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7.6 ENHANCED COMPLIANCE, ENFORCEMENT, & AMBIENT MONITORING

2016

This work is made possible by National Institute of Health and Environmental Sciences, RO1ES022616, and the Fred A. and Barbara M. Erb Family Foundation. Additional support was provided by the Michigan Center on Lifestage Environmental Exposures and Disease (M-LEEaD), #P30ES017885.

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7.6 Enforcement and monitoring

7.6.1 What are air pollution regulations and enforcement activities?

7.6.1.1 Type of air pollution regulations

Broadly, air pollution regulations can be placed into the following categories:

- Emission regulations. These regulations limit emission releases, usually at the source, for sources such as tailpipe emissions from vehicles, stack emissions from industry, and other emissions at gas stations, dry cleaners, and other smaller sources. Federal emission regulations, enforced by Michigan, include the New Source Performance Standards, for new sources, Reasonably Achievable Control Standards for modified sources, National Emission Standards for Hazardous Air Pollutants (NESHAPS), and standards on vehicle emissions.

  Michigan also regulates emissions of air toxics, including many VOCs and metals (other than lead). There are no ambient air quality standards for air toxics. Rather, a screening processing is used to restrict emissions of toxics for new or modified sources seeking a permit to install.

- Ambient air quality standards. These are limits on concentrations of specific pollutants in air that are intended to protect public health. They include the National Ambient Air Quality Standards (NAAQS), which apply to six pollutants (SO_2, NO_2, O_3, CO, lead, and particulate matter, including both $PM_{2.5}$, PM_{10}). Exceeding a NAAQS may result in an area being defined as non-attainment for that pollutant.

  The NAAQS (and other standards) evolve, and standards for some pollutants (notably $PM_{2.5}$, O_3, and SO_2) have become considerably more stringent as the science improves. The NAAQS consider pollutants individually, that is, the effects of exposures to multiple pollutants (part of a cumulative effects assessment) is not normally considered.

- Process standards. These standards specify what materials may be used, or how an activity may be performed. For example, these may restrict or ban the use of certain chlorinated solvents and ozone-depleting substances like Freon, or limit the sulfur content and volatility of fuels like gasoline and diesel.

- Reporting, disclosure and emergency planning requirements. These impose a duty on industry to inform authorities regarding quantity and nature of both routine and emergency emissions.

Air pollution regulations are set by federal, state and local laws, as described below.

7.6.1.2 United States Environmental Protection Agency (US EPA)

Under the Clean Air Act (CAA), the US Environmental Protection Agency (US EPA) sets limits on certain air pollutants through the National Ambient Air Quality Standards (NAAQS), and also specifies source standards that limit emissions of air pollutants coming from certain sources (described later). States may adopt stronger air pollution laws than the federal minimum, but not weaker pollution limits than those set by US EPA. In addition, US EPA must approve state, tribal, and local agency plans for reducing air pollution, and if a plan does not meet the necessary requirements, US EPA can issue sanctions against the state and, if necessary, take other

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actions. US EPA has a lay person-oriented description of the Clean Air Act. [1] Additional air quality activities of US EPA include:

- Setting national air quality standards and emission standards, including those on industries, vehicles, and fuels;
- Addressing interstate and international air pollution;
- Providing oversight on state plans and actions;
- Participating in reviews and approvals of transportation policies that receive federal funding to ensure that construction of highways and transit rail lines are consistent with state air quality goals and do not cause or contribute to new violations of the air quality standards, worsen existing violations, or delay attainment of air quality standards (called Conformity Analysis); and
- Funding research, air quality monitoring, emission reduction programs, and other programs. These funds also support state level programs like Michigan's.

Unfortunately, US EPA does not have a field or district office in Detroit. The Region V office is located in Chicago. Its office directory lists 378 individuals;[2] the number of individuals working on air quality related issues is not clearly identifiable due to overlapping areas.

US EPA delegates much of its regulatory authority to individual states, which implement much of the Clean Air Act and other applicable federal laws.

7.6.1.3 State of Michigan

The Michigan Department of Environmental Quality (MDEQ) enforces the Clean Air Act (CAA) under authority delegated from US EPA and Michigan laws pertaining to air pollution regulations. State administrative rules are in Part 55 (Air Pollution Control) of the Natural Resources and Environmental Protection Act, Public Act 451 of 1994, as amended (Act 451). The Air Quality Division (AQD) of the MDEQ is responsible for developing and implementing state air quality requirements and enforcing compliance with both state and federal air quality requirements. AQD activities include monitoring air quality, inspecting facilities, developing and enforcing permits, rules and standards, developing State Implementation Plans (SIPs) that outline how pollution will be reduced, involving the public and industries through hearings and comment opportunities, and other activities related to air quality.

MDEQ's main office is in Lansing, and there are ten MDEQ District or Field Offices, including:

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[1] The Plain English Guide to the Clean Air Act, United States Office of Air Quality Planning and Standards Publication No. EPA-456/K-07-001 Environmental Protection, Research Triangle Park, NC April 2007. https://www.epa.gov/sites/production/files/2015-08/documents/peg.pdf

[2] Culled from EPA Region V Expert's List: https://www.epa.gov/aboutepa/region-5-experts-list

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- Detroit District (Wayne County) Office at Cadillac Place, Suite 2-300, 3058 West Grand Blvd., Detroit, MI 48202-6058, 313-456-4700,
- Southeast Michigan District (handling Macomb, Oakland and St. Clair counties) at 27700 Donald Court, Warren, MI 48092-2793. 586-753-3700.

As of May 2016, the MDEQ Air Quality Division directory listed 182 personnel, with Lansing having 91, the Detroit Field office having 31, and the Southeast District having 17.[3]

When MDEQ identifies permit or other violations, they are required to take enforcement action. Enforcement action can include the levying of fines, requiring greater monitoring, or conducting facility inspections. Field offices conduct inspections and perform other analyses. Based on these inspections, MDEQ can issue Violation Notices (VNs) and obtain Administrative Consent Orders that may include various corrective actions and penalties. Prior to 1991, the Wayne County Air Pollution Control Commission enforced air quality laws in Detroit.

The MDEQ has a toll-free telephone number (800-662-9278) to report air pollution problems and other air quality issues. MDEQ Field office personnel investigate complaints and perform inspections that may address issues such as:

- Strong odors from commercial or industrial companies.
- Fall-out (such as soot, ash, or dust) that has settled on property.
- Excessive dust generation (from commercial or industrial operations).
- Open burning activities at commercial and industrial businesses.
- Events that cause significant health effects such as difficulties breathing, burning and itching of the skin or eyes, or life-threatening allergic reactions.

Michigan's support and capacity to address environmental problems was flagged in a federal audit of the water program in 2010, and, more recently, with widespread investigations related to the Flint water crisis. The governor's current budget recommendation (FY2016 and FY2017) for MDEQ is $487.9 million, of which AQD receives about 5% ($26.7 million). The funding level is fundamentally unchanged since 2000 when the AQD received $24.4 million.[4] Since 2000, MDEQ's staff has been cut by more than a quarter, and the agency's general fund budget declined nearly 60%. Since its formation in 1995, the MDEQ has accounted for a declining share state's general fund budget (1.16% in 1996, and 0.41% in 2015).[5]

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[3] Based on current staff directory http://www.michigan.gov/documents/Phone_List_86623_7.pdf and zip code information

[4] State budget office data, http://www.michigan.gov/budget/0,4538,7-157-11460_18526---,00.html

[5] "Michigan DEQ's Responsibility to Ensure Public Safety Collapsed in Flint," Resilience, http://www.resilience.org/stories/2016-01-25/michigan-deq-s-responsibility-to-ensure-public-safety-collapsed-in-flint

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Michigan has several documents on their website designed to assist business and the public on environmental laws.[6] Helpful guides on public participation are available from Michigan[7] and elsewhere. [8]

Michigan's air quality rules under Act 451 are organized as follows:

- Part 1 - Definitions.
- Part 2 – Air Use Approval (Air Permitting, Offsets, and Air Toxics). This is a key provision with two types of permits.

  Permit to Install (PTI) is a list of general and special conditions with which certain emission sources must comply. PTIs typically limit emission rates, hours of operation, amount and type of raw materials, and/or specifies the operation of air pollution control devices, monitoring devices, and stack heights. Typically, small sources are exempt from PTI requirements. If the proposed installation or modification of an emission unit or source meets the definition of a major Prevention of Significant Deterioration (PSD) or offset source, then the source may be subject to additional stringent regulations such as modeling emissions, installing best available control technology (BACT), and conducting a public hearing. The only way to avoid these added requirements is to accept restrictions limiting the maximum emissions (Potential to Emit) below the major source emission threshold levels using permit conditions. PTIs are free, do not expire, and do not need renewal, but may require MDEQ notification for installation, construction, reconstruction, relocation, or modification of the facility. PTI conditions are eventually folded into a facility's Renewable Operating Permit.

