APPENDIX

Annotations and References
EPA Article: Next Generation Compliance
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Purpose

This Appendix serves as companion piece to the article, *Next Generation Compliance*, written by EPA Assistant Administrator Cynthia Giles and published in the September/October 2013 issue of the Environmental Law Institute's newsletter, *Environmental Forum*. This document includes annotations, references, and relevant examples intended to provide additional information to readers.

EPA gathered most of the information described in this document during the course of extensive research and analysis on topics related to Next Generation Compliance. The reference information provided in this document has been organized by the specific sections of the article, as described below:

Introduction

"William D. Ruckelshaus, EPA's first administrator, said that the first thing he did when he took the helm in 1970 was to file a bunch of lawsuits against the country's biggest polluters. He made it clear to everyone that there was a new sheriff in town who was going to take action to stop the all too apparent air and water emissions plaguing the nation." For more information on William Ruckelshaus, *see* http://www2.epa.gov/aboutepa/william-d-ruckelshaus. The following are excerpts from an April 2009 interview with Ruckelshaus for the PBS show Frontline (full interview can be viewed at http://www.pbs.org/wgbh/pages/frontline/poisonedwaters/interviews/ruckelshaus.html):

- **Reporter: What did you see your job as being when you got the agency started?**

- It seemed to me we had a societal issue, and that was the federal government had never been very active in trying to deal with pollution abatement or protection of the environment or public health. … It was left up to the states. And my impression from having had that experience in the state of Indiana was the states weren't good regulators of industry on the question of health, safety and the environment. They had competed so strongly for industry being located in their borders that they just weren't good regulators, or there wasn't much political support for going after polluters and after this kind of problem.

- So what you needed to do was ... to focus the attention on the central government, set some reasonable standards and then go about enforcing them.

- That was important to do because the public was all riled up about this problem -- for justifiable reasons, in my judgment -- and they needed to be reassured that their government was responding to their demands that something be done about this problem. Having the opportunity to do that in a federal agency and act responsibly toward a legitimate public

demand was well worth doing. So we had to select some big, visible polluters -- both industrial and municipal -- go after them, make sure the public understood we were being responsive to their concerns, and that would energize the agency and get us in a position to do things that needed to be done in order to address the problem.

- **Reporter: So you had to enforce the law. You had to be a tough regulator.**

- That's right, in order to be successful you had to reassure the public that this was a problem the government was taking seriously. We had to be tough. We had to issue standards and we had to enforce them. ... There were targets galore, and most of the people running big American manufacturing facilities in those days believed this was all a fad; it was going to go away, and all they had to do was sort of hunker down until the public opinion subsided, public concern subsided, and it would go away. ...

- We went after U.S. Steel. There was Dow Chemical. We went to a national mayor's conference down in Atlanta, at the request of now-Senator, then-Mayor [Richard] Lugar of Indianapolis. … I told him when I got there we're going to announce that we're going to sue Atlanta, Cleveland and Detroit, who are in violation of requirements for treatment of sewage going into these waterways around their community.

For general information on the history of EPA, we have provided the following article by The Guardian: http://www2.epa.gov/aboutepa/guardian-epas-formative-years-1970-1973

"Today, strong criminal and civil enforcement is – and will continue to be – an essential part of our environmental protection work. But we can accomplish even more by moving our compliance programs into the 21st century." There is a rich theoretical and empirical literature demonstrating the effectiveness and limits of traditional individual-facility monitoring and enforcement in promoting compliance and deterrence. *See, e.g.,*: (1) *Monitoring, Enforcement, & Environmental Compliance: Understanding Specific & General Deterrence* (State of the Science White Paper prepared for EPA Oct. 2007) http://www.epa.gov/Compliance/resources/reports/compliance/research/meec-whitepaper.pdf; (2) Compliance Literature Search Results – Citations to Over Two Hundred Compliance-Related Books and Articles From 1999 to 2007 (April 2007). http://www.epa.gov/Compliance/resources/reports/compliance/research/lit-results-2007.pdf

Rules With Compliance Built In

"Research shows that enforcement cases do more than just improve compliance by the entity sued; they also deter potential violators and thus improve compliance generally – much as seeing a speeder get ticketed tends to slow traffic." For example, an academic analysis of the compliance of 251 major pulp, paper, and paperboard mills in 28 states over 14 years found that, in the year following a sanction, plants reduced their discharges by a statewide average of 7% across the entire range of emissions distribution. Even complying plants responded to penalties against other facilities in their states by further reducing discharges to increase compliance margins. J. Shimshack & M. Ward, *Enforcement and Over-Compliance*, J. Environ. Econ. 55(1): 90-105 (2008).

