe strengthen their capacity to manage the environment and protect human health.

b. Representatives from U.S. Environmental Protection Agency, Environmental Protection Administration Taiwan (EPAT), Climate and Clean Air Coalition, ICLEI, CITYNET, United Cities and Local Governments Asia Pacific, Norwegian Air Research Institute (NILU) and Stockholm Environment Institute (SEI).
through a “seal of approval” (or eco-label). The certification program is set to be launched in 2016 and will offer international recognition for cities taking significant steps to improve air quality levels and governance.

Air Pollution is a Concern for Every City

At the wake of the rising economic and social costs of air pollution, CCAP offers an extensive framework of support to empower cities to fight air pollution. “We can only significantly impact upon and reduce the problem of air pollution through meaningful and effective partnerships among cities, which is the driving principle of CCAP,” said Pedersen. “This is a landmark initiative towards air pollution prevention and control in Asia. We are looking forward to both delivering real impacts under this pioneering initiative as well as bringing more partners on board.”

The “twinning” of volunteer cities will allow exchange of effective practices and innovative solutions to help address specific air quality challenges faced by cities. The CCAP city-to-city cooperation (C³) is an opportunity for learning cities to tap into experiences of mentor cities. Taipei City’s bike-sharing system and heavy-duty diesel vehicle emission testing center, Taichung City’s air quality management camp by students participating in the Kids Making Sense program, and a demonstration on Taoyuan City’s use of thermal imaging camera and other equipment for enforcing air quality regulations for point sources are some of the city-level solutions that have been introduced to participating CCAP cities via a study visit in April 2015.

Following the program launch in San Francisco, several Asian cities have expressed interest to take part in the initiative. The member base of the Partnership grew from 7 inaugural cities in 2014 to about 30 participating cities in 2015, including these capital cities: Bangkok, Colombo, Delhi, Jakarta, Kathmandu, and Ulaanbaatar. The South Coast Air District, Bay Area District, and California Public Utilities Commission in the U.S. have also expressed support as initial partners of the program.

CCAP also offers city learning events to foster peer-to-peer learning and provides online resources recommending effective measures to reduce air pollution from critical sources through its knowledge platform. A training was organized for CCAP cities in April 2015 on the management
and control of PM$_{2.5}$ emissions. About seven out of ten developing cities in Asia exceed World Health Organization (WHO) air quality guideline levels for annual mean PM concentrations. Particulate Matter (PM$_{2.5}$ and PM$_{10}$) are critical pollutants to manage because of the negative health impacts they pose. Dr. Alison Simcox of Particle Pollution Program, Air Quality Planning Unit of US EPA Region 1 shared US experiences in controlling PM$_{2.5}$ and Prof. Lai Hsin-Chih of Chang Jung Christian University presented key factors contributing to successful PM$_{2.5}$ management in cities including Kaohsiung and Tainan.

**Next Steps for the Cities Clean Air Partnership (CCAP)**

The CCAP started strong and will be moving forward with pace this year to: a) facilitate city-to-city cooperation to encourage adoption of replicable practices, and technical assistance to cities; b) develop a voluntary certification system that gives a clear roadmap to manage air pollution and drive transformational change towards better air quality and livable cities; and c) establish a knowledge platform for sharing best practices and networking, with an online experts database accessible to CCAP cities.

The Partnership is a new framework of cooperation that fosters collaboration and learning among participating cities. This year, Clean Air Asia expects to engage no less than 30 Asian cities to participate in training, knowledge events and city-to-city cooperation program, with a much more ambitious target once the city certification scheme is fully operational by 2016.

To mark its first anniversary, a CCAP event is organized on August 10-12, 2015 and will be hosted by the U.S. EPA and EPAT in Washington, DC. The first set of partnering cities matched through CCAP’s city-to-city cooperation (C$^3$) program will be recognized in this event. Details can be found at www.cleanairasia.org/ccap.
Highlights of the 2015 Leadership Training Academy

by Michelle Gehring and Tony van der Vooren

Nearly 40 volunteer leaders from 20 different states and provinces gathered in Pittsburgh in April to attend this year’s A&WMA Leadership Training Academy. It was a great weekend full of seminars, workshops, and networking events. We spent time learning more about the Association, about our peers, and about ourselves. We also gained a lot of valuable tools and resources for conducting productive meetings, managing volunteer leaders (good and bad), and maintaining a successful section or chapter long into the future.