  Renewable Operating Permit (ROP) program is part of Title V of the US Clean Air Act Amendments of 1990. This clarifies which requirements apply to a facility that emits air contaminants. This applies to facilities that are "major sources",[9] acid rain, and waste incineration facilities. ROP's are typically renewed every five years, providing the opportunity for public comment on draft ROP's.

[6] For a summary of air quality regulations in Michigan see http://www.michigan.gov/documents/deq/deq-ess-caap-manufguide-chap1_313400_7.pdf

[7] A Citizen's Guide To Participation in Michigan's Air Pollution Control Program, MDEQ, 2007 http://www.michigan.gov/documents/deq/deq-ess-caap-citizensguidetomiairpollutioncontrol_195548_7.pdf

[8] A Guide to Public Participation & The Clean Air Act, Washington University Interdisciplinary Environmental Clinic St. Louis ttp://www.cacwny.org/docs/Title%20V%20-%20The%20proof%20is%20in%20the%20permit.PDF

[9] There are four different types of major sources: major prevention of significant deterioration source (PSD), major offset source, major ROP source, and major HAP source. Each one of these major sources has different annual emissions threshold levels. For example, under the ROP program, a major source is one that has a potential to emit (PTE) exceeding 100 tons/year of any regulated air contaminant, 10 tons of a single hazardous air pollutant (HAP), or 25 tons of a combination of HAPs. Under PSD, a major source may be one that has a PTE great than 100 or 250 tons of any regulated air contaminant, depending on the type of source.

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- Part 3 – Emissions Limitations and Prohibitions – Particulate Matter. This rule limits PM emissions from industrial and other facilities, open burning of trash, trees, and brush,[10] and fugitive dust. It includes emission limits, and opacity limits that prevent businesses from discharging dense black or white smoke.
- Part 4 – Emissions Limitations and Prohibitions – Sulfur-Bearing Compounds. This rule established SO_2 limits and limits regarding the sulfur content of fuels. US EPA regulates most motor vehicle fuels; the Part 4 limitations apply to other sources, including coal.
- Part 6 – Emissions Limitations and Prohibitions – Existing Sources of Volatile Organic Compound (VOC) Emissions. This rule implements US EPA requirements regarding application of reasonable available control technology (RACT) for VOC releases.
- Part 7 – Emissions Limitations and Prohibitions – New Sources of VOC Emissions. When a new source is installed or an existing source is modified, emission rates are to be limited to the lowest of those resulting from an evaluation of four procedures (best available control technology or BACT[11]; maximum allowable emission rate specified by a US EPA New Source Performance Standard (NSPS)[12] the maximum allowable emission rate specified as a PTI condition; or the maximum allowable emission rate specified in the Part 6 rules). Part 6 rules also include screening analyses designed to ensure that maximum emissions do not exceed thresholds for acute or chronic health risks.
- Part 8 – Emissions Limitations and Prohibitions – Oxides of Nitrogen. These rules apply to larger fossil fuel-fired emission units, e.g., power plants, boilers/process heaters, stationary internal combustion engines, cement kilns, and stationary gas turbines.
- Part 9 - Miscellaneous Provisions.
- Part 10 – Intermittent Testing and Sampling – See next part.
- Part 11 – Continuous Emissions Monitoring

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[10] Open burning of trash from a business is prohibited, and open burning from other sources is restricted. Public Act 102 of 2012 was signed into law on April 19, 2012, prohibiting the open burning of household trash that contains plastic, rubber, foam, chemically treated wood, textiles, electronics, chemicals or hazardous materials. The law amends the open burning provisions contained in Section 11522 of the Natural Resources and Environmental Protection Act (Public Act 451 of 1994). The changes took effect on October 16, 2012, and contain penalty provisions, which may be enforced by local units of government, should a local ordinance not exist. Open burning of brush, logs, stumps, and trees is prohibited within 1,400 feet of an incorporated city or village limit. The open burning of grass clippings and leaves is not allowed in municipalities having a population of 7,500 or more unless the local governing body has specifically enacted an ordinance authorizing it.

[11] BACT is defined as the most stringent emission limit or control technique that has either been achieved in practice for a category of emission units, is found in other state air quality rules, or is considered by the regulatory agency to be technically feasible and cost effective. A BACT analysis, performed as part of the permit review process, triggers continual use of technology that results in low emissions of air contaminants. The definition of BACT evolves as technology improves and/or as industry adopts technology.

[12] Under Section 111 of the Clean Air Act, U.S. EPA establishes new source performance standards (NSPS) for new or modified sources in particular industrial categories, which include emission limits for over 75 source categories. The NSPS requirements are found in the federal rules published in the Code of Federal Regulations (CFR).

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Parts 10 and 11 give MDEQ the authority to require sources to quantify their air emissions to verify compliance with the emission standards using short-term tests (Part 10) or Continuous Emission Monitoring Systems (CEMS). These are discussed later (Section 7.6.2.3)

- Part 14 – Clean Corporate Citizen Program. Michigan's Clean Corporate Citizen Program allows sources that have demonstrated environmental stewardship and a strong environmental ethic to receive public recognition and air quality permit processing benefits.
- Part 15 - Emission Limitations and Prohibitions-Mercury
- Part 16 - Organization, Operation, and Procedures
- Part 17 – Hearings. Hearings provide an opportunity for public input on rule changes, consent orders, PTIs, and ROPs. MDEQ may decide, at its discretion, to hold informational meetings, and typically holds informational meetings immediately preceding a hearing given large interest from the local community, for controversial projects, and for major sources. Public hearings are recorded and transcribed for MDEQ staff so they may review and respond to comments made during the public comment period and hearing process. If there are substantive written or oral comments made during the public comment and hearing process, the MDEQ develop a "Response to Comment Document." Typically, MDEQ provides 30 days' notice of pending actions on their web site. An extension of the public comment period may be granted at DEQ's discretion.
- Part 18 - Prevention of Significant Deterioration (PSD) of Air Quality. This requires a review of new and existing major sources prior to construction or modification. The rule is designed to ensure compliance with the national ambient air quality standards, the applicable PSD increment concentrations, and the requirement to apply best available control technologies on the project's emissions of air pollutants above significance. Somewhat complicated rules determine which sources fall into the PSD rules, but basically PSD applies if a major modification is made to the source that results in a significant emissions increase (by itself) and a significant net emissions increase (across the whole stationary source).
- Part 19 - New Source Review for Major Sources Impacting Nonattainment Areas

7.6.1.4 Southeast Michigan Council of Governments

As the 7-county metropolitan planning organization, SEMCOG has a role in air-quality planning, primarily to ensure conformity of transportation plans, that is, that long-range transportation plan and transportation improvement program are consistent with air quality goals established in state air quality implementation plan (SIPs). This applies primarily to O_3, NO_x and $PM_{2.5}$ pollutants. SEMCOG also promotes awareness in ozone action plans.

SEMCOG has a small staff (68 in total).[13] While a few staff have detailed knowledge about air quality, internal capacity is limited and SEMCOG will typically contract out air quality analyses. Most of SEMCOG's recent work

[13] SEMCOG (Southeast Michigan Council of Governments). Available: http://semcog.org/About-SEMCOG/Staff-Directory [accessed 5 May 2016].

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pertaining to air quality has been to assist with earlier SIP attainment plans for $PM_{2.5}$ and O_3 by quantifying emissions from vehicles, evaluating the effectiveness of potential emission control measures, and developing air quality attainment strategies.

7.6.1.5 Air quality regulations in practice

Emission reductions can be achieved by developing cleaner technologies, using cleaner fuels and feedstock, improving efficiencies in manufacturing or other processes, or adding pollution controls. Frequently, emission reductions demonstrate increasing costs, i.e., removing the first 25% of pollution is cheaper than the next 25%, and the costs of removing 90 or 99% of pollution may extremely high. To determine emission limits, MDEQ enters negotiations with industry, often months and sometimes years before a PTI or ROP is announced publically. Section 7.4 of the Resource Manual discusses emission controls for point sources and additional factors that influence emission limits and controls.

Facilities defined as "major" sources get special attention. If a facility emits more than 25 tons per year of any combination of Hazardous Air Pollutants (HAPs) or over 100 tons per year of other regulated pollutants, then Title V of the CAAA designates these as major sources that require a Title V permit. In Michigan, these permits are called Renewable Operating Permits (ROPs), as discussed above. The ROP application process includes an initial review by MDEQ, negotiation by MDEQ and industry to determine permit conditions, issuance of a draft permit, possible issuance of public information document, a public comment period, possibly a hearing for controversial cases, incorporation of comments, final review, a final permit and approval.[14] This application includes analysis of how the proposed emission increases will impact air quality, but the analysis generally is limited to only the facility seeking the permit and only the change at the facility proposed. Some facilities have many permits and large emissions from other sources at the facility -- these are rarely analyzed in this process.

