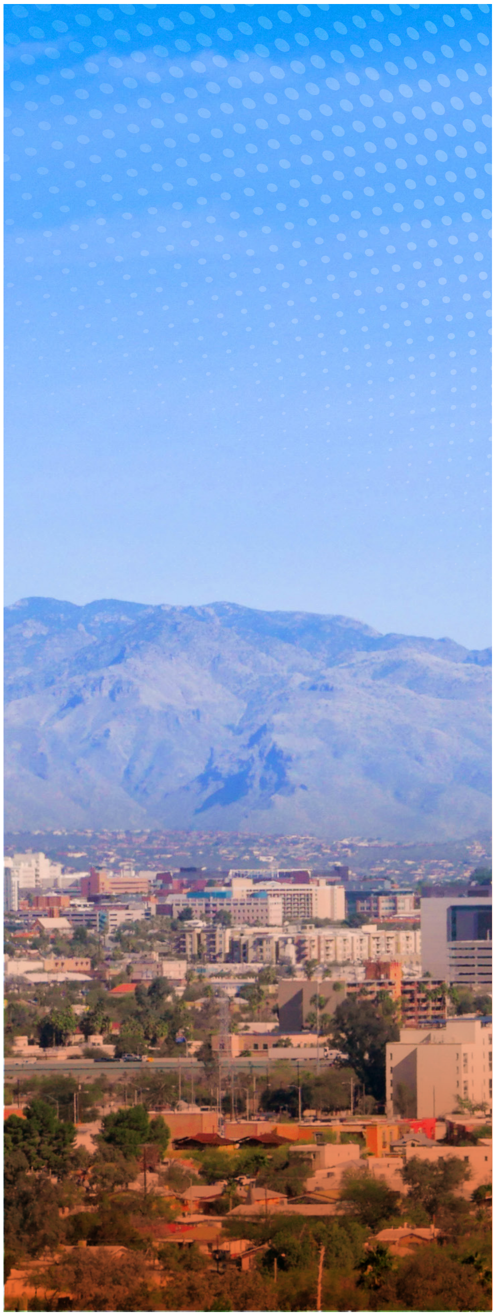
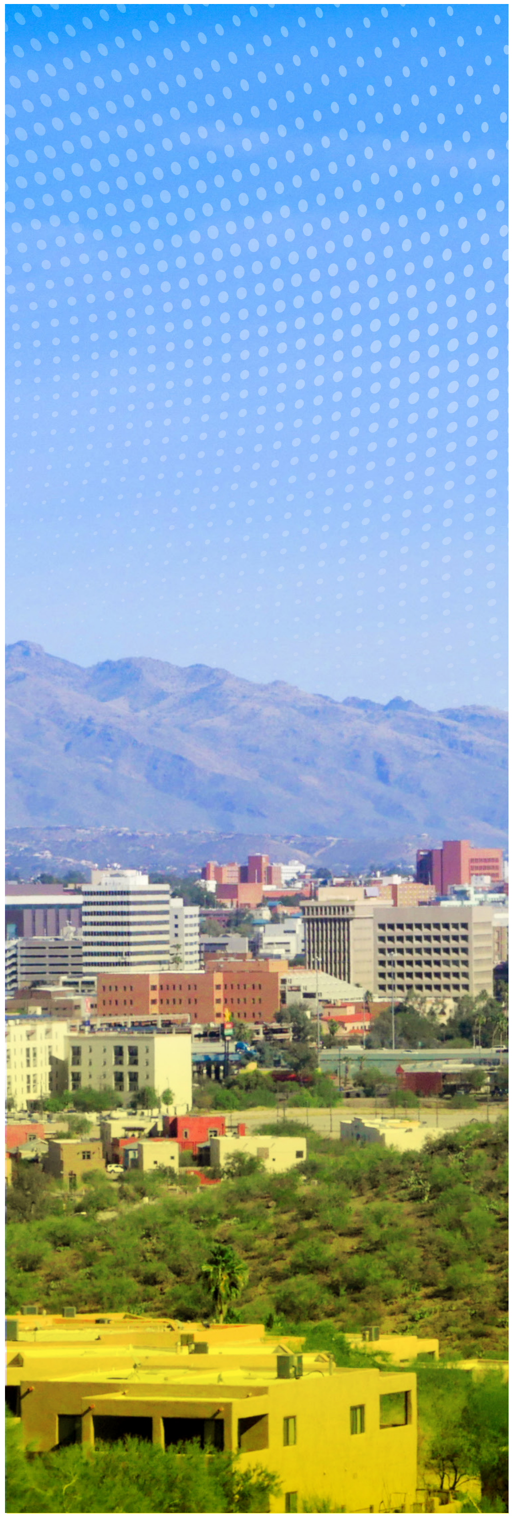
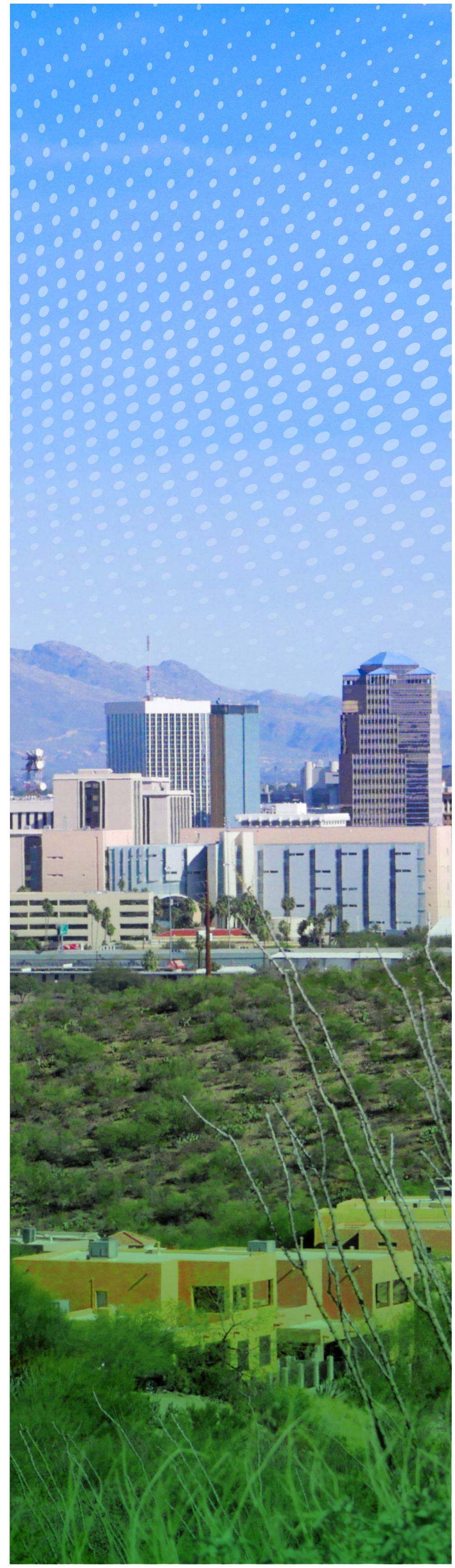