A&WMA President Dallas Baker and Tony van der Vooren presented the Association’s strategic plan and reviewed ways in which the organization is designed to support local member units. During a breakout session, attendees put their own take on the Association’s strategic plan for their local units and helped to shape our message for key Association goals moving forward.

Jim Walker gave a great presentation on A&WMA membership initiatives and ways in which we can all work to increase membership in the Association. Building on this discussion, attendees put together elevator speeches speaking to key goals of the association and membership involvement for each of our pillars of membership: government, academia, regulators, and young professionals. Some groups clearly had a longer elevator ride than others, but every group provided great ideas on how to build the different tenants of our membership.

We also spent considerable time working on our personal leadership styles and volunteer leadership skills. Amy Gilligan led attendees through a mini-Myers-Briggs workshop that determined our leadership styles and presented details on what motivates and discourages each type. Attendees spent time discussing how to deal with polar opposites. Related to leadership styles, Michele Gehring covered helpful information on leading...
and motivating a multi-generational work force. Attendees from three different generations had an open and sometimes frank discussion on generational differences and ways to manage and work with everyone.

Diane Freeman presented helpful hints on networking yourself and the Association through social media. A lot of positive discussions came out of examples on social media failures and cautions. It’s very likely that every attendee did a “self search” to see how they are portrayed on the web!

Working more directly on Sections and Chapters issues, Jayme Graham gave a great overview on the basic tenants of nonprofit governance, followed by Harry Klodowski, who led us all through a brief on Robert’s Rules of Order. Executive Director Stephanie Glyptis reviewed the essentials of running great meetings; including ones by teleconference. Closing out this discussion, Diane Freeman discussed succession planning, helping everyone to focus on the future of the Association and their individual sections and chapters.

All of the time wasn’t spent in the conference room, however. Friday night, the group took a trolley tour of Pittsburgh led by Harry Klodowski, who’s knowledge on Pittsburgh history is phenomenal as he offers his personal experiences along the way. Some attendees took the trolleys back to the hotel, while others opted to stop for some refueling along the way (#ThirdTrolley). Saturday night was A&WMA’s night at the Pirates game. Lifting everyone’s spirits with a 6-2 win over the Brewers, the Pirates also provided an unbelievable fireworks show to conclude the night. Leave it up to a bunch of engineers to dissect the formulations and emissions of fireworks. All in all, both evenings provided a great opportunity for networking with fellow attendees and expounding upon the day’s discussions.

Attend next year’s Leadership Training Academy

Didn’t make it to this year’s event? We host leadership training every April in Pittsburgh. Look for announcements in early January 2016. We’d love to see you next year!

All of the materials from this year’s training are available via the secure member portal online in the Volunteer Resources Center. www.awma.org/resources/volunteers/volunteer-leader-resource-center/leadership-training-academy. Keep checking the Section & Chapter’s LinkedIn page for more discussions on key topics.

Comments From 2015 LTA Attendees:

“The combination of learning, group activities, and networking was great. It was a thoroughly enjoyable weekend!”

“Terrific!!!!!”

“This was a great experience. I intend to recommend that we send someone from our section on an annual basis.”

“I feel energized about going forward with A&WMA activities.”
The U.S. will use its two-year chairmanship of the Arctic Council to press for significant action in cutting black carbon and methane, two short-lived but powerful greenhouse gases that contribute to rapid melting of sea ice in the region, Secretary of State John Kerry said. The U.S. has been laying the groundwork for using the chairmanship to highlight the need for action on the two super pollutants since last summer, when it named Adm. Robert Papp Jr. as U.S. special representative to the council. On curbing emissions, a senior State Department official told reporters hours before Kerry spoke that the U.S. will push for reductions in gas flaring, particularly in the Arctic during oil exploration. Other actions will include the development of a “pan-Arctic digital elevation map” that will assist policy makers and scientists in monitoring reductions in sea ice and other environmental impacts in the region, the official said. The U.S. priorities are seen as a departure from the economic development focus that has been central to Canada’s chairmanship over the last two years, which included the creation of the Arctic Economic Council and adopted the theme “Development for the People of the North” for its 2013-2015 chairmanship, thus highlighting economic development issues within the Arctic Council.