The provided example of requiring auto manufacturers to build pollution control equipment into all cars and trucks sold in the United States combines two design principles for highly effective regulations: (1) focusing regulatory requirements on fewer, better-defined "upstream sources" rather than numerous

diverse or diffuse "downstream sources"; and (2) structuring regulations to make compliance easier than noncompliance by building in physical structures and product designs to make compliance easier and noncompliance difficult.

- For an introduction to legal and practical considerations in building compliance into rules through physical structures or product designs, *see* Edward K Cheng*, Structural Laws and the Puzzle of Regulating Behavior*, 100 NW U. L. Rev. 655-718 at 657 (2006).

- Another example of regulating "upstream" through physical structure and product design:

Gas nozzle inlet restrictors

When EPA banned leaded gasoline, the Agency mandated **gas nozzle inlet restrictors** to make it physically difficult for automobile owners to pump cheaper leaded gasoline into vehicles not designed for it. This made it virtually impossible for drivers to violate the rule and dramatically simplified compliance monitoring. Rather than needing to monitor the gas pumping actions of millions of drivers, EPA could focus on assuring that a much smaller set of pump manufacturers and installers met their applicable nozzle standards.

The referenced April 2013 proposed rule requiring emissions controls for thousands of oil and gas producers is the *Oil and Natural Gas Sector: Reconsideration of Certain Provisions of New Source Performance Standards*, 78 Fed. Reg. 22126 (April 12, 2013). The proposed rule is published at http://www.gpo.gov/fdsys/pkg/FR-2013-04-12/pdf/2013-07873.pdf. In the final rule, the manufacturer is not required to report who purchased the compliant equipment; the owner or operator reports this information. The final rule is published at http://www.gpo.gov/fdsys/pkg/FR-2013-09-23/pdf/2013-22010.pdf.

"Independent third-party validation can work in some cases."

- For an introduction to designing rules to incorporate third-party approaches, *see* Lesley K. McCallister, *Regulation by Third Party Verification,* 53 B.C.L. L. Rev. 1 (2012). http://lawdigitalcommons.bc.edu/cgi/viewcontent.cgi?article=3182&context=bclr

- On December 6, 2012, the Administrative Conference of the United States published a recommendation on *Agency Use of Third-Party Programs to Assess Regulatory Compliance* at http://www.acus.gov/sites/default/files/documents/Recommendation%202012-7%20%28Third-Party%20Programs%20to%20Assess%20Regulatory%20Compliance%29.pdf. A review of third-

party regulatory verification programs in a variety federal rules and voluntary programs developed in support of the recommendation, *Third Party Programs to Assess Regulatory Compliance* (Oct. 22, 2012), is available at http://www.acus.gov/sites/default/files/documents/Third-Party-Programs-Report_Final.pdf.

- *Third-party verification regulatory example*: EPA recently proposed two rules aimed at protecting the public from risks associated with exposure to formaldehyde. The first proposal would implement the formaldehyde emission standards under TSCA Title VI for hardwood plywood, medium-density fiberboard, particleboard, and other finished goods. The second proposal would establish a framework for a third-party certification program to ensure that composite wood panel producers comply with their formaldehyde emission limits. Under the proposed framework, third-party certifiers (TPCs) would apply to EPA-recognized accreditation bodies who would verify the certifiers' ability to ensure that panel producers comply with the formaldehyde emission standards. The TPCs would audit composite wood panel producers and verify compliance with the formaldehyde emission standards. The proposed rule with the 3rd party framework is available at https://www.federalregister.gov/articles/2013/06/10/2013-13254/formaldehyde-third-party-certification-framework-for-the-formaldehyde-standards-for-composite-wood.