2018 OZONE STATUS REPORT

Pima Association of Governments
PAGregion.com

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List of Acronyms

ADEQ	Arizona Department of Environmental Quality
B5	Biodiesel
CNG	Compressed natural gas
EPA	U.S. Environmental Protection Agency
GHG	Greenhouse gas
I/M	Inspection and Maintenance Vehicle Inspection Program
LPG	Liquified Petroleum Gas
MOVES	MOtor Vehicle Emission Simulator
NAAQS	National Ambient Air Quality Standards
NOx	Oxides of nitrogen
NSR	New Source Review Permitting Program
O_3	Ozone
PAG	Pima Association of Governments
PDEQ	Pima County Department of Environmental Quality
ppb	Parts per billion
ppm	Parts per million
RFP	Reasonable Further Progress
TRP	Travel reduction program
VMT	Vehicles miles travelled
VOC	Volatile organic compounds

Table of Contents

Executive Summary

As Pima County's designated air quality planning agency, the Pima Association of Governments (PAG) is responsible for developing plans in cooperation with its stakeholders, to ensure regional compliance with the Environmental Protection Agency's (EPA) national ambient air quality standards (NAAQS). The EPA sets these standards for 6 criteria pollutants[1] to protect human health and the environment.

One of these pollutants, ozone, is of particular regional concern because levels have hovered near the EPA standards for several years. In 2015, the EPA revised the primary and secondary ozone standards to 0.070 part per million (ppm), down from the 2008 standards (0.075 ppm) to be more protective of human health. At high concentrations, ozone can irritate the respiratory system, reduce lung function and cause breathing difficulties. It is particularly harmful to those with preexisting health conditions, older adults and children.

Ground level ozone is not directly produced but results from a chemical reaction of precursor chemicals in the presence of sunlight. The sources of these ozone precursors, oxides of nitrogen (NOx) and volatile organic compounds (VOC), are anthropogenic in origin and also can result from biological processes. The major local sources of NOx are on-road motor vehicles and point sources; the major sources of VOCs are biogenic (plant emissions) and area sources (ERG, 2017).

In Pima County, ozone concentrations are highest during the warmer months (April through October) and start to increase in late morning and continue to rise until leveling off in early evening.

In April 2018, EPA determined that Pima County was in compliance with the 2015 ozone standards, based upon 2014 to 2016 monitoring data. However, recent ozone monitoring trends emphasize the need to revisit and evaluate ozone precursor sources and potential control measures.

This report summarizes the ozone formation process, national and regional sources of ozone precursor emissions, current and historic ozone concentrations, and a preliminary review of reduction measures from existing and potential measures. Quantification of regional onroad and nonroad emissions reductions were estimated using the most recent EPA emissions model (MOVES2014b).

Based upon this initial analysis, federal onroad and nonroad vehicle regulations, if phased in as anticipated, would provide the largest ozone precursor reductions. Quantifiable local control programs administered by PAG and ADEQ currently provide a total of a 6 percent and a 7 percent reduction in NOx and VOC emissions, respectively.

This report suggests areas where more current research is needed such as evaluating biogenic sources of ozone precursors, refining temporal parameters associated with high ozone levels and developing a more detailed analysis of ozone control measures that include regional cost/benefit analysis.

[1] EPA's criteria pollutants: carbon monoxide, ozone, particulates (PM_{10}, $PM_{2.5}$), lead, nitrogen dioxide, and sulfur dioxide.

1. Introduction

a. Ozone Characteristics and Regional Patterns

Ozone is a colorless gas composed of 3 oxygen molecules (O_3). It occurs naturally in the stratosphere and protects the Earth from harmful solar ultraviolet radiation. However, the ozone that occurs closer to the Earth's surface is an air pollutant. Ground level ozone forms from a chemical reaction of precursor chemicals in the presence of sunlight. The ozone precursors are chemicals produced from anthropogenic activities and biological processes.

In 2017, the highest ozone levels occurred in April, May and June and started to level off at the beginning of the monsoon season (July) (Figure 1). Locally, ozone concentrations start to increase in late morning and continue to rise until leveling off in early evening (Figure 2).