The [EPA] has proposed to revise the current 75 parts per billion standard to somewhere in the range of 65 ppb to 70 ppb. The Environmental Protection Agency is unlikely to grant a request by state air regulators to issue proposed implementation rules and guidance with an upcoming final decision on national ozone standards, the agency’s top air official said. Janet McCabe, EPA acting assistant administrator for air and radiation, said it is “not going to be realistic” for the agency to release the supporting guidance and implementation rules with the final ozone rule, which must be signed by Oct. 1. The agency has proposed to revise the current 75 parts per billion standard to somewhere in the range of 65 ppb to 70 ppb. McCabe said the EPA and states have gotten “a jump” on addressing implementation issues because the proposed rule to revise the ozone standards includes specific requests for comment on various issues.

EPA Push for Carbon Capture Said to Jeopardize Development by DOE

The Environmental Protection Agency’s push to mandate carbon capture systems for new power plants before the technology has been properly vetted could undermine the Energy Department’s work to develop the technology, an organization that describes itself as a regulatory watchdog said. The EPA’s proposal to set a carbon dioxide performance standard for new power plants, which would force coal-fired units to install carbon capture systems before the technology has been proven commercially viable, could dissuade power generators from investing in the technology once the rule is inevitably litigated, Jim Tozzi, an advisory board member at the Center for Regulatory Effectiveness, said in a letter to Energy Secretary Ernest Moniz. To satisfy peer review requirements of the Data Quality Act, Tozzi recommended the administration propose a carbon dioxide standard for new power plants that requires new coal-fired units to apply the best available control technology until carbon capture has been determined to be viable.
Climate Change Threatens Superfund Sites, Which Could Affect Liability, Lawyers Say

Hurricanes, rising sea levels, floods and other weather events linked to climate change pose an increasing threat to some Superfund sites that may change the calculus of liability under the federal hazardous waste law, environmental lawyers told Bloomberg BNA. Attorneys representing companies and others involved with contaminated properties falling under the Comprehensive Environmental Response, Compensation and Liability Act may have to contend with a number of developing issues caused by climate change, including the scope of liability for releases stemming from natural disasters, due diligence and the availability of the act of God defense. These legal issues are explored by Bloomberg BNA through recent interviews with Superfund litigators and academics. And some say planning for climate change’s impact on the U.S.’s most polluted properties couldn’t be coming soon enough. “In view of the increasingly confident projections of continued sea level rise and associated storm surges, I believe it is incumbent upon parties designing and approving CERCLA remedies to take these potential events into account,” Michael Gerrard, a law professor and director of Columbia Law School’s Center for Climate Change Law in New York, said. A total of 521 of the U.S.’s 1,639 National Priority List hazardous waste sites identified by the Environmental Protection Agency face risks from rising tide levels, according to EPA data. em

Countries Should Consider Reductions in Methane Paris Talks, Report Says

Nearly 3.6 trillion cubic feet of natural gas valued at $30 billion was leaked into the atmosphere in 2012, according to a report from the Environmental Defense Fund. Those leaks accounted for 3 percent of global natural gas production and were the equivalent of 1,680 million metric tons of carbon dioxide, which should factor into upcoming global climate negotiations, researchers said in the report, “Untapped Potential: Reducing Global Methane Emissions from Oil and Natural Gas Systems,” released April 21. Countries should consider the cost-effective controls that are available to contain methane emissions as they meet to negotiate a new climate goal in Paris later this year, Kate Larsen from the Rhodium Group, told reporters. The seven countries with the largest methane emissions accounted for more than half of global emissions in 2012, according to the report. However, researchers said much of the data provided by countries about their emissions is out of date. The Environmental Protection Agency plans to directly regulate methane emissions from new oil and natural gas wells for the first time as part of a White House strategy to curb methane emissions. The EPA will propose the rule this summer with a final rule expected in 2016. em