Historically, MDEQ has denied very few air quality permits, but applications are routinely modified during the permitting process to ensure compliance with state and federal regulations.

Emission limits or other permit conditions may not be very stringent for a number of reasons:

- Older facilities are largely "grandfathered" out, that is, older facilities do not necessarily have to meet current standards. This is a particular issue in Detroit since many facilities date from the 1940s through the 1970s when few rules applied.
- The application of best available control technology (BACT) and similar rules incorporate cost and industry practices. Often, costs are inflated, and industry individually and collectively is reluctant to install new equipment or controls, thus, many BACT options are deemed too costly, undemonstrated, and infeasible.
- Air pollution regulations involve trade-offs or unintended consequences, both real and perceived, that may offset the desired benefits of the regulations. These can include economic penalties that cause a

[14] MDEQ (Michigan Department of Environmental Quality). 2001. Title V Renewable Operating Permit Overview. http://www.michigan.gov/documents/deq/deq-aqd-field-ROP-Overview_458312_7.pdf [accessed 4 May 2016].

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loss of business competitiveness or threats to economic viability, as well as many other considerations as depicted in Figure 7.6-1. Thus, it is argued that regulations should consider both positive and negative impacts (and risks) in setting standards. Some of these impacts may be trivial, others important.

- Permitting rules do not fully consider health impacts (other than compliance with NAAQS and other ambient standards), cumulative effects, environmental justice, or other issues. There is a lag in NAAQS and other standards and guidelines, and the notion of a threshold or acceptable level of air pollution is no longer well accepted for $PM_{2.5}$ and some other pollutants.
- Information provided in permits, public information documents and other documents can be both very technical and very limited in score and relevance. FOIA requests, and associated fees, may be required to obtain additional material. For large sources undergoing a modification, for example, these documents describe only a component of the facility's operation and not its overall impact.
- Public participation may not be very effective for several reasons, including (1) a lack of technical capacity in potentially affected communities; (2) a lack of information provided by MDEQ regarding impacts; (3) difficulty in developing or coordinating responses given a 30 day comment period and no prior notice of a pending action; (4) the relatively few types of MDEQ decisions that can be contested; and (5) perceptions and reality that very few permits are denied.[15]
- MDEQ's negotiations with industry are not transparent nor made available to the public.
- Funding and agency influence by industry are continual concerns for state agencies like MDEQ.

[15] MDEQ maintains a calendar of pending actions: http://www.michigan.gov/deq/0,1607,7-135-3308_3325---,00.html

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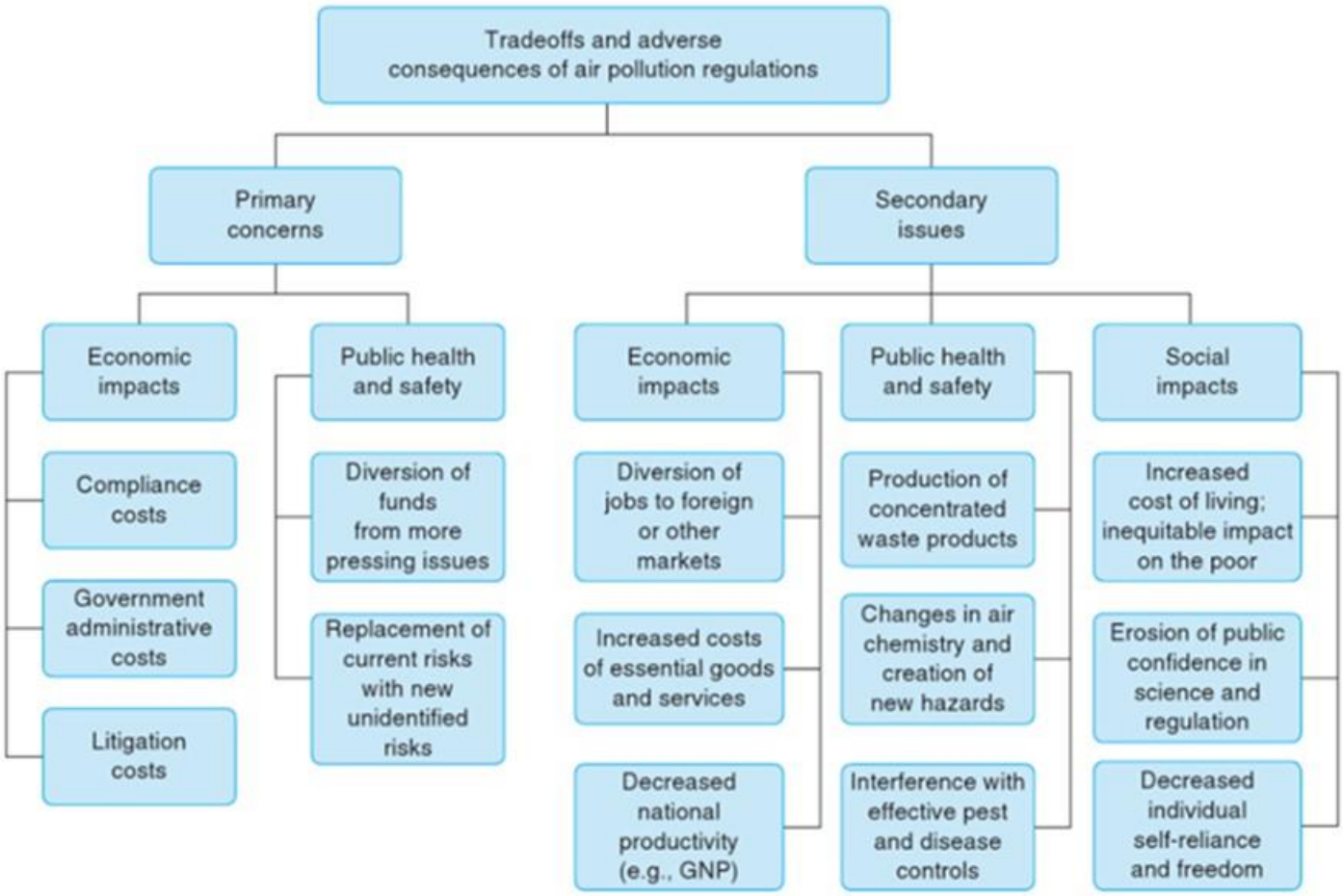
Figure 7.6-1. Potential trade-offs and consequences of air pollution regulations. From University of California Air Pollution Health Laboratory. No Permission obtained for reproduction



7.6.2 Air quality monitoring

Air quality monitoring (or surveillance) is one of the tools used enforce ambient air quality and emission standards. Air quality monitoring is conducted by US EPA, MDEQ, and sometimes county and local governments, tribes, industry, community organizations, researchers, and individuals. Air quality monitoring falls into several broad types, and ambient air quality monitoring, deposition and emissions monitoring are discussed in turn.

7.6.2.1 Ambient air quality monitoring

Ambient air quality monitoring was discussed in Section 4 of the Resource Manual. Ambient monitoring uses instruments that measure specific pollutants or parameters in outdoor air, most commonly the NAAQS pollutants (SO_2, NO_2, O_3, CO, lead and $PM_{2.5}$). This type of monitoring is used to measures the concentration of pollutants in the atmosphere which you may breathe.

The importance of ambient air monitoring should not be understated. Monitoring ambient air quality is the best way to tell if the air is getting cleaner, because monitors accurately report how much of a pollutant is in

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the air. However, monitoring has limitations due to spatial, temporal and parameter coverage. This means that there are only a limited number of sites that are monitored; many locations of interest do not have monitors; monitored variables focus on the six criteria pollutants (not toxics); and pollutant levels can change from hour-to-hour and day-to-day and some monitoring is intermittent (e.g., samples are taken every 3 or 6 days).

In Michigan, the state's ambient air quality monitoring network and the collected data are described by the MDEQ each year in its annual Air Monitoring Network Review[16], and its annual Air Quality Monitoring Reports[17]. US EPA also makes the same data available. Section 4 of the Resource Manual discussed monitoring performed by MDEQ and industry in the Detroit area. It also described many aspects of ambient air quality monitoring, including the number of sites, type of equipment, and that procedures used must meet US EPA guidelines.

All monitoring programs need quality assurance (QA) programs to (1) assess the quality of data collected; (2) ensure that the quality of the collected data is sufficient to address the intended use; and (3) improve the data collection process. MDEQ and US EPA programs are of high quality and meet QA requirements pertaining to most studies.[18] The importance of QA programs in all monitoring activities should not be underestimated.