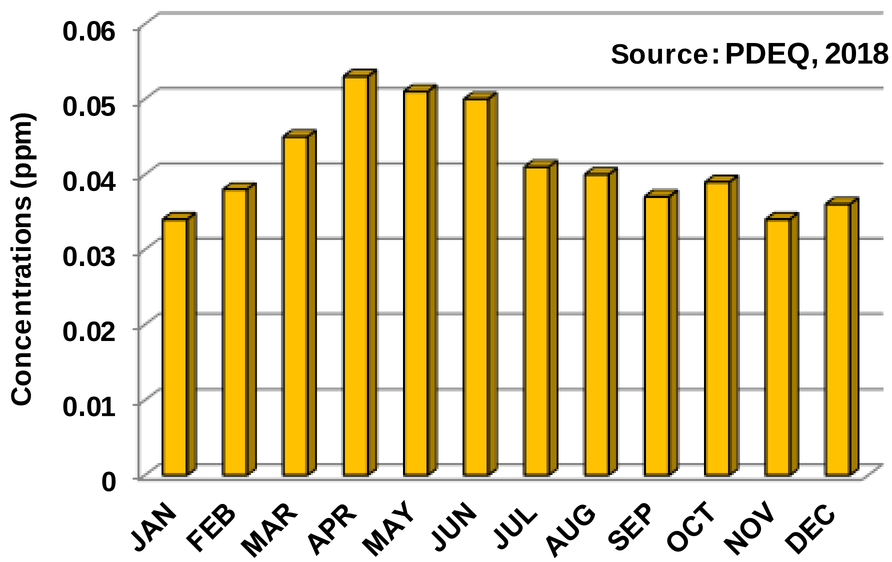


Figure 1. 2017 Monthly Ozone Concentrations: Saguaro National Park Monitor

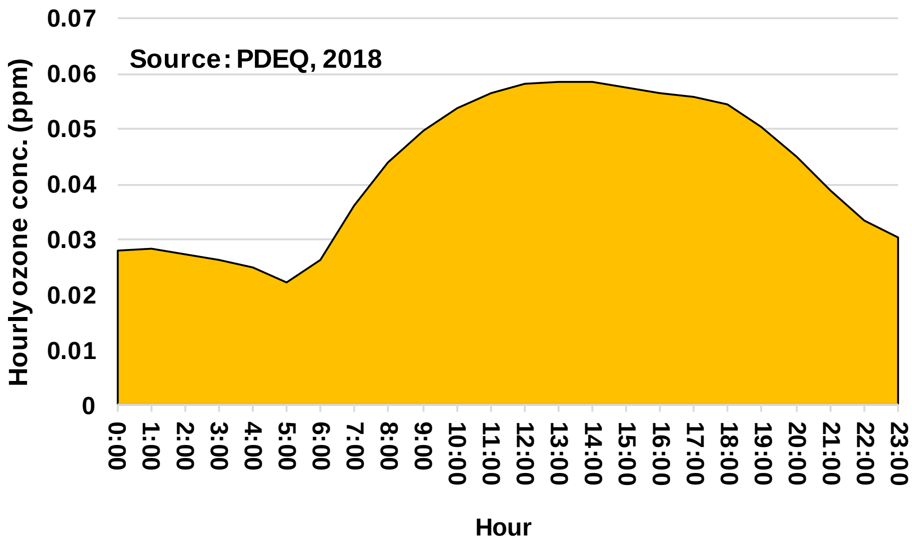


Figure 2. May 2017 Average One-hour Ozone Concentrations**:** Craycroft and 22nd Street monitor

b. Human and Environmental Health Impacts

At high concentrations, ozone can irritate the respiratory system, causing coughing, throat irritation, and an uncomfortable sensation in the chest. These effects can reduce lung function, making it more difficult to breathe. Individuals with preexisting conditions such as asthma, emphysema and heart disease, and older adults and children are more acutely affected by elevated ozone levels.

In addition to being a human health concern, ozone can affect plant growth. High ozone concentrations can reduce crop yield (Avnery, 2011) by reducing the photosynthetic rate and making plants more susceptible to pests. In uncultivated areas, entire ecosystems can be impacted due to the loss of species diversity and changes in species composition.

Ozone is also considered a greenhouse gas (GHG) due to its ability to remove methane and other hydrocarbons from the atmosphere, thereby affecting how long other GHG remain in the air.

c. Federal Health Standards and Area Designations

In 2015, the EPA revised the primary and secondary ozone standards to 0.070 part per million (ppm), from the 2008 standards (0.075 ppm), to be more protective of human health. In 2018, EPA issued the final ozone designation criteria (Table 1) and the attainment/nonattainment designations for all regions.

Table 1. EPA's 2015 Ozone Standard Designations

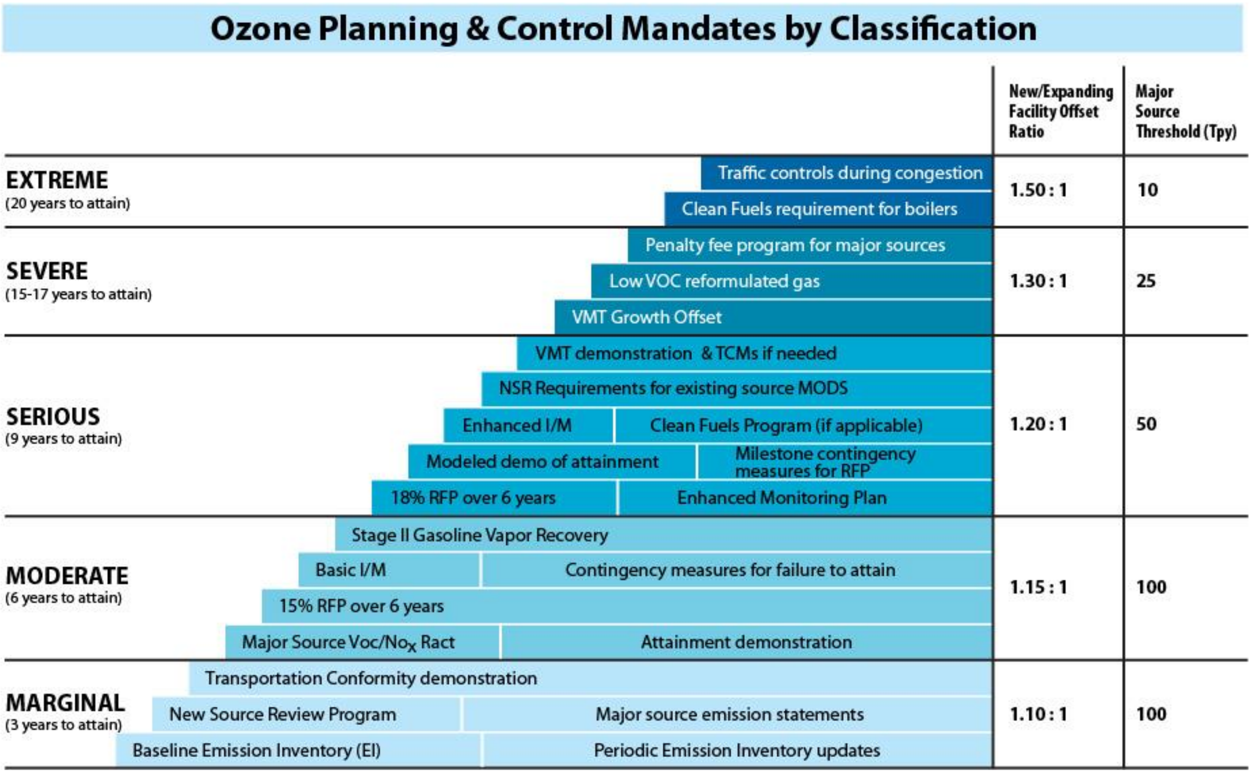
Area Designation	**8-Hour Ozone Design Value (ppm)**[2]	**Attainment Date**
Attainment/unclassifiable	Less than 0.070 or data not available	N/A
Marginal	0.071-0.081 [3]	2021
Moderate	0.081-0.093 [2]	2024
Serious	0.093-0.105 [2]	2027
Severe -15	0.105-0.111 [2]	2033
Severe - 17	0.111-163 [2]	2035
Extreme	0.163 [4]	2038

Source: https://www.gpo.gov/fdsys/pkg/FR-2018-03-09/pdf/2018-04810.pdf

As shown in Figure 3, mandatory requirements are associated with each nonattainment designation. As the degree of the nonattainment increases, the requirements are additive and include all the requirements listed in the lower categories. A nonattainment designation can have economic impacts on a region due to stricter regulations and the need to acquire emission credits or offsets. The emission target level at which offsets are required decreases with increasing nonattainment severity.