[Natural gas] leaks accounted for 3 percent of global natural gas production and were the equivalent of 1,680 million metric tons of carbon dioxide.
Hydraulic fracturing and associated oil and natural gas drilling activities can threaten the quality or quantity of drinking water resources, but the instances of contamination have been relatively few, the Environmental Protection Agency said June 4 in the release of a long-awaited study. “We did not find evidence that these mechanisms have led to widespread, systemic impacts on drinking water resources in the United States,” the EPA said in its draft assessment of risks to drinking water.

"Of the potential mechanisms identified in this report, we found specific instances where one or more mechanisms led to impacts on drinking water resources, including contamination of drinking water wells. The number of identified cases, however, was small compared to the number of hydraulically fractured wells," the report said.

The report used an expanded definition of drinking water resources, including in the category for undrinkable saline waters on the theory that those waters might someday be desalinated and used for drinking. The importance of the 998-page report is that it can serve as a critical resource for federal, state, local and tribal authorities and for industry to better protect drinking water, said Thomas Burke, deputy assistant administrator of the EPA Office of Research and Development, during a telephone news conference.

**EPA Official Cautious on Study**

Several industry and environmental advocacy groups saw the draft assessment as a vindication of what they have been saying for years, despite
their opposing views. Burke was more cautious. The study is a compilation of data drawn from case studies and more than 950 other studies that can be used by policymakers and regulators as reference material for their work, Burke said.

“The study is not a human health risk assessment,” Burke said. Nor is it a policy document, nor does it identify policy options, he said. Nor was the study developed to quantify instances of contamination, he said. The study itself said, “Although no attempt has been made in this assessment to identify or evaluate comprehensive best practices for states, tribes, or the industry, we describe ways to avoid or reduce the impacts of hydraulic fracturing activities as they have been reported in the scientific literature.”

The report, requested by Congress and planned by EPA in 2011, was released for public comment and peer review. The EPA Science Advisory Board will conduct the peer review and has scheduled three public teleconferences and a two-day meeting during Sept. 30-Oct. 30. Results of the peer review are not expected before 2016.

**Contamination Risks Detailed**

The draft assessment found that hydraulic fracturing poses the risk of contamination to drinking water from spills at the well site, mishandling of wastewater, underground leaks from flaws in well casing or well cementing, and drilling directly into drinking water resources—risks that have been recognized for decades.

“In the draft report, the agency appears to take a very broad definition and scope of fracturing and categorizes some processes that are not part of actual fracturing activity, such as casing and cementing of wells,” said Barry Russell, president of the Independent Petroleum Association of America, in a statement released after the report appeared.

The study repeatedly referenced “fracturing-related” activities connected to contamination incidents, leaving unclear the question of whether it was fracturing itself or something like poor well casing that led to a spill. Those factors can be interrelated, Burke indicated. “There are instances where fracturing itself led to problems with well construction that led to contamination,” Burke said. The study cited examples drawn from 2006-2012 state and industry data.

**Water Resources Viewed Broadly**

The study complicated the issue through its definition of drinking water resources. That had bearing especially on the report’s treatment of drilling into some saline aquifers as drilling directly into drinking water resources. The report did not make clear whether drilling and fracturing were ever conducted in freshwater resources.

Similarly, the report’s examples of contamination through leaks typically referred to drinking water resources without specifying whether the leaks were into freshwater aquifers or untapped saline aquifers. The definition for drinking water resources used by the EPA study was any water with total dissolved solids below 10,000 milligrams per liter. That is a common dividing point between moderately and highly saline water, and it is used, for example, by the U.S. Geological Survey. U.S. drinking water systems typically restrict drinking water to less than 500 m/L total dissolved solids.

**Data Limits Noted**

“This study provides solid scientific analysis that fracking has contaminated drinking water around the country,” said Amy Mall, a senior policy analyst for the Natural Resources Defence Council, an activist group, in a statement released June 4.