7.6.2.2 Deposition monitoring

Deposition monitoring is a type of ambient monitoring that measures the rate at which pollutants accumulate or deposit on the ground or in a water body. Deposition is important to understand for the accumulation and concentration of pollutants in or on soils, plants, water bodies, fish, surface soil and dust. Deposition samples are used to measure, for example:

- Acid rain, which can lead to soil and water acidification and a variety of ecological impacts;
- Mercury and PCB accumulation in sediments and lakes, which can be taken up and biomagnified in fish;
- Pesticide spray from agricultural applications; and
- Lead and asbestos released as buildings are demolished

Deposition monitoring in urban areas is relatively rare outside the research context, although it is relevant for lead exposure in Detroit due to contaminated soils and brownfields present. It also may be relevant for deposition of other metals and organic compounds from steel mills, coke facilities, storage piles, and other sites.

7.6.2.3 Emissions monitoring

A third type of air quality monitoring, called emissions monitoring, measures the type and quantity of pollutants released from polluting or potentially polluting facilities. Often, emissions monitoring measures pollutants in

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[16] 2016 Air Monitoring Network Review, Michigan Department of Environmental Quality Air Quality Division. June 29, 2015, http://www.michigan.gov/documents/deq/deq-aqd-toxics-2016_Air_Mon_Network_Review_489490_7.pdf

[17] 2014 Air Quality Monitoring Report, Michigan Department of Environmental Quality Air Quality Division. June, 2015 http://www.michigan.gov/documents/deq/deq-aqd-amu-2014_Annual_Air_Quality_Report_492732_7.pdf

[18] This is a non-trivial issue. Illinois, for example, had to invalidate many years of $PM_{2.5}$ data. Also, without implementing an appropriate QA plan, the value of low-cost monitoring may be very limited.

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the process device itself or in the stack, and thus is called "stack" monitoring. Emissions monitoring can serve several purposes, the most common being:

- Accurately estimating the pollutant release rate from a source, say, in pounds per hour;
- Detecting whether emissions are acceptable, e.g., within normal procedures, or whether an operational issue or equipment failure of a pollution control systems has occurred;
- Confirming design or permit specifications that specify an emission limit or other restriction; and
- Aiding or optimizing process control.

Emissions monitoring may be required under federal law and/or MDEQ permits. Emissions monitoring complements ambient air quality monitoring discussed in the previous section. MDEQ has considerable discretion with respect to the emissions monitoring, and can set the parameters, frequency, averaging time and other aspects of emissions monitoring.

Examples of emissions monitoring include:

- Continuous emission monitoring systems (CEMS). All power plants covered by the Acid Rain Program (including DTE's facilities) must install CEMS under the 1990 CAAA that track SO_2 and NO_x emissions. These data are reported to EPA four times each year. There are monetary penalties if the facility releases more pollutants than are covered by their allowances.
- Opacity monitoring. This is a type of CEMS that may be required for large facilities (power plants) to ensure that particulate matter controls are functioning properly. Opacity is used as a surrogate for $PM_{2.5}$, which is more difficult to measure.

  Typically, facilities are prohibited from having visible plumes (other than steam) that may indicate excessive levels of gaseous or particulate pollutants. Visual observation of smoke is impossible at night; thus CEMS provide additional assurance that emissions are acceptable.
- Short-term (intermittent) emission (stack) tests. Some types of facilities require emissions tests as part of their permitting conditions, typically when the facility is first constructed and then periodically, e.g., every 5 years. For example, for incinerators, EPA rules requires demonstration of a minimum destruction and removal (DRE) efficiency, e.g., 99.9999% in the case of a hazardous waste incinerator (demonstrated by a "challenge" feedstock.)
- Vehicle inspection and maintenance (I&M) monitoring. A number of states require periodic inspections and/or emissions tests for vehicles. These may include visual inspections of the vehicle's emission control systems, as well as measurements of CO, NO_x and VOCs in tailpipe emissions. States on both US coasts have used these I&M programs as part of O_3 SIPs designed to reduce emissions; Michigan has never utilized such tests.
- Fugitive emissions monitoring and inspections. As a combination of ambient, perimeter, and source monitoring, air quality monitoring is sometimes used to find leaks or releases. The technology may

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utilize handheld or fixed instruments, temporary sites, and sometimes infrared and other types of cameras.

Without emissions monitoring, emission rates must be estimated, typically using an emission factor approach. This approach can be reasonably accurate for some pollutants and some sources. For example, it is easy to estimate SO_2 emissions based on the coal sulfur content and the number of tons of coal burned. However, estimates can be highly uncertain for pollutants like $PM_{2.5}$.

7.6.3 What types of air ambient air monitors can be used, and where can they be used?

There are several types of air quality monitoring and surveillance systems. These can be grouped into four categories

- Stationary monitoring networks
- Mobile monitoring (vehicles, aircraft)
- Remote sensing (satellite, DIAL – differential absorption LIDAR)
- Low-cost monitoring

There are many types of monitors that can be used.

- Federal reference method (FRM) or Federal equivalent method (FEM) monitors meet EPA requirements and are used to determine compliance with NAAQS and for other purposes. Typically, FRM/FEM monitors are operated by MDEQ, US EPA or industry (See Section 4.1). The equipment, which is relatively expensive, is installed in a climate-controlled trailer, building or other fixed site. These semi-permanent facilities require site access, security, power, telecommunications, relatively open land, and other constraints.
- Non-FEM monitors are used by MDEQ and researchers, also at fixed sites. These can measure pollutants such as volatile organic compounds (e.g., benzene), aldehydes (formaldehyde), semivolatile compounds (PAHs), metals (cadmium), diesel particulates, and ultrafine PM.
- Some monitors or data can be triggered or analyzed for directional sampling, which measures pollutants that come from a certain direction.
- Both continuous (real-time) and integrated (long duration) sampling technology is available for a number of pollutants.
- Mobile monitors are installed in vehicles (typically electrically-powered vans), and have been used to measure on-road or traffic-related pollutants.
- Handheld or portable instrumentation is used to measure some pollutants.
- Ground-based remote sensing systems can monitor a number of pollutants along a line of sight, typically using DIAL or FTIR technology.

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- Satellite-based remote sensing allows measurements or estimates of several pollutants, including PM and O_3, across relatively large areas. Currently, concentrations are estimated to a 1 x 1 km scale.
- Passive samplers include both natural surfaces like moss, and special adsorbents to sample primarily gases and vapors, to provide a long-term measure of concentration and deposition.
- Visibility monitoring is a measure of distance which related to haze and PM.
- Personal samplers are used to measure air in the breathing zone of an individual, and to account for an individual's activity and mobility through the day.
- Low cost monitors. These include several types relevant for community use discussed below.

As noted in Section 7.5.2.1, ambient air quality monitoring can be used to estimate population, source-impacted, and background exposures. Some important cases are described below.

- Population-oriented monitoring typically uses fixed site monitors placed in residential locations.
- Near-road monitors are placed within about 50 m (160 feet) of major highways, and measure CO, NO_x and sometimes other pollutants arising in part or largely from traffic-related emissions.
- Perimeter monitors are placed at or near the fence line of facilities to measure the impact of that facility's emissions, e.g., Marathon has four SO_2 monitors for this purpose, and lead deposition has been monitored around homes being demolished.
- Traffic surveys and traffic-related air pollutants can be monitored at high traffic areas.

Low-cost monitoring. In recent years, many so-called "low-cost" monitors and sensors have been used for individual or community-level air quality monitoring use.[19] EPA and others have developed some guidance for individuals and communities interested in employing low-cost air monitors or sensors within their community.[20] In many ways, low-cost monitoring represents a paradigm shift (see Figure 7-6-2). As noted above, while these low-cost monitors are not appropriate for all air monitoring uses, they can have many advantages and applications, including: [21]

- Measuring "personal" exposure of an individual by carrying the monitor throughout their day
- Identifying potential pollution hotspots to be further investigated
- Enabling and empowering community organizing and activism
- Supplementing existing air monitoring networks
- Increasing dialogue between citizen groups and state and federal environmental regulators

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[19] Low cost has been defined as under $5000 for a monitor; sensors runs from about $100 to about $20,000 for a single pollutant.

[20] EPA. 2014. Air Sensor Guidebook. Available: https://cfpub.epa.gov/si/si_public_record_Report.cfm?dirEntryId=277996 [accessed 25 Feb 2016].

[21] Snyder, E, et al. "The changing paradigm of air pollution monitoring". *Environ Science and Tech*, *47*(20), 11369-11377, 2013.