For example, in a marginal nonattainment area, companies wishing to establish a new facility must obtain pollution credits from a local activity/company if its new site has the potential to emit 100 tons per year (tpy) of ozone precursors. Existing companies that already have the potential to emit 100 tpy and plan to make modifications with the potential to emit an additional 40 tpy would also need emission offsets before construction could begin.

[2] Ozone concentration data represents the annual fourth-highest daily maximum 8-hour concentration, averaged over 3 years
[3] Up to but not including the highest concentration
[4] Equal to or above



Source: Barr, M. and Droessler, B. *Clean Air Minnesota.* 2012.
https://www.slideshare.net/Environmental-Initiative/hansel-droessler-update-on-changing-federal-naaqs-what-they-mean-for-you

Figure 3. Overview of the Clean Air Act Ozone Nonattainment Area Planning and Control Requirements by Nonattainment Classification

2. Ozone Concentration Trends

A. U.S. Ozone Concentration Trends

From 2010 to 2017, average U.S. ozone concentrations declined by 6 percent (Figure 4). The EPA attributed this to significant reductions in NOx emissions from electricity generation and the considerable reductions that occurred in on-road and non-vehicle VOC emissions (EPA, 2018a). In the Southwest U.S., average ozone concentrations have declined about 7 percent over the same period.[5] (EPA, 2018a).

[5] EPA defined Southwestern states for this report as Arizona, New Mexico, Utah and Colorado.

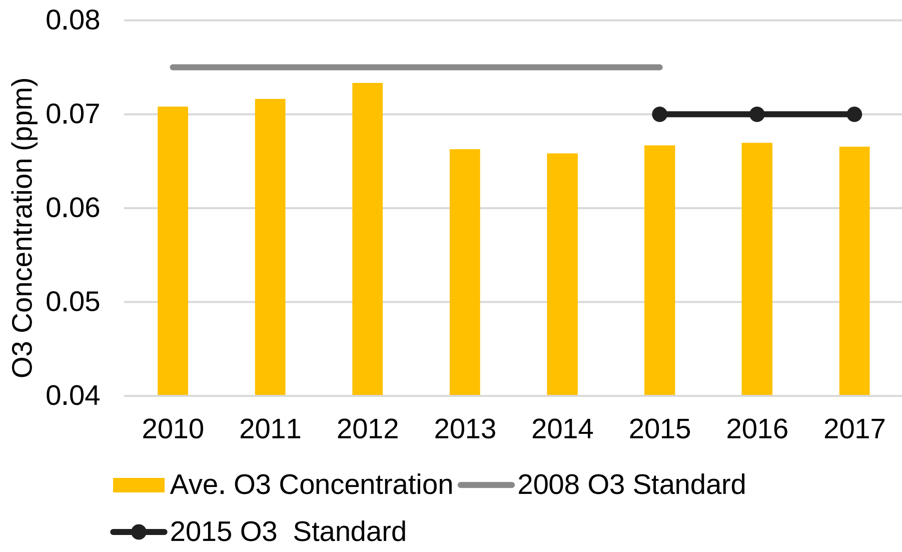
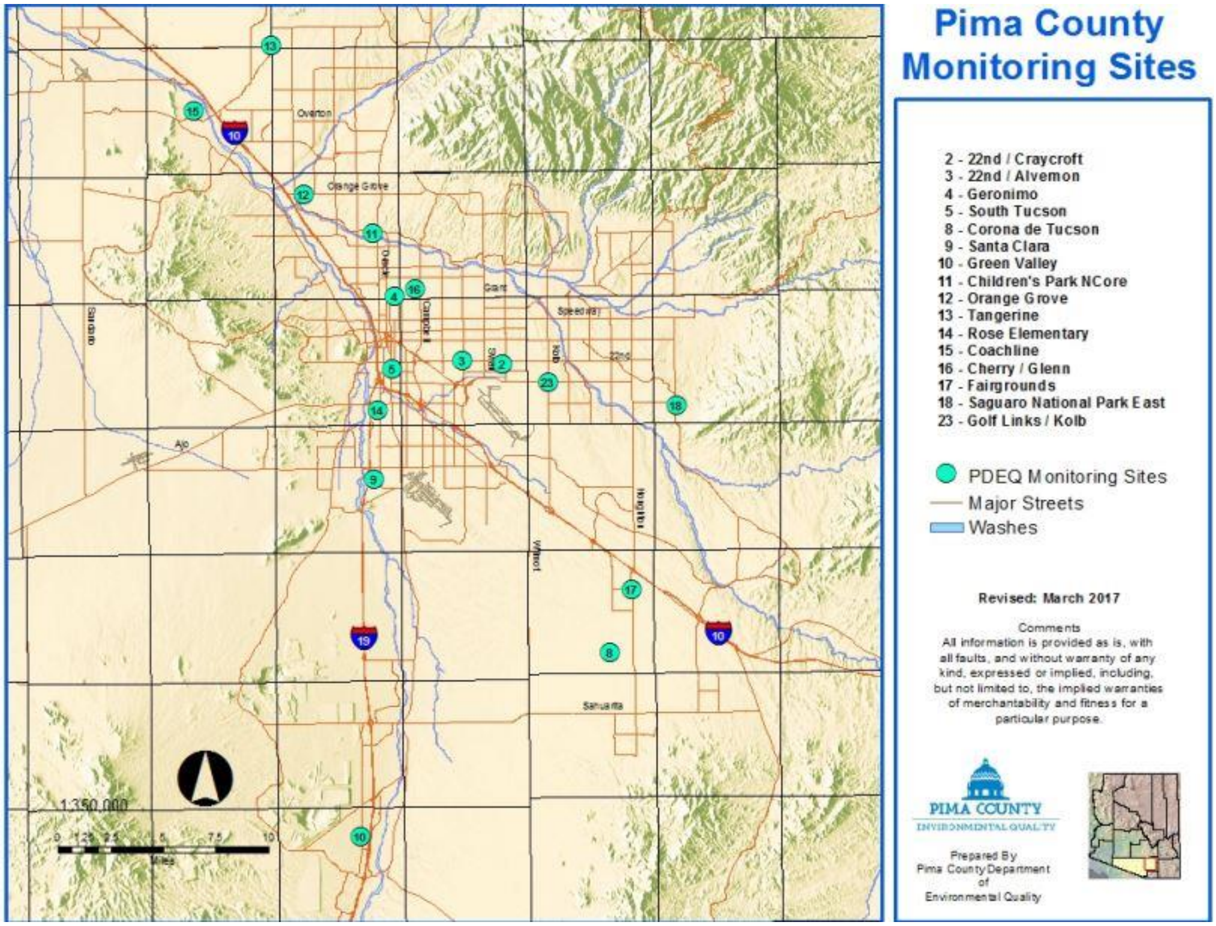


Figure 4. U.S. Ozone Concentration Trends 2010-2017

B. Pima County

Pima County was designated as an ozone attainment/unclassifiable area based upon the 2014-2016 monitoring data, but levels continue to hover near the ozone standard (Figure 5).