“This study is missing some critical elements, hamstringing its comprehensiveness. Among other things, there are reports industry has not cooperated in providing important information,” Mall said. The study cited some limitations on information available, such as claims of confidentiality for some chemicals used, sealed documents in litigation, or the scarcity of baseline water sampling prior to oil or gas drilling.

“There is a lack of baseline surface water and ground water quality data. This lack of data limits our ability to assess the relative change to water quality from a spill or attribute the presence of a contaminant to a specific source,” the study said.

The draft assessment found that hydraulic fracturing poses the risk of contamination to drinking water from spills at the well site, mishandling of wastewater, underground leaks from flaws in well casing or well cementing, and drilling directly into drinking water resources—risks that have been recognized for decades.
But for the work on the five-year study, oil and gas companies were helpful, Burke said, remarking, “We had a generally very cooperative relationship with industry.”

**Industry Sees Verification of Safety**

Industry groups and some Republicans in Congress welcomed the study as a verification of the safety of hydraulic fracturing as practiced by U.S. companies and regulated by states. “After more than five years and millions of dollars, the evidence gathered by EPA confirms what the agency has already acknowledged and what the oil and gas industry has known,” said Upstream Group Director Erik Milito of the American Petroleum Institute, an industry group. “Hydraulic fracturing is being done safely under the strong environmental stewardship of state regulators and industry best practices.”

Similar statements were released by Sens. Lisa Murkowski (R-Alaska) and Jim Inhofe (R-Okla.), the chairmen, respectively, of the Senate Energy and Natural Resources Committee and the Environment and Public Works Committee. Statements from Inhofe and Rep. Rob Bishop (R-Utah), chairman of the House Natural Resources Committee, suggested the Obama administration has been looking for excuses to increase regulation of hydraulic fracturing, as it did with its final rule in March to update regulations for oil and gas drilling on federal lands (46 ER 947, 3/27/15).

**Action by Congress Suggested**

Three members of Congress focused in part on the study’s notes about data limitations. “Congress must be looking closely at ways to close these data gaps moving forward in order to prevent any further contamination,” said a statement from Reps. Frank Pallone (D-N.J.), Diana DeGette (D-Colo.) and Paul Tonko (D-N.Y.).

Sen. Ed Markey (D-Mass.) said, “This draft report verifies what we have known for years, that hydraulic fracturing and related activities have the potential to severely impact drinking water and endanger public health and the environment. While the number of cases studied may be small, the impacts to public health and safety are large.” Markey may have been making a general reference to case studies that have appeared elsewhere when he mentioned public health and safety.

The EPA draft assessment said it “did not contain a human health risk assessment” and it “does not identify populations that are exposed to chemicals, estimate the extent of exposure, or estimate the incidence of human health impacts.” —By Alan Kovski, Bloomberg BNA

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**Practicality, Costs of Federal Fracking Rule Defended Against Industry Injunction Request**

Oil and gas industry plaintiffs seeking a preliminary injunction against the new federal rule on hydraulic fracturing have misread the rule, ignored explanations in the rule and failed to properly present evidence of imminent harm to justify an injunction, the government told a federal court (Indep. Petroleum Ass’n of Am. v. Jewell, D. Wyo., No. 2:15-cv-00041, 6/1/15).

The rule will involve only “modest compliance costs,” the Interior Department said in a June 1 brief defending its rule. The higher costs assumed by the petitioners are not a basis for an injunction, the department told the U.S. District Court for the District of Wyoming.

The Independent Petroleum Association of America and the Western Energy Alliance, in requesting the preliminary injunction, said the rule includes technical and legal requirements that in several instances can be impossible to comply with, making the rule “arbitrary and capricious.”
under the Administrative Procedure Act (46 ER 1571, 5/22/15).

The technical requirements aren’t as much of a change from existing practice as petitioners claim and aren’t impossible, according to the responding brief from the government. Similarly, the chemical disclosure requirements aren’t as big change, and they do make adequate allowances for trade secrets, the government said.

The rule (RIN 1004-AE26) on hydraulic fracturing, or fracking, was issued by the Bureau of Land Management in March and is due to go into effect June 24. Judge Scott Skavdahl set a court hearing on the preliminary injunction motion for June 23.