"[M]arket strategies that set standards but allow companies to decide how best to get there can be simple and effective in the right circumstances … We saw that approach work in the acid rain program, where an integrated system of pollution allowances, continuous monitoring, electronic reporting, and market trading got fast and efficient results and very high levels of compliance."

- An analysis of the Acid Rain Program determined that it led to the "largest quantified human health benefits of any federal regulatory program implemented in the last 10 [years], with annual benefits exceeding costs by >40 to 1" by promoting "public confidence in the programs, highly accurate and complete emissions data, and a high compliance rate (>99% overall)." *See* John Schakenbach, et al., *Fundamentals of Successful Monitoring, Reporting, and Verification under a Cap-and-Trade Program*, 56 J. Air & Waste Mgmt. Ass'n, 1576, 1576 (2006). http://www.epa.gov/airmarkt/cap-trade/docs/fundamentals.pdf

- Under the Acid Rain Program's missing data provisions, sources also must substitute increasingly conservative emission values if the actual emissions data that is available drops below regulatory "cut points." Because the missing data is substituted automatically, the deficiencies are not automatically violations, saving regulators and sources enforcement and litigation costs. And because the substitute data provisions increase a facility's reported emissions, they create an incentive for sources to properly maintain and quality-assure their monitoring equipment.

Advanced Pollution Monitoring

"[I]n one much-used river, EPA has installed solar powered continuous monitoring devices that upload via cell phone technology to agency computers." Below is a picture of this device in use on the Charles River in Massachusetts. The parameters measured include: temperature, conductivity, pH, dissolved oxygen, turbidity, chlorophyll, and phycocyanin (measured to estimate the level of cyanobacteria, a harmful algal bloom). The buoy takes measurements every 15 minutes and uploads the results to a password-protected website.

"In our enforcement cases we are getting agreements to install [advanced monitoring] technologies at fence lines so that companies and communities can know about pollution, and prompt action can be taken to fix problems before they become serious health concerns." For example, on May 23, 2012, EPA and the U.S. Department of Justice announced an enforcement settlement with BP North America Inc. The settlement requires BP to pay an $8 million penalty and invest more than $400 million to install state-of-the-art pollution controls and cut emissions from BP's petroleum refinery in Whiting, IN. In addition, as a supplemental environmental project, BP will install, operate and maintain a $2 million fence line monitoring system at the Whiting Refinery and will make the data collected available to the public by posting the information on a publicly-accessible website. The fenceline monitors will continuously monitor benzene, toluene, pentane, hexane, SO2, hydrogen sulfide (H2S), and all compounds containing reduced sulfur. http://www2.epa.gov/enforcement/bp-whiting-settlement-flaring

"[M]ake previously invisible pollution visible. Infrared cameras, for example, allow the user to actually see dark plumes that look like smoke when volatile organic compounds such as benzene are released to the air, even though these emissions are invisible to the naked eye." The following Government Accounting Office (GAO) video shows vented gas, which appears as "smoke" billowing from the top of cylindrical metal oil storage tanks and from a pneumatic valve, as seen through an infrared camera. The video also shows the equipment as seen through the naked eye where the gas is invisible. The video clips were supplied to GAO by EPA and a private emission detection firm. http://www.youtube.com/watch?v=N7tLcPQk3PA

"Communities with monitoring data will encourage better performance by industries they host." The following EPA-produced "citizen science" video demonstrates how EPA and the New York State (NYS) Department of Environmental Conservation collaborated with citizens tracking air quality in Tonawanda, New York to identify and address excessive levels of benzene and other hazardous air pollutants. The citizen monitoring led to a series of enforcement actions by EPA and NYS to bring the Tonawanda Coke Facility into compliance with Clean Air requirements. The company ultimately agreed to improve its operations, monitor for leaks, and upgrade pollution controls, slashing pollution releases by at least two thirds. Also, in March 2013, the company and one of its executives were convicted of related criminal violations. What began as a community effort to assess air pollution quality led to reduced air pollution and effective enforcement responses. http://www.youtube.com/watch?v=DZKxn1nioNA

"These changes [lower cost monitoring devices, improved public access to pollution monitoring tools, and more available data], driven by new technologies, will encourage more direct industry and community engagement, and reduce the need for government action." In the context of air monitoring, for example, EPA is already working with the commercial sensor industry, academic institutions,

community groups, and innovative individuals to develop, evaluate, and apply new and innovative air quality and exposure monitoring technologies. http://www.epa.gov/research/airscience/next-generation-air-measuring.htm

Electronic Reporting

"E-reporting is a solution that saves time and money while improving results."