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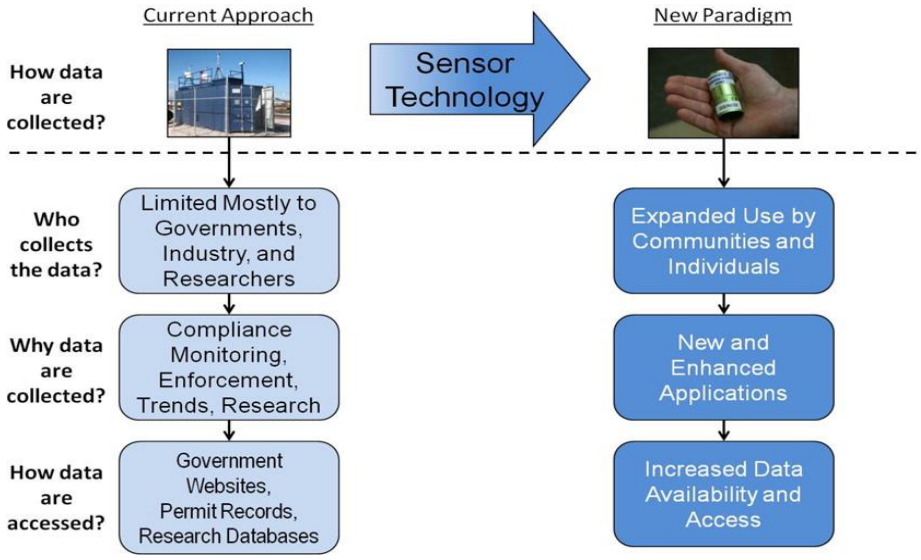
- Enhancing monitoring of fugitive emissions at facilities for compliance monitoring.

Figure 7.6-2. Differences between traditional stationary air monitoring and low-cost air monitoring systems.[22]



7.6.4 Why is this important?

Improving monitoring, permitting and enforcement can have a great impact on public health within a community. These activities help to ensure that regulatory decisions consider all stressors being experienced by a community; prevent the siting or operation of new polluting facilities; and decrease emissions of existing facilities. Monitoring data can provide the best data to community members to know what is in the air they breathe. To both community members and regulatory officials, monitoring data describes concentrations, exposure, emissions, the adequacy of source controls, and the performance of the overall air quality management strategy. Specific reasons why ambient air quality monitoring is important include:

- Monitoring data indicate current air quality, which is used in air quality alerts and ozone action days, for example.
- Historical monitoring data show trends that indicate whether air quality is changing.
- Monitoring data are the basis for determining compliance with air quality standards,[23] including both the primary health protective NAAQS and the secondary welfare protective NAAQS,[24] and to determine

[22] EPA. 2014. Air Sensor Guidebook. https://cfpub.epa.gov/si/si_public_record_Report.cfm?dirEntryId=277996 [25 Feb 2016].

[23] NAAQS Status is shown by county by US EAA at https://www3.epa.gov/airquality/greenbk/anayo_mi.html.

[24] Primary standards provide public health protection, including protecting the health of "sensitive" populations such as asthmatics, children, and the elderly. Secondary standards provide public welfare protection, including protection against decreased visibility and damage to animals, crops, vegetation, and buildings.

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whether further emission reductions or other actions are needed. These monitors may be placed at "hotspots," that is, locations where the highest concentration is expected.

- Monitors may be used to quantify impacts of specific sources, including industry and roadways. These are called "source-oriented" or "near-road" sites, respectively.
- Perimeter or fence line monitoring is sometimes required as part of a permit condition to ensure adequate control of fugitive dust or other emissions. This is relatively rare in Michigan although some landfills and waste sites employ such monitoring.
- Monitoring data aid source apportionments, which identify the source(s) that cause or contribute to air pollution, depend on monitoring data.
- Some monitoring sites are placed to determine "upwind" or "background" concentrations of pollutants that are transported into the area (called "transport-oriented" sites). This is particularly important for $PM_{2.5}$, ozone (O_3), and O_3 precursors to understand how much of the pollutants arise from local sources, and how much comes from elsewhere.
- Monitoring data provide exposure information that are used in risk and epidemiological studies aimed at understanding health and environmental impacts of air pollution.
- Monitoring data are sometimes used to estimate emissions and for a variety of research purposes, including evaluation/validation of dispersion and other models.

It is also important to make air quality monitoring data accessible. Much of the data is available on MDEQ or EPA websites for researchers. Simplified data interpretations are available for the public in several forms:

- Michigan EnviroFlash Program. This sends to subscribers an email message if the Air Quality Index is predicted to reach or exceed the health level selected by participants, plus notification when an air quality "Action!" Day (advisory) is announced. (Figure 7.6-3. http://www.deqmiair.org/notify.cfm)
- Air Quality Index (AQI). MDEQ has maps showing the current Air Quality Index, which considers both O_3 and $PM_{2.5}$. (Figure 7.6-4. http://www.deqmiair.org/index.cfm?page=home)
- Air quality maps for current or historical levels of O_3 and $PM_{2.5}$ with up-to-the hour results are available on the web. (Figure 7.6-5. http://www.deqmiair.org/ozonemaps.cfm?date=6%2F10%2F2015)
- Summaries of data are provided in MDEQ annual reports.

US EPA has both similar and more detailed information at https://www.airnow.gov.

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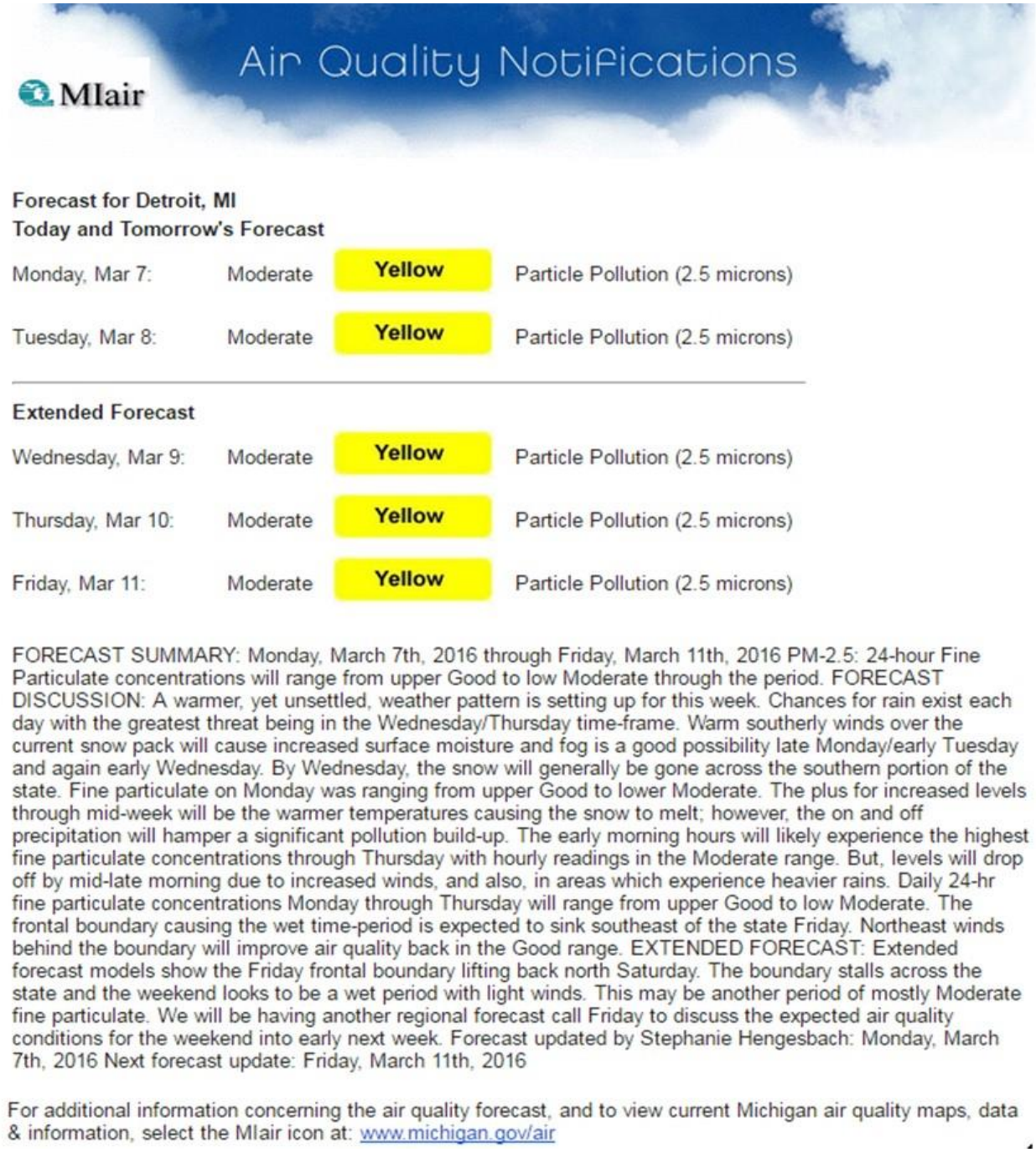
Figure 7.6-3. Example of Enviroflash email alert available from MDEQ.