The Pima County Department of Environmental Quality's (PDEQ) has 8 ozone monitors in eastern Pima County (Figure 5). The air quality monitors that are located in the more rural areas of eastern Pima County generally show higher ozone concentrations (e.g. Saguaro National Park East) (Figure 6). Afternoon winds heading toward the southeast are thought to contribute to this pattern.



Source: PDEQ, 2018

Figure 5. PDEQ Air Quality Monitors

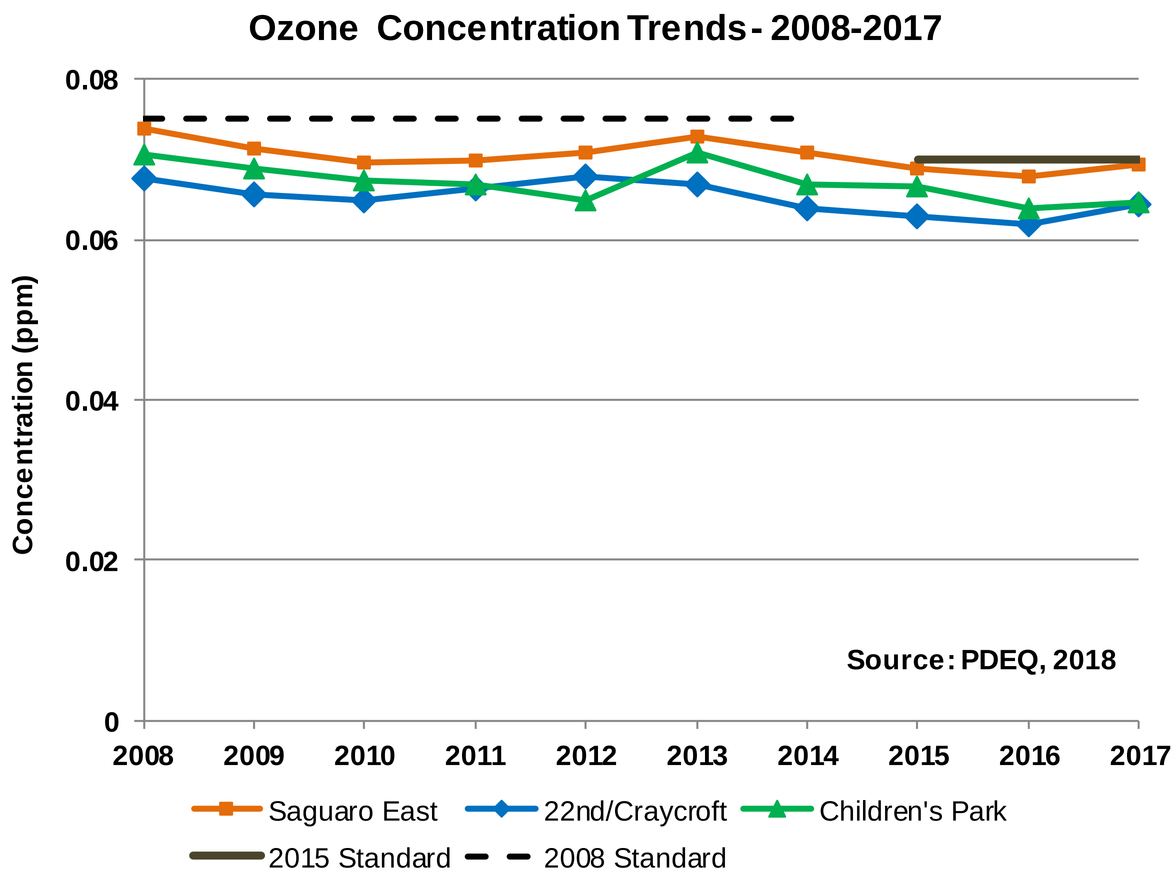


Figure 6. 2008-2017 Pima County Ozone Concentrations at Select PDEQ Monitors

3. Sources of Ozone Precursors

Ozone is produced when two principle precursor chemicals, volatile organic compounds (VOCs) and oxides of nitrogen (NOx), combine in the presence of the sun's ultraviolet rays. Both VOCs and NOx are emitted directly into the air from sources such as fossil fuel combustion, manufacturing and industrial activities. Natural events such as wildfires, plant processes and soil microbial reactions also produce these precursors.

A. United States

Every three years, the EPA, in cooperation with states, tribes and local entities, develops a national emissions inventory (NEI) for all regulated criteria and toxic air pollutants. The data are compiled at the national, state and county scales and include emissions from industrial and manufacturing and municipal activities (point), motor vehicles and equipment (on-road, nonroad), small commercial operations (area sources), aircraft and locomotive use and emissions from natural sources such as wildfires, plants and soils (biogenics). The EPA's last inventory was conducted for 2014 and Table 2 summarizes the relative contributions of the various U.S. sectors to each precursor's total (NOx, VOC) from the latest version of this report (EPA, 2018b)

Table 2. 2014 U.S. Ozone Precursor Emissions by Sector

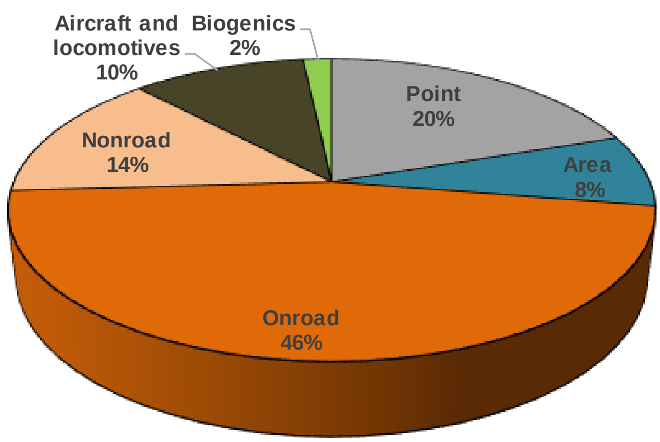
U.S. Sector	NOx	VOC
	Percent of total	
Point	21.4	7.1
Area	13.9	16.1
Onroad	34.0	4.0
Nonroad	9.8	3.0
Aircraft & locomotives	14.6	0.2
Biogenics	6.3	69.6

B. Pima County

PDEQ contracted with Eastern Research Group (ERG) to develop a Pima County emissions inventory for the major ozone precursors (VOC, NOx) (ERG, 2017). The Inventory included eastern Pima County's emission estimates from point and area sources, on-road and nonroad vehicles and equipment, aircraft, locomotives, and biogenics. Although biogenic emissions are not created by human activity, they were included in the inventory because they are significant contributors to air chemistry.