Brief Explains Requirements
The lawsuit, naming Interior Secretary Sally Jewell as lead defendant, zeroed in on such problems as a requirement for a mechanical integrity test that, according to the plaintiffs, isn’t defined and consequently makes compliance impossible.

The government brief countered that while the rule requires a more stringent mechanical integrity test than the established test designated Onshore Order 2, the new requirement is spelled out in the rule and is appropriate for making sure the well can cope with the greater pressures generated by fracking.

The petitioners said the operators of a well cannot provide affidavits on the chemical contents of fracturing fluids if the fracturing service providers refuse to share the chemical details with the operators. The government responded that there is nothing new in requiring a well operator to certify that a service company is in compliance with applicable laws and regulations.

The rule also requires temporary storage of fluids recovered from a well pending approval of a wastewater disposal plan. Such a requirement may in many cases be inapplicable, but the work at the well wouldn’t be hindered by the inapplicability of the requirement, the government said.

Risk of Harm Disputed
“Because Petitioners have failed to demonstrate a likelihood of success on the merits, the Court may deny Petitioners’ motion on that basis alone,” the government said.

At the same time, an injunction should be denied because the petitioners failed to establish that their member companies would suffer irreparable harm without an injunction, the government said.

The rule maintains protection for confidential information about fracturing fluids despite the plaintiffs’ concern about disclosure of trade secrets, according to the government.

The BLM estimated the cost of the rule at $11,400 per well, or no more than 0.21 percent of the typical cost of drilling a well, leading the government to argue that the harm wouldn’t be enough to justify an injunction.

“Petitioners’ assertions that these and other costs of the rule are underestimated have been refuted and shown to be speculative,” the federal government said. Even if the costs were twice what BLM estimated, “they would still be less than half of one percent of the average cost of drilling and fracturing a horizontal well,” the government said. —By Alan Kovski, Bloomberg BNA.
NS proposing administrative penalties for approvals violations

Nova Scotia Environment is proposing to amend the province’s Environment Act to allow the ministry to levy monetary administrative penalties against approval holders who do not comply with either the terms of their approvals or with directives issued by a ministry inspector.

The range of fines being currently considered is $200 to $5,000, depending on a company’s compliance history and the severity of the non-compliance. The ministry would also be able to restrict future renewals of approvals, new approvals, or transfers or amendments of approvals in cases where an approval holder has failed to pay an administrative penalty.

The administrative penalties are being considered for the following types of approvals: industrial (e.g., mining, electricity generation, pulp and paper facilities), asbestos, dangerous goods, municipal (water and sewage treatment and septage), solid waste, and registered public drinking water supplies. Not every violation would result in an administrative penalty. Inspectors would consider the seriousness and length of time of the offence and could choose to issue a warning, a summary offence ticket, or formal prosecution as an alternative to an administrative penalty. The ministry says it will develop criteria to ensure inspectors exercise the discretion available to them fairly and consistently. —By Mark Sabourin, EcoLog

Manitoba looking at changes to The Environment Act

There are a number of reasons why the Manitoba Law Reform Commission believes now is the right time to consider reform of the province’s environmental assessment legislation. The core provisions from the original 1988 The Environment Act remain intact, but technology and public attitudes about environmental assessment have changed.

The 2012 amendments to the Canadian Environmental Assessment Act provide additional impetus. Under the amended federal Act, it’s expected that federal environmental assessments will significantly shrink in number and narrow in scope. The province may have to pick up the slack.

The province is also in the midst of a review of The Environment Act. A review of Manitoba’s environmental assessment legislation provides recommendations for reform. For the most part, those recommendations are confined to areas where there is a significant body of knowledge that identifies good, or even best, practices. The report and recommendations should interest not only Manitoba legislators, but lawmakers across Canada.