MIair

Air Quality Notifications

Forecast for Detroit, MI
Today and Tomorrow's Forecast

Monday, Mar 7:	Moderate	Yellow	Particle Pollution (2.5 microns)
Tuesday, Mar 8:	Moderate	Yellow	Particle Pollution (2.5 microns)

Extended Forecast

Wednesday, Mar 9:	Moderate	Yellow	Particle Pollution (2.5 microns)
Thursday, Mar 10:	Moderate	Yellow	Particle Pollution (2.5 microns)
Friday, Mar 11:	Moderate	Yellow	Particle Pollution (2.5 microns)

FORECAST SUMMARY: Monday, March 7th, 2016 through Friday, March 11th, 2016 PM-2.5: 24-hour Fine Particulate concentrations will range from upper Good to low Moderate through the period. FORECAST DISCUSSION: A warmer, yet unsettled, weather pattern is setting up for this week. Chances for rain exist each day with the greatest threat being in the Wednesday/Thursday time-frame. Warm southerly winds over the current snow pack will cause increased surface moisture and fog is a good possibility late Monday/early Tuesday and again early Wednesday. By Wednesday, the snow will generally be gone across the southern portion of the state. Fine particulate on Monday was ranging from upper Good to lower Moderate. The plus for increased levels through mid-week will be the warmer temperatures causing the snow to melt; however, the on and off precipitation will hamper a significant pollution build-up. The early morning hours will likely experience the highest fine particulate concentrations through Thursday with hourly readings in the Moderate range. But, levels will drop off by mid-late morning due to increased winds, and also, in areas which experience heavier rains. Daily 24-hr fine particulate concentrations Monday through Thursday will range from upper Good to low Moderate. The frontal boundary causing the wet time-period is expected to sink southeast of the state Friday. Northeast winds behind the boundary will improve air quality back in the Good range. EXTENDED FORECAST: Extended forecast models show the Friday frontal boundary lifting back north Saturday. The boundary stalls across the state and the weekend looks to be a wet period with light winds. This may be another period of mostly Moderate fine particulate. We will be having another regional forecast call Friday to discuss the expected air quality conditions for the weekend into early next week. Forecast updated by Stephanie Hengesbach: Monday, March 7th, 2016 Next forecast update: Friday, March 11th, 2016

For additional information concerning the air quality forecast, and to view current Michigan air quality maps, data & information, select the MIair icon at: www.michigan.gov/air

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Figure 7.6-4. Example of AQ information available from MDEQ.

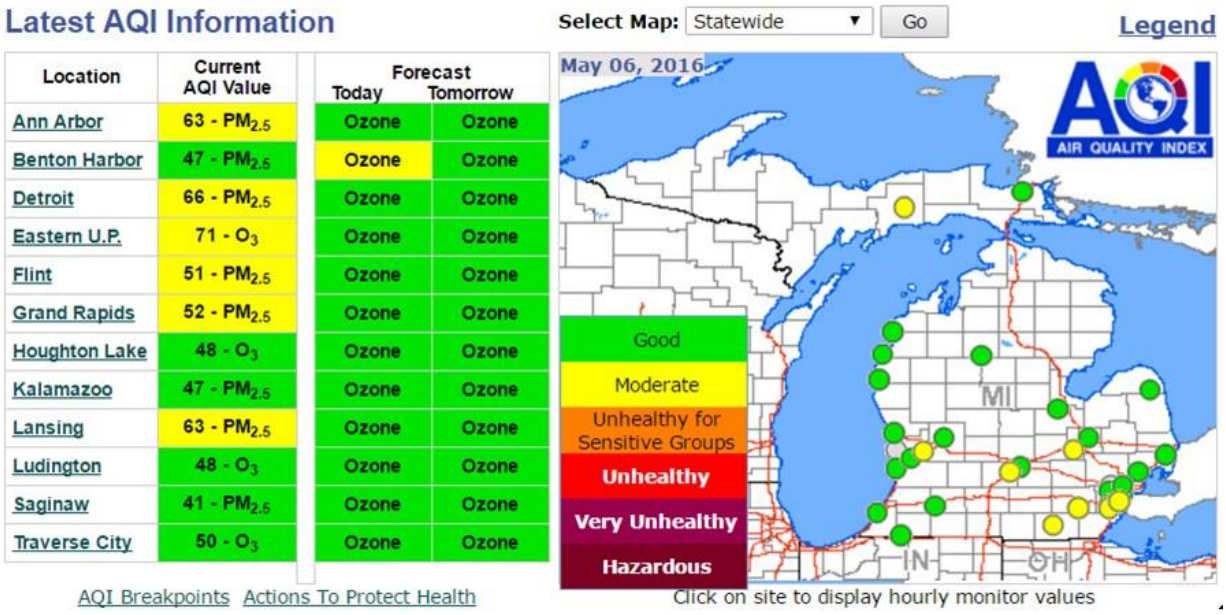
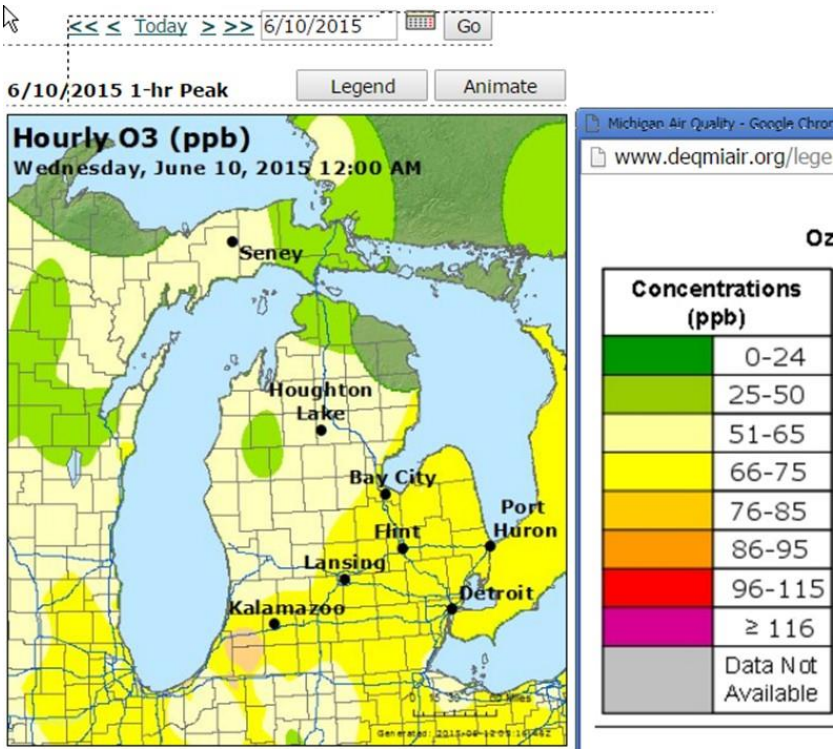


Figure 7.6-5. Example of air quality map for O_3 available from MDEQ.



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7.6.5 Which pollutants are monitored?

Monitoring in the Detroit area, as in other urban areas, includes the following:

- Criteria pollutants: $PM_{2.5}$, PM_{10}, O_3, NO_x, CO, SO_2 and lead.
- Toxics are monitored at a few sites.
- Diesel exhaust (or surrogates known as black carbon) is measured at a few sites.
- Bioaerosols are measured at one site (not by MDEQ).

Monitoring of ultrafine PM, reactive species, metals, organics, and other species is also conducted, but the number of sites and frequency of such measurements is comparatively low.