- *See* the NPDES Electronic Reporting Proposed Rule's preamble for a qualitative and quantitative elucidation of the benefits and costs of e-reporting. For example, "The cost of implementing the proposed rule in the first four years after the effective date is approximately $50.6 million. The cost is estimated to drop to $2.9 million per year after that time period, when all regulated facilities will be converted to electronic reporting. However, two years after rule promulgation, annual savings greatly outweigh annual costs, by approximately $29 million per year. EPA anticipates that the proposed rule will save money for states, tribes, and territories as well as EPA and NPDES permittees, while resulting in a more complete, accurate, and nationally-consistent set of data about the NPDES program. By the fifth year of implementation, the anticipated savings for the states is $28.9 million annually; for the permittees, $1.2 million annually; and for EPA, $0.7 million annually." *NPDES Electronic Reporting Proposed Rule* (July 30, 2013). http://www.regulations.gov/#!documentDetail;D=EPA-HQ-OECA-2009-0274-0097

- *See also*, "… Ohio EPA launched its electronic discharge monitoring report (eDMR) system and, as of 2011, has achieved a 99% electronic reporting adoption rate by its permit holders. According to Ohio EPA, based on interviews and data collection, their work demonstrates how electronic reporting in this instance produced significant efficiency savings (time and resources) while increasing data quality. In the opinion of Ohio EPA, this has led to more effective human health and environmental protection through improving its ability to monitor and enforce CWA compliance. (Case Study: Ohio Environmental Protection Agency's Electronic Discharge Monitoring Report (eDMR) System Reaches 99% Adoption. *http://eitlc.ross-assoc.net/images/4/4c/Ohio_eDMRs_Case_Study_04_30_10_FINAL.doc*). In the Ohio EPA Case Study, the authors found that the automated compliance tools within its eDMR system informed permit holders if their discharge amounts exceeded authorized permit limits or were otherwise entered erroneously, and reduced errors from 50,000 to 5,000 per month. Permit holders were often able to quickly to correct their data, leaving the Ohio EPA with more accurate and robust data. Simultaneously, as the need for data entry and error checking diminished, Ohio EPA was able to move almost five full-time personnel away from those tasks and into other productive types of work. Id." *NPDES Electronic Reporting Proposed Rule*, supra.

- "Software developers can take advantage of the market created by electronic reporting to develop e-reporting tools that work better for the user, with no additional cost to the taxpayer." Many people are personally familiar with federal income tax return e-reporting using IRS-approved tax preparation software. *See* the Internal Revenue Service web page, "How Tax Preparation Software is Approved for Electronic Filing," for further background information. http://www.irs.gov/Tax-Professionals/e-File-Providers-&-Partners/How-Tax-Preparation-Software-is-Approved-for-Electronic-Filing

"[S]oftware reporting tools that allow self-correction by flagging inconsistent or mathematically impossible entries, as is done by EPA's electronic Greenhouse Gas Reporting Tool (e-GGRT), helps to

prevent mistakes before they happen, saving everyone time and money." The e-GGRT supports facility and supplier reporting for the EPA Greenhouse Gas Reporting Program. It requires electronic reporting of greenhouse gas (GHG) emissions from large sources and suppliers in the United States. The e-GGRT may be accessed at https://ghgreporting.epa.gov/ghg/login.do. For more information on the Greenhouse Gas Reporting Program generally, *see* http://www.epa.gov/ghgreporting/.