Oxides of Nitrogen (NOx)

The report indicated that in 2014 the major sources of NOx emissions were on-road motor vehicles (46 percent) and point sources (20 percent) (Figure 7).

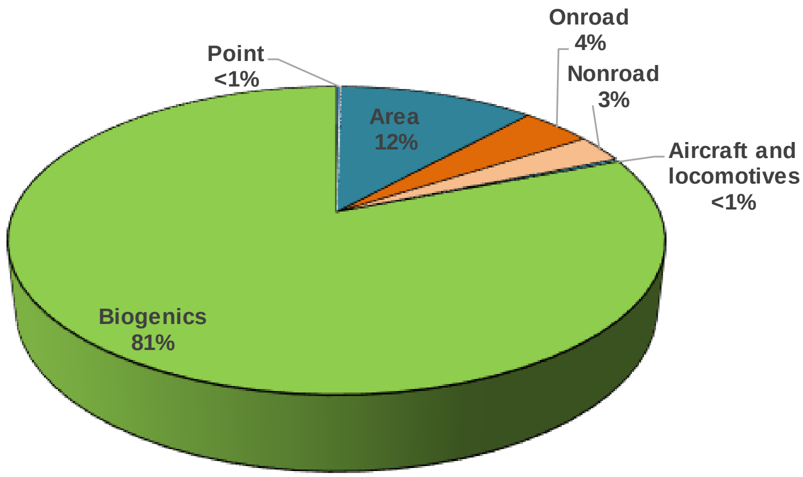


Source: ERG, 2017

Figure 7. 2014 Eastern Pima County NOx Emissions

Volatile Organic Compounds (VOC)

By far, biogenics were the major contributor of VOC emissions in the region (Figure 8).



Source: ERG, 2017

Figure 8. 2014 Eastern Pima County VOC Emissions

4. Previous Regional Studies

A. Monthly Variation in Precursory Sensitivity

Control measures are developed based on precursor emission sources and influenced by meteorological conditions. Since ozone formation results from chemical reactions involving VOC and NOx, the relative amount of each is important and can vary temporally and by location. Generally, under low VOC/NOx ratios (VOC-sensitive conditions), limiting VOC emissions would reduce ozone formation. At high VOC/NOx ratios (NOx-sensitive conditions), lowering NOx emissions would reduce ozone formation.

Studies conducted by University of Arizona researchers (Diem, et al., 2001) in the late 1990's revealed that NOx/VOC sensitives fluctuated by month and by location (Table 3).

Table 3. Monthly Ozone Sensitives 1995 - 1998 using MAPPER[6]

April	May	June	July	Aug	Sep
NOx-sensitive; downtown Tucson – VOC sensitive	Transitioning from NOx to VOC-sensitive	By the end of the month, most of the Tucson- metro area is VOC sensitive	Transitioning to NOx sensitive	Continuing transitioning to NOx sensitive	VOC-sensitive

Primary source: Diem, 2001; Secondary source: PAG, 2003

The study indicated that due to these temporal and spatial variations in ozone production, both NOx and VOC control measures may be required to reduce ozone levels in the Tucson area.

In the same study, data suggested that transport of pollutants from Phoenix might impact elevated regional ozone concentrations during April, May and June, while El Paso/Ciudad Juarez-originating pollution may contribute to elevated concentrations in August and September.

A more recent study coordinated by the Western Regional Air Partnership (WRAP, 2014) indicated that ozone originating from California and Mexico contributed to ozone concentrations measured at a rural, southeastern PDEQ monitor. Ozone formed in California and Mexico contributed 1 to 15 percent and 2 to 5 percent, respectively, to the total PDEQ's measured ozone level at that monitor.

B. Weekend/Weekday Ozone Variation

Weekday/weekend patterns of ozone concentrations provide insight into its production and can guide the development of regional control strategies.

Studies conducted in 1999, (Diem, 2000) indicated that ozone concentrations in the Tucson metropolitan area were higher during the weekend than during the week (weekend effect) but vary by location and month. In April, the 'weekend effect' was present only at the downtown monitor but extended to another monitor east of the downtown area in May. By June, all monitors except for the Saguaro National Park East, exhibited the 'weekend effect'. In July and August, none of the monitors had significantly higher weekend concentrations, but instead exhibited a 'weekday effect' (significantly higher weekday concentrations) with the exception of the downtown monitor. In September, the weekend effect was observed at all monitors. Researchers indicated that the weekend effect was associated with VOC-sensitivity and weekday effect indicated NOx-sensitivity.

The study results also indicated that the weekend and weekday effects were not controlled entirely by variations in anthropogenic ozone precursor emissions. The month-to-month variation could be partially explained by the variations in atmospheric conditions. Prevalent mountain/valley circulation, temperature and relative humidity changes all appear to affect

[6] MAPPER: Measurement-based Analysis of Preferences in Planned Emission Reductions. This program uses measurements of ozone, nitric oxide (NO), and the sum of all oxidized nitrogen species to compute the extent of reaction to determine if an area is NOx or VOC sensitive.

precursor sensitivities, but precipitation seems to be a major factor. Rainfall was thought to have a significant impact on the release of biogenic emissions (Diem, 2000).

C. Regional Biogenic Emissions

Researchers at the University of Arizona conducted a multi-year project that involved the development of a model (SMOGMAP) to provide more detailed information on ozone precursor sources, and how they fluctuate in time and space to form ozone. One portion of this study focused on biogenic emissions. Results indicated that approximately 50 percent of VOCs in eastern Pima County were from biogenic sources. In the Tucson metro area, biogenics produced about 6 percent of VOCs; anthropogenic VOCs were responsible for the other 94 percent (Comrie, et al. 1998). This is in contrast to the Pima County inventory, which used EPA's default data for Pima County, factored by relative square miles, to represent eastern Pima County (ERG, 2017).

In Eastern Pima County, both the forested areas containing oak/pine/juniper mix and desert scrub, containing Palo verde, creosote, and triangle-leaf bursage, were large sources of biogenic emissions. In the Tucson metropolitan area, urban parks and densely vegetated residential areas produced the highest biogenic emissions.

5. Current and Anticipated Control Measures

A. Federal Mobile Vehicle Standards and Programs

Several federally mandated programs are already in place or are expected to be phased in over the next few years. According to EPA, these programs will continue to reduce ozone precursor emissions and help states meet the 2015 ozone standards.

1. On-road Motor Vehicles:

- *Tier 2 Vehicle Emission and Fuel Standards (Effective 2004)*

  In 2000, EPA issued a final rule setting Tier 2 motor vehicle emissions standards and lower gasoline sulfur content requirements (65 FR 6698). The Tier 2 program established lower standards for tailpipe emissions for all passenger vehicles, sport utility vehicles, minivans, vans and pick-up trucks.

- *Federal Heavy-Duty Diesel Vehicle Emission Standards (Effective 2006)*

  In 2001, EPA issued a final rule setting more stringent emission standards for new heavy-duty diesel vehicles (66 FR 5002). The rule requires that high-efficiency catalytic converters or comparable technologies be installed on diesel vehicles model years 2007 forward. The rule also mandated that ultra-low sulfur diesel (15 ppm sulfur or less) be used in all on-road diesel vehicles beginning in 2006.

- *Mobile Source Air Toxics Rule (MSAT) (Effective 2011)*

  Beginning in 2011, this rule reduced hazardous air pollutants, such as benzene emitted from cars and trucks through changes in gasoline content. The MSAT gasoline fuel program requires that refiners meet an annual average gasoline benzene content (2011) and maximum average benzene standard (2012). The program helped to decrease benzene levels in gasoline throughout the country and lessen geographic variability in gasoline.

- *Phase 1 and 2 Light-Duty Vehicle and Phase 1 Medium and Heavy-Duty Vehicle Greenhouse Gas Rules (Effective 2012-2025)*

  In 2010, the EPA finalized the Phase 1 light-duty vehicle GHG emissions standards and corporate average fuel economy (CAFÉ) standards for vehicle model years 2012-2016 (75 FR 25324).

  In 2012, the EPA and the and the National Highway Traffic Safety Administration (NHTSA) jointly established a national program for light-duty vehicles standards that reduced GHG emissions and improved fuel economy. the (77 FR 62624). Part of this ruling was to conduct a mid-term evaluation of these standards that affected model years 2022-2025. In April 2018, the EPA in its reconsidered mid-term evaluation determined that the 2022-2025 standards should be revised since the previous standards were based on outdated information, and newer information indicated that the standards may be too stringent. This revised determination is not a final agency action, but it initiated a rulemaking process whose outcome will be a final agency action. Until that rulemaking has been completed, the current standards remain in effect and there is no change in the legal rights and obligations of any stakeholders (83 FR 16077).

- *Tier 3 Vehicle Emissions and Fuel Standards (Effective 2017)*

  In 2014, the EPA issued Tier 3 motor vehicle emission and fuel standards (79 FR 23414), which lowered vehicle emission standards and further reduced the amount of sulfur in gasoline. Tier 3 vehicle emissions standards reduce tailpipe and evaporative emissions from passenger cars, light-duty trucks, medium-duty passenger vehicles and some heavy-duty vehicles.

The emission reductions achieved through the light, medium and heavy-duty vehicle emission and fuel efficiency standards are expected to improve over time as the population of older vehicles is replaced with newer, more fuel-efficient vehicles.

Table 4 shows the pollutant reductions estimates using MOVES2014b modeling, provided that the regulations affecting model year 2022 vehicles remain as originally proposed.

Table 4. Estimated Changes to Eastern Pima County On-road Vehicle Emissions due to Anticipated Federal Regulations

Pollutant	**2017**	**2022**	**2017-2022 Percent change**
	On-road Annual (Short tons)		
NOx	7,205.6	4,311.9	**- 40.2**
VOC	5,226.7	3,627.4	**- 30.6**

2. Nonroad Vehicles and Equipment:

- *Tier 1, Tier 2, Tier 3 and Tier 4 Emission Regulations for VOCs, NOx and CO*

  Federal standards (Tier 1) for new nonroad diesel engines were adopted in 1994 for engines over 50 horsepower (hp) and were phased-in from 1996 to 2000, varying by the engine size. In 1998, Tier 1 regulations for equipment under 50 hp were added. The more stringent Tier 2 regulations were phased in over 2001-2006, according to engine size. Tier 3 standards for all equipment types were phased-in over the 2000 to 2008 period. The Tier 1-3 standards are met through advanced engine design, with no or limited use of exhaust gas after treatment (oxidation catalysts). Tier 3 standards for NOx and VOC are similar to the 2004 standards for highway engines.

  In 2004, the EPA finalized the Tier 4 emission standards, which were phased-in over 2008-2015. These standards required that NOx emissions be reduced by an additional 90 percent through control technologies such as advanced exhaust gas aftertreatment, similar to those required by the 2007-2010 highway engine standards.

  Since the Tier 1-3 regulations did not affect the sulfur content in nonroad diesel fuels, the EPA mandated reductions in sulfur content in these fuels to allow compatibility with the technologies required for the Tier 4 engines. Starting in 2010, there was a 15-ppm sulfur limit for nonroad diesel fuel; in 2012, these diesel sulfur limits were implemented for locomotive and marine fuels. Table 5 shows the reduction benefits as estimated by the EPA's nonroad MOVES2014b model.

Table 5. Estimated Changes to Eastern Pima County Emissions from Anticipated Federal Nonroad Vehicle Regulations (excludes locomotive and aircraft)

Pollutant	**2017**	**2022**	**2017-2022 Percent change**
	Nonroad Annual (Short tons)		
NOx	2,160.2	1,665.8	**- 22.9**
VOC	2,729.3	2,212.9	**- 18.9**

- *Tier 6 and Tier 8 Regulations for NOx Emissions from Aircraft (Effective 2000 and 2014, respectively)*

  In 2008, EPA adopted more stringent emission standards for NOx for aircraft gas turbine engine manufacturers of commercial passenger and freight aircraft. These Tier 6 standards reduced NOx emissions by an estimated 12 percent below the previous engine regulations. The Tier 8 standards (effective 2014) further reduced NOx by an additional 15 percent from the Tier 6 standards.

- *Tier 4 Locomotives (Effective 2015)*

  In 2008, EPA finalized the last of a three-part series of locomotive emission standards for VOCs, NOx, CO, PM for in-line-haul, switch, and passenger rail diesel locomotives. The NOx emissions are estimated to decrease by as much as 80 percent when the regulations are fully implemented. The standards are based on the application of high-efficiency catalytic after-treatment technology for manufactured engines. Starting in January 2015, all manufacturers were required to produce engines that reduce particulates by 70 percent and NOx emissions by 76 percent from the Tier 3 regulations. These standards also apply for existing locomotives when they are remanufactured.

B. Federal Non-Vehicle Standards

1. Federal Portable Fuel Container Rules

In 2007, EPA issued a final rule that included emission standards for portable fuel containers, such as gas cans (72 FR 8428*).* Starting in 2009, all containers were required to limit the container evaporation and permeation emissions to 0.3 grams of hydrocarbons per gallon per day.

2. Regional Haze Regulations

In 1999, the EPA issued the Regional Haze Rule (RHR) designating federal, state, local agencies to work together to improve visibility in the national parks and wilderness areas. Each of these natural areas received a reasonable progress goal (RPG) for reaching “natural conditions” by 2064. The RPGs incrementally reduce the amount of emissions allowable until this goal is achieved.

The RHR focuses on controlling pollutants that impair visibility (NOx, VOC and others) in Class I visibility areas. The Clean Air Act gives special air quality and visibility protection to national parks larger than 6,000 acres and wilderness areas larger than 5,000 acres that were in existence when it was amended in 1977. These are Class I areas; all other areas are Class II. The RHR requires state agencies to make Best Available Retroactive Technology (BART) determinations for stationary sources located near national parks and wildernesses. The result of these BART determinations establishes whether a source must comply with emission limits or apply control measures to reduce its emissions.

Saguaro National Park is a nearby Class I area and two stationary sources are subject to control requirements under the RHR: Tucson Electric Power (TEP), Sundt Generating

Station and Cal-Portland Cement, Rillito Plan. Both facilities were required to modify their emissions to help nearby natural areas reach their visibility goals.

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3. National Emission Standards for Hazardous Air Pollutants (NESHAP)

These are standards for stationary sources that regulate hazardous air pollutants (HAP), not included in the criteria air pollutant regulations. These HAPs are known carcinogens or suspected of causing cancer or other serious health effects. These regulations cover equipment and processes in the industrial, manufacturing and commercial sectors. Many of these HAPs are VOCs and the EPA anticipates that these control measures will also aid in impeding ozone formation.

C. Mandated State and Regional Programs

1. Arizona Department of Environmental Quality (ADEQ) Programs

- ADEQ's I/M Vehicle Inspection Program

  Eastern Pima County's vehicle inspection program began in 1975. The Steady State Loaded/Idle test is used for most vehicles MY 1967 thru 1995 (passenger cars and trucks, commercial trucks, single unit short-haul trucks). Vehicles are tested at idle running at approximately 25 to 30 miles per hour. The resulting exhaust emissions (VOCs, NOx and CO) are reported in percent or parts per million.

  In 2002, on-board diagnostic (OBD) test became a part of the regional inspection program for MY1996 and newer light duty gasoline vehicles. The engine operating data is accessed by connecting directly to a computer in the vehicle that continuously monitors engine emission control systems. The OBD test can identify problems before they lead to engine damage and emissions system failure.

  Diesel vehicles are tested for smoke density using an instrument that measures the percentage of exhaust opacity. All Tucson area diesel vehicles are tested under load on a dynamometer.

  In 2017, Eastern Pima County NOx and VOC reductions from the ADEQ vehicle inspections were estimated to be about 5 and 6 percent, respectively (MOVES2014b).

- ADEQ's Stationary Source Permitting Program

  ADEQ is the air quality regulatory authority for one point source in Pima County, Cal Portland Cement, Rillito Plant.

2. *Pima County Department of Environmental Quality (PDEQ)*

PDEQ serves by protecting public health and the environment by operating programs to monitor air and water quality, hazardous waste, solid waste, and pollution prevention. PDEQ also provides public outreach, education, and citizens' assistance, processes environmental permits, and responds to public complaints and inquiries with investigations and enforcement.

- PDEQ’s Stationary Source Permitting Program

  PDEQ has air quality regulatory authority for most stationary sources within Pima County including municipalities, excluding the Tohono O'Odham, Pasqua Yaqui and San Xavier Indian Reservations, under provisions of the Arizona Revised Statutes (A.R.S.), Arizona Administrative Code (A.A.C.), Pima County Code (PCC), Federal Environmental Statutes. This authority is delegated from the EPA via the Clean Air Act, and the ADEQ.

  PDEQ issues air quality operating permits to facilities, buildings, structures or installations which emit or have the potential to emit air pollutants. These facilities must comply with the conditions in their operating permits to limit air pollution.

  There are several types of permits based primarily on the quantity of air pollutant(s) the facility has the potential to emit: Class I (major source), Class II (minor source), Class III and general permits.

- Compliance and Enforcement Program

  PDEQ is also responsible for ensuring that facilities comply with the permit parameters, and they conduct enforcement proceedings if the facilities do not meet these specifications. PDEQ staff inspects permitted facilities annually to review a source’s permit and compliance file, facility records and conduct facility walk-throughs of the facilities as well as unannounced inspections.

  PDEQ staff issues open burning permits to residents for combustion of weeds and dead plant materials. Inspections are conducted to verify that only authorized materials are burned.

- PDEQ’s Voluntary No-Drive Days Program (Clean Air Program)

  This federal and state-mandated Voluntary No-Drive Day program began in 1988. It is aimed at increasing awareness of air quality issues and encouraging actions to reduce emissions by eliminating vehicle trips. Their program includes community outreach at schools (K-12+), small businesses and community groups, tabling and providing a speakers’ bureau for special events and at employment centers and advertising campaigns that target the reduction of vehicle-related emissions. In addition, the program enhances air quality knowledge and awareness by issuing air quality advisories and news releases that include actions to reduce air pollution.

3. Pima Association of Governments

- Travel Reduction Program (TRP)

  The TRP was created in 1988 when Pima County, the Cities of Tucson and South Tucson, and the Towns of Marana and Oro Valley each passed Travel Reduction Ordinances and entered into an Intergovernmental Agreement (IGA) to implement the program. The Town of Sahuarita passed its ordinance in 1996, and the IGA was amended. PAG manages the TRP by providing area employers with resources and tools to encourage employees to use alternative transportation (e.g. carpooling, vanpooling or transit), which helps to reduce traffic congestion, energy consumption and pollution. The TRP is another state and federally mandated program.

Employers with 100 or more full-time equivalent employees at one site, are required to participate in the program; other employers may participate voluntarily. PAG promotes travel reduction through its Sun Rideshare program, a free commuter assistance program, that serves as the marketing arm of the TRP.

Table 6. PAG TRP Pollution