7.6.6 What is happening in and around Detroit?

- MDEQ operates a network of monitors in the state, with approximately ten sites in Wayne County and six in Detroit. As in most other cities, these emphasize the criteria pollutants. The network includes source-oriented sites (e.g., Dearborn), population sites (e.g., East-7 mile), and traffic-oriented sites (Eliza Howell and Schoolcraft College). See Section 4.2 for a discussion of the current monitoring network and needs for expansion.
- MDEQ obtained additional support in Sept. 2015 from US EPA to collect toxics data for 2 years at two near-road monitoring sites (Eliza Howell and School Craft College). This will encompass a large number of parameters (including carbonyls, continuous BTEX, carbon black, ultra-fine PM, metals, both continuous and filter-based). These data will aid source apportionments and other analyses.
- MDEQ has been discussing siting an additional monitor in southwest Detroit to respond to citizen requests.
- Marathon operates four sites providing continuous measurements of SO_2, H_2S, PM_{10} and volatile organic compounds such as benzene. A December 1, 2015 rule requires perimeter monitoring at refineries for benzene, which must not exceed 2.8 ppb, otherwise corrective actions will be required.
- Portions of Michigan may be in non-attainment of the new O_3 standards. MDEQ will make attainment and non-attainment recommendations to US EPA by Oct. 1, 2016, based on monitoring. Figure 7.6-5 shows the current status of O_3 attainment. In addition, O_3 will be monitored for a longer period (Mar – October, and instrumentation will be added to some sites to measure VOC precursors of O_3.
- The proposed SIP for SO_2 will soon be submitted to US EPA.
- The Detroit-based non-profit, Zero Waste Detroit, launched a campaign encouraging residents living near the Detroit Incinerator to call the MDEQ hotline and to send reports via email to the organization

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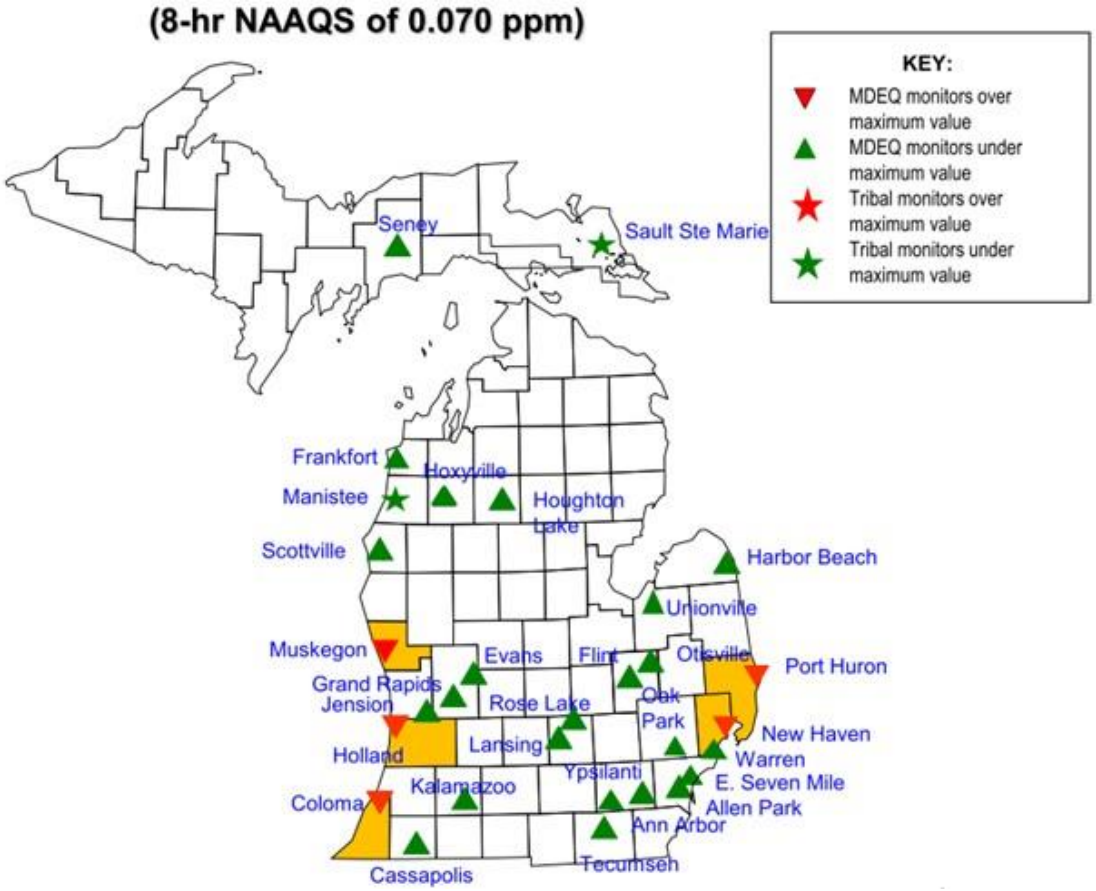
that includes information to help target enforcement actions, e.g., observations of visible smoke from the incinerator's stack.[25] See Figure 7.6-6.

Figure 7.6-6. Potential O_3 non-attainment areas. Uses 2013-15 data. From Fitzner, 2016. http://www.michigan.gov/documents/deq/deq-oea-tou-AirMonitoringWebinarPresentation_517496_7.pdf



[25] Zero Waste Detroit. 2016. Available: http://zerowastedetroit. org/our-work/report-an-odor. [Accessed 4 May 2016].

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Figure 7.6-7. Outreach materials from Zero Waste Detroit encouraging community reporting of air pollution concerns. Taken from: http://zerowastedetroit.org/our-work/report-an-odor

State and academic researchers have conducted many special monitoring studies. These include:

- Detroit Air Toxics Initiative (2005) and research investigating the toxicity of PM at Dearborn (Salinas School by EPA/MDEQ);
- Measurement of impacts around the bridge and intermodal facilities.
- Lead deposition around homes being demolished (UM);
- NO_x and PM monitored at fire stations across Detroit to improve the understanding of spatial patterns (WSU).
- Detroit Exposure and Aerosol Research Study (DEARS) to understand personal exposure
- NEXUS Near-Road Study to understand indoor and outdoor pollution and health effects from traffic-related air pollutants, focusing on the Eliza Howell site (US EPA and UM).
- Air quality and toxicology studies at Dearborn using concentrated air pollutants and animals (US EPA, MSU, UM).
- US EPA and others will be conducting a near-road study to investigate effects of sound barriers and vegetation.
- Truck survey and air quality measurements will be conducted by CBC and UM.

7.6.7 How many people could be affected in Detroit by improved monitoring and enforcement?

While increasing monitoring does not directly decrease air pollution emissions or exposures, it has the potential to identify areas of air pollution concern and to promote enforcement actions. For example, additional SO_2 monitoring might expand the geographic area and number of facilities covered by the SO_2 State Implementation Plan, and possibly lead to greater emission reductions. In addition, greater access to air monitoring data would allow individuals to limit their exposure during times of high air pollution levels.

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Greater enforcement of air pollution violations would impact both individuals living nearest to those facilities being targeted for enforcement, as well as others at greater distances that also receive exposure. The use of sophisticated analyses and approaches to enforcement and permitting decisions, including health oriented analyses and cumulative impact assessments, could affect large populations throughout Detroit and southeast Michigan, with those areas containing larger populations that are susceptible and vulnerable receiving the largest benefits.

7.6.8 What are the best practices? What is applicable to Detroit?

Best practices for monitoring and enforcement are in part drawn from programs in other areas. For enforcement-related practices, best practices that are applicable to Detroit include:

- Shift the approach used by regulators to public health and safety protection rather than the existing focus on compliance with applicable laws and rules.
- Routinely incorporate and use of analyses that investigate and consider human health effects, including health impact assessment (HIA) and cumulative impact assessment (CIA).

  Canada has requirements in this area, as does Minnesota.[26] Other states, including New Jersey and California, have begun investigating and implementing ways to incorporate CIA in permitting and enforcement practices.[27] [28] Overall, these approaches strive to evaluate a facility or permit's impact on a community, and thus give regulators and others a more accurate picture of risk and pollution burden within a community when making permitting decisions.

  Cumulative impact is "an analysis, characterization, and possible quantification of the combined risks to health or the environment from multiple agents or stressors", [29] and can include analyses of multiple pollutants, facilities, routes or pathways of exposure, multiple stressors (including chemical, physical, biological, economic or psychosocial). (A discussion of CIA is provided in Section 3.1.) Where applicable, the Minnesota rule requires an assessment of cumulative risk to individuals that accounts for the permit as well as existing pollution levels, demographics, existing disease burden within the community, current and historic pollution data, exposure data, and various socioeconomic indicators, e.g., poverty and racial make-up. It also includes considerable community engagement. The development of this rule used a series of stakeholder meetings, incorporated community feedback, and provided opportunities to open

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[26] The Minnesota Pollution Control Agency (MPCA) cumulative risk assessment statute and program indicates that MPCA may not issue a permit to a facility without analyzing and considering the cumulative levels and effects of past and current environmental pollution from all sources on the environment and residents of the geographic area within which the facility's emissions are likely to be deposited for certain facilities in Hennepin County. https://www.revisor.mn.gov/statutes/?id=116.07

[27] New Jersey Department of Environmental Protection. 2009. A preliminary screening method to estimate cumulative environmental impacts. Available: http://www.nj.gov/dep/ej/docs/ejc_screeningmethods20091222.pdf. [accessed 8 March 2016].