The themes that run throughout the report will be familiar to analysts of Canadian environmental law: First Nations involvement, access to information, public participation, transparency, certainty. However, despite the familiarity of the themes, there was often little in the way of consensus on the proper course of action, reflecting, according to the report, “the competing interests and perspectives involved in environmental assessment and licensing.” —By Mark Sabourin, EcoLog

Que, Ont to collaborate on water issues

Quebec Minister of Sustainable Development, Environment and the Fight against Climate Change David Heurtel and Ontario Minister of the Environment and Climate Change Glen Murray announced on May 29, 2015 the creation of a joint Ontario-Quebec Committee on Water Management. The joint committee will facilitate co-operation and the sharing of information between Ontario and Quebec on water management issues, including water management of the Great Lakes and the St. Lawrence River and water quality in the rivières des Outaouais, lac Témiscamingue and lac Abitibi. The joint committee also will search for common solutions for shared drainage basins. Each minister will designate four representatives to the joint committee. The joint committee will produce an annual work plan and will issue a report on its work. (ehscompliance.ca) —By Mark Sabourin, EcoLog
Listed here are the papers appearing in the July 2015 issue of EM’s sister publication, the Journal of the Air & Waste Management Association. For more information, go to www.tandfonline.com/UAWM.

Technical Papers

- Pollutant in palm oil production process
- Meteorological and urban landscape factors on severe air pollution in Beijing
- Forty-year (1971–2010) semi-quantitative observations of visibility-cloud-precipitation in Korea and its implication for aerosol effects on regional climate
- Improving artificial neural network model predictions of daily average PM\textsubscript{10} concentrations by applying principle component analysis and implementing seasonal models
- Degradation of volatile organic compounds in the gas phase by heterogeneous photocatalysis with titanium dioxide/ultraviolet light
- An interprovincial cooperative game model for air pollution control in China
- Optimizing chemical oxygen demand removal from synthesized wastewater containing lignin by catalytic wet-air oxidation over CuO/Al\textsubscript{2}O\textsubscript{3} catalysts
- A more accurate method using MOVES (Motor Vehicle Emission Simulator) to estimate emission burden for regional-level analysis
- Estimation of methane emission from California natural gas industry
- Sensor transition failure in the high flow sampler: Implications for methane emission inventories of natural gas infrastructure
- Evaluating measurements of carbon dioxide emissions using a precision source—A natural gas burner
- Evaluation of ozone, nitrogen dioxide, and carbon monoxide at nine sites in Saudi Arabia during 2007
- Uncertainty associated with the gravimetric measurement of particulate matter concentration in ambient air

Events sponsored and cosponsored by the Air & Waste Management Association (A&WMA) are highlighted in bold. For more information, call A&WMA Member Services at 1-800-270-3444 or visit the A&WMA Events Web site: www.awma.org/events.

To add your events to this calendar, send to: Calendar Listings, Air & Waste Management Association, One Gateway Center, 3rd Floor, 420 Fort Duquesne Blvd., Pittsburgh, PA 15222-1435. Calendar listings are published on a space-available basis and should be received by A&WMA’s editorial offices at least three months in advance of publication.

2015

**JULY**

28–29 Understanding Today’s Clean Air Act Permit Programs
Dallas, TX | permitting.awma.org

**AUGUST**

19–21 A&WMA’s Southern Section Conference
Callaway Gardens, GA
www.ss-awma.org/annual.php

**SEPTEMBER**

9–10 Addressing Climate Change: Emerging Policies, Strategies, and Technological Solutions
Chicago, IL | climatechange.awma.org

22–23 Gulf Coast Oil & Gas Environmental Conference
New Orleans, LA
awma.org/gulfcoastoilandgas

**OCTOBER**

20–22 International Conference on Thermal Treatment Technologies & Hazardous Waste Combustors
Houston, TX | it3.awma.org

**DECEMBER**

1–2 40th Annual A&WMA/EPA Information Exchange
Research Triangle Park, NC

2016

**MARCH**

15–17 Air Quality Measurement Methods and Technology
Chapel Hill, NC

**APRIL**

12–14 Guideline on Air Quality Models: The New Path
Raleigh, North Carolina

**JUNE**

20–23 2016 Annual Conference & Exhibition
New Orleans, LA
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Auto-download of worldwide terrain and land use data.

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