"Greater accessibility [to e-data] could also drive better compliance performance as facilities learn from each other about what performance is possible." Research has demonstrated similar impacts from public access to Toxics Release Inventory (TRI) data. *See, e.g.,* Fung, A. & O'Rourken, D.; *Reinventing Environmental Regulation from the Grassroots Up: Explaining and Expanding the Success of the Toxics Release Inventory*; Env. Man., Vol. 25(2), pp. 115–127 (2000) at 126: "By encouraging the most advanced firms to develop ever more effective pollution prevention and reduction practices and by pressuring the worst performers to adopt these demonstrated technologies, public policies [like TRI] can effectively deploy the resources of environmental agencies and utilize the energy and wisdom of ordinary people to improve the quality of our air, soil, and water and thereby to create safer communities for all of us." http://nature.berkeley.edu/orourke/PDF/tri.pdf

"Electronic reporting is not a one-way street. Once an electronic mode of communication is set up between government and facilities, government can provide specific, relevant information and compliance assistance to industry." To support these outcomes, the FY 2014 President's Budget proposes "investing in the E-Enterprise Initiative to assess and reformulate business processes, transition from paper-based to electronic reporting, and develop an interactive portal for regulatory transactions with States and the business community. This investment will improve the quality of data used for decision-making and allow the Agency and States to regulate and enforce compliance more effectively and efficiently." http://www.whitehouse.gov/sites/default/files/omb/budget/fy2014/assets/environmental.pdf And, in addition to promoting e-reporting, E-Enterprise supplements and amplifies the positive impacts of advanced pollution monitoring and increased transparency.

EPA's current Priority Goal under the FY 2011-2015 EPA Strategic Plan is to "increase transparency and reduce burden through E-reporting." In furtherance of this goal, the Agency established a joint EPA/Environmental Council of the States (ECOS) E-Enterprise Working Group to develop recommendations advancing the goals of E-Enterprise for both EPA and ECOS. Since many environmental reports are submitted directly to delegated state agencies, the success of this initiative is dependent upon a shared commitment to the joint pursuit of a vision grounded on the open and transparent exchange of information and data. http://goals.performance.gov/goal_detail/epa/368/print

Increased Transparency

"A 2008 study in Massachusetts found that larger drinking water systems required to mail [Safe Drinking Water Act Consumer Confidence Reports] directly to customers reduced their total violations by 30-44% as a result of this new reporting, and reduced the more severe health violations by 40-57 percent." The referenced study is, L. Bennear and S. Olmstead, *Impacts of the "Right to Know": Information Disclosure and the Violation of Drinking Water Standards*, 56 J. Envt'l Econ. & Mgmt. 117 (2008).

"Using transparency as a way to improve performance is one the most important things we have learned about strategies to increase compliance."

- The mandatory disclosure of information to the public is an increasingly pervasive and important regulatory tool that has become "one of the most striking developments in the last generation of American law." Cass R. Sunstein, Informational Regulation and Informational Standing: Akins and Beyond, 147 U. Pa. L. Rev. 613 (1999).

- There is a large and growing body of academic literature on the uses and effectiveness of transparency as a regulatory tool to improve compliance and performance. For an overview of transparency principles, begin with A. Fung, M. Graham, D. Weil, and E. Fagotto, *Transparency Policies: Two Possible Futures*, Harvard Univ. Taubman Center Policy Brief 2007-1. http://www.hks.harvard.edu/var/ezp_site/storage/fckeditor/file/pdfs/centers-programs/centers/taubman/transparency_new.pdf. For more detailed information, s*ee also,* A. Fung, M. Graham, and D. Weil, *Full Disclosure – The Perils and Promise of Transparency* (Cambridge University Press 2007). The Transparency Policy Project web page is another potentially helpful resource. http://www.transparencypolicy.net/

"[The Toxics Release Inventory] requirement to report and publish information is credited with a significant drop in emissions." *See, e.g.*, Fung and O'Rourken, supra. *See also*, Konar S. & Cohen, M.; *Does the Market Value Environmental Performance?*; Rev. of Econ. and Stats, Vol. 83, No. 2, pp. 281-289 (May 2001). This study found a significant positive relationship between the environmental performance and the intangible asset value of publicly traded S&P 500 firms. Firms with worse performance had lower intangible asset values – approximately 9% of the replacement value of the tangible assets – after controlling for other variables known to affect firms' market value. On the other hand, a 10% reduction in toxic chemical emissions resulted in a $34 million increase in value. http://econpapers.repec.org/article/tprrestat/v_3a83_3ay_3a2001_3ai_3a2_3ap_3a281-289.htm

"Some companies are using transparency as part of their business model, believing that sharing more information with the public about strong performance provides a competitive edge." *See,* USEPA; *The Toxics Release Inventory in Action: Media, Government, Business, Community and Academic Uses of TRI Data* (July 2013)
http://www2.epa.gov/sites/production/files/documents/tri_in_action_final_report_july_2013.pdf

The referenced Enforcement and Compliance History Online (ECHO) state dashboards, along with state comparative maps, can be referenced from EPA's main ECHO web page at http://www.epa-echo.gov/echo/. EPA delegates much of its Clean Air Act (CAA) authority to state, local and tribal agencies. To manage the national CAA stationary source compliance monitoring and enforcement program, EPA requires delegated agencies to regularly report data on the type of facilities within their jurisdiction and the activities conducted such as compliance evaluations, compliance determinations, and enforcement actions. The dashboards provide an easy-to-use summary of activities to answer questions like which facilities are regulated, how many have been evaluated, and how many have alleged violations and have been subject to enforcement. The ECHO State Comparative Maps provide a quick interactive way to review national enforcement and compliance trends and compare states and territories.

"Releasing an avalanche of data is not the answer. For the public, the key is relevant, user-friendly information, such as easy-to-understand miles per gallon ratings for vehicles. For more expert users, larger sets of more comprehensive data can be values, especially is they can be quickly and easily viewed and sorted."

- Disclosed information may be provided in summary form or in more detail. Summary disclosures aim to highlight the information most relevant to users, often in the form of scales or ratings, to increase the likelihood that they will see it, understand it, and act on what they have learned. Summary disclosures typically occur at or near the point in time when the consumers of the information will be making their decisions, e.g., buying products such as cars or major appliances. In contrast, detailed disclosure is more comprehensive. It tends to include data on multiple variables, underlying or supporting data, and/or data extending over long periods of time. This allows viewers to access large data sets in their entirety, analyze them, and release or repackage the data to best suit their interests, audiences, or clients. Both types of disclosure may include taking advantage of emerging technological capacities such as social media and smart phone applications.

- For a discussion of the structuring and uses of both summary and comprehensive disclosure, *see*, Memorandum for the Heads of Executive Departments and Agencies – Disclosure and Simplification as Regulatory Tools (Cass R. Sunstein, OMB; June 18, 2010). http://www.whitehouse.gov/sites/default/files/omb/assets/inforeg/disclosure_principles.pdf

- For a video example of a non-governmental organization (NGO) that downloaded and re-formatted individual-facility Greenhouse Gas Reporting Program information to inform its members, *see* http://www.youtube.com/watch?v=5rdSSeomIho. The NGO's description of the video reads, "It just got a whole lot easier for Americans to find out which power plants and industrial sites are releasing the most emissions. The Environmental Protection Agency recently released its greenhouse gas database, and included some great tools for tracking polluters. While it doesn't include any requirements to reduce those emissions, it could be a first step in that direction by simply making clear who is releasing it and how much is being released. After the Toxics Release Inventory was created in the 80's, companies - under pressure from the public - began cutting even before mandatory reductions were phased in." Note that EPA was not involved in the decision or steps to produce this video. Consistent with comprehensive disclosure, the NGO, on its own, analyzed and repackaged publicly available data for its members.

- "[T]here is an online tool that allows easy identification of the biggest contributors to water pollution problems (http://cfpub.epa.gov/dmr/)." This tool is the CWA Discharge Monitoring Report (DMR) Pollutant Loading Tool. It is designed to help users determine who is discharging, what pollutants they are discharging, and how much and where they are discharging. The tool calculates pollutant loadings from permit and DMR data from EPA's Integrated Compliance Information System for the National Pollutant Discharge Elimination System (ICIS-NPDES). Data is available presently for the years 2007 through 2011. Pollutant loadings are presented as pounds per year and as toxic-weighted pounds per year to account for variations in toxicity among pollutants. The tool ranks dischargers, industries, and watersheds based on pollutant mass and toxicity, and presents "top ten" lists.

Innovative Enforcement Strategies

The referenced scoring system to identify drinking water suppliers with the most serious violations and have them face enforcement if not returned to compliance in six months is described more fully in: EPA Memorandum from Cynthia Giles to Regional Administrators, *Drinking Water Enforcement Response*

Policy with attachment (December 8, 2009).
http://www2.epa.gov/sites/production/files/documents/drinking_water_erp_2009.pdf

ADDITIONAL USEFUL REFERENCE STUDIES IDENTIFIED AFTER PUBLICATION OF THE MAIN ELR ARTICLE

Advanced Air Monitoring:

Advanced monitoring programs present new opportunities to meld emissions/pollutant monitoring and information technology to better identify and address adverse human health and environmental impacts.

- The state of the science for pollution monitoring is changing from "expensive, complex, stationary equipment [only], which limits who collects data, why data are collected, and how data are accessed," to a new paradigm characterized by "the materialization of lower-cost, easy-to-use, portable … pollution monitors (sensors) that provide high-time resolution data in near real-time." Emily G. Snyder, Timothy H. Watkins, Paul A. Solomon, Eben D. Thoma, Ronald W. Williams, Gayle S. W. Hagler, David Shelow, David A. Hindin, Vasu J. Kilaru, and Peter W. Preuss; *The Changing Paradigm of Air Pollution Monitoring*; Env. Sci. & Tech. Vol. 47, No. 20 (Oct. 15, 2013) at 11369-77. http://pubs.acs.org/doi/pdf/10.1021/es4022602

Deterrence – Monitoring and Enforcement:

Empirical deterrence research demonstrates that monitoring and enforcement improve compliance and reduce pollution through general and specific deterrence.

- In 2001, two researchers reviewed the existing empirical evidence on the impacts of monitoring and enforcement. They described the literature's consistent findings as: "(1) environmental monitoring and enforcement activities generate substantial specific deterrence, reducing future violations at the targeted firm; (2) environmental monitoring and enforcement activities generate substantial general deterrence, reducing future violations at facilities other than the targeted one; and (3) environmental monitoring and enforcement activities generate not only reductions in violations but also significant reductions in emissions." Wayne Gray and Jay Shimshack; *The Effectiveness of Environmental Monitoring and Enforcement: A Review of the Empirical Evidence*; Rev. of Env. Econ's and Policy, 2011, pp. 3-24 (Abstract). http://reep.oxfordjournals.org/content/early/2011/05/13/reep.req017.full.pdf+html

- The Norwegian Environmental Protection Agency conducted a natural field experiment on the effects of self-reporting, inspection frequency, and specific deterrence. The results included evidence of under-reporting of violations in firms' self-audits (more violations were detected in on-site inspections than in self-audits). Announcing an increased inspection frequency had no effect on firm compliance but having had a past inspection raised subsequent compliance substantially. Kjetil Telle; *Monitoring and enforcement of environmental regulations: Lessons*

from a natural field experiment in Norway; Journal of Public Economics, Vol. 99 (March 2013) at pp. 24–34. http://ideas.repec.org/p/ssb/dispap/680.html

Third-Party Compliance Verification:

Third-party compliance verification (or certification) occurs when an independent third party verifies to a regulator that a regulated entity is meeting one or more of its compliance obligations. The regulator retains the ultimate responsibility to monitor and enforce compliance but, as a practical matter, gives significant weight to the third-party verification when provided in the context of a regulatory program with appropriate standards, procedures, and oversight.

- A recent field experiment in the State of Gujarat in India revealed major weaknesses of their traditional 3rd-party regulatory audit system and measured how a series of market-based alterations improved auditor accuracy. While the study occurred in another country and the researchers couldn't apportion the improvements in third-party auditing among the instituted changes, its findings reinforce the importance of designing third-party programs to promote competent and truthful reporting. *See* Esther Duflo, Michael Greenstone, Rohini Pande & Nicholas Ryan; *Truth-Telling By Third-Party Auditors And The Response of Polluting Firms: Experimental Evidence From India* (Quarterly Journal of Economics, Vol. 128, Issue 4) (2013) at pp. 1499-1545. http://qje.oxfordjournals.org/content/128/4/1499.full.pdf