[28] OEHHA (Office of Environmental Health Hazard Assessment). 2010. Cumulative impacts: Building a scientific foundation. Available: http://oehha.ca.gov/ej/cipa123110.html. [accessed 8 March 2016].

[29] EPA (Environmental Protection Agency). 2003. Framework for Cumulative Risk Assessment. Available: https://www.epa.gov/sites/production/files/2014-11/documents/frmwrk_cum_risk_assmnt.pdf [accessed 25 Feb 2016].

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a dialogue on ways to better engage with stakeholders (i.e. better notification of permit review and comment periods).

CIA can be built into various parts of the regulatory process, including the permitting process, when identifying where to prioritize enforcement action, when deciding where and how many monitoring sites to maintain, and in setting health-protective standards.

MDEQ should initiate a CIA framework as a collaborative process conducted with stakeholders.

- Conduct periodic integrated and long-range air quality planning, including incorporation of transportation, buffers, green energy, and other trends.
- Provide additional funding for technical staff and inspectors to allow more frequent inspections, enhanced monitoring, and other analyses.
- Obtain additional staff at the Attorney General and Department of Justice offices responsible for enforcement. These staff can often pay for themselves by enforcing laws and collecting fines through consent orders, settlements, or judgments.
- Increase notification, information and transparency related to the permitting process, including posting received permit applications; increased time for review of draft materials; assessment of overall facility emissions, impacts and environmental performance in public information documents; and dedicated MDEQ staff to translate technical materials.
- Provide external technical assistance services and advisors for communities. The Superfund Program, for example, has a Technical Assistance Services for Communities (TASC) Program that provides scientists, engineers and other professionals to review and explain information to communities at no cost to communities; a Technical Assistance Grant (TAG) Program for non-profit incorporated community groups to contract with independent technical advisors to interpret and help the community understand technical information, and a similar Technical Assistance Plan (TAP) (funded by polluters) enabling community groups to retain the services of an independent technical advisor.[30] In some ways, these are similar to community benefit agreements.
- Provide more opportunities for meaningful public participation, potentially including use of balanced stakeholder advisory board.

  The public plays an important role in environmental decision making. Individuals living near an air pollution source may know more about the local environmental conditions than an environmental agency located several hours away, and citizens can offer a wide range of perspectives, views, and experiences that are not necessarily represented by the government or regulated industries.

[30] See https://www.epa.gov/superfund/technical-assistance-communities

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- Reduce emissions from point, non-point, non-road, and fugitive sources by reviewing and updating Act 451 rules.
- Improve emissions inventory data, particularly for PM and toxics.
- Require additional emissions monitoring and testing. Deficiencies in available PM and toxics data have been noted.

  In addition, some areas have used real-time air monitoring systems that can detect pollutant levels that are designated to be harmful to public health, and require real-time dissemination of this information and notification of communities and emergency personnel should a health protective standard be exceeded. This has been proposed recently by Louisiana for all major point sources[31,32] Warning systems have been used in industrial areas in the US, Canada, and elsewhere.
- Revamp and promote the Clean Corporate Citizen Program, and provide other incentives to encourage meaningful emission and exposure reductions. A stakeholder's panel should be involved.
- Utilize targeted studies to investigate toxics deposition, health risks, and other topics.
- Regularly evaluate program effectiveness and impact.
- Tighten permit conditions, including emission limitations and averaging times in PTIs and ROPs. This includes reducing the large differences between allowable (permitted) and actual emissions, and the differences between emission limitations at short and long averaging times.
- Incorporate community data in to enforcement action. Expand outreach by groups, such as Zero Waste Detroit, and create web-based systems for residents to report air pollution concerns. These reports should be incorporated in to MDEQ reporting systems to help target enforcement action.

Ultimately, permits that are effective and credible in controlling emissions may be the most critical element of enforcement.

Best practices for monitoring include the following:

- Additional source monitoring to better understand actual PM emissions.
- Increase industry monitoring, including fence line monitoring to measure pollution as it travels over the fence-line. This can be done either through legislation or through negotiation with individual facilities. There is relatively little monitoring considering the nature and magnitude of emissions in this area.
- Expand the SO_2 monitoring network. The SO_2 SIP relies heavily on modeling, but additional monitoring in areas identified as 'hotspots' by modeling is required.

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[31] House Bill No. 469, Louisiana House of Representatives. Available: https://www.legis.la.gov/legis/ViewDocument.aspx?d=998311.

[32] Associated Press. 2016. Bill requiring industrial air monitoring advances in house. Available: http://www.ktbs.com/story/31833042/bill-requiring-industrial-air-monitoring-advances-in-house. [accessed 4 May 2016].

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- Identify other monitoring gaps using a structured process with public input.
- Apply remote sensing and other technologies to develop spatially-resolved understanding of pollutant exposures.
- Provide further analyses of collected data to understand trends and apportionments.
- Deploy semi-permanent or transportable ambient monitoring equipment to understand spatial impacts from particular sources, particularly heavy industry in southwest Detroit, with sufficient data to develop annual average concentrations of toxics
- Fund and provide in-kind support for low-cost and community air monitoring activities. Use low-cost air monitoring systems to supplement existing monitoring networks, identify pollution hotspots and empower communities to document air pollution within their own neighborhood. A formal process to encourage collocation with existing MDEQ monitoring sites, assistance with data interpretation, quality assurance, and other actions could be taken to increase the value of data provided by low-cost monitoring.
- Enhance the websites and public information to allow more informative displays of source emissions and ambient monitoring results.

  For example, reports of odors, smoke, flaring and emissions around oil refineries and chemical plants in Louisiana are mapped on the web by a small NGO[33] using community-based reporting with narrative reports (via text or voicemail that are transcribed, tagged by content, and posted.[34] The map (see Figure 7.6-8) also includes reports of air emissions above permit limits reported by facilities to the National Response Center (NRC). Weekly summaries were sent to state and federal regulators. This mapping increased the understanding of locations of air quality concern and allowed communities to identify emissions that may impact health.

[33] Louisiana Bucket Brigade (LABB), has been using community mapping since 2005.

[34] Bera, R, Hrybyk, A. "iWitness Pollution Map: Crowdsourcing petrochemical accident research". *New Solutions,23*(3), 21-533, 2013.

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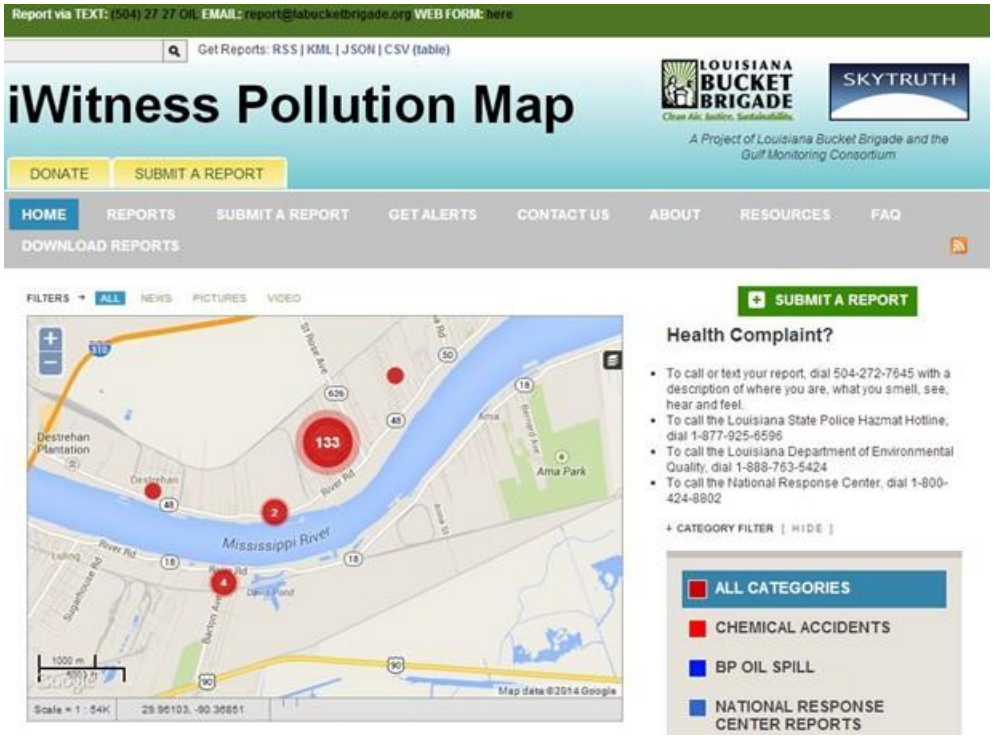

Figure 7.6-8. iWitness Pollution Map website. Red circles represent community or industry reports of air pollution. The size of the circle corresponds to the number of reports made during the specified time frame. Taken from: http://www.iwitnesspollution.org.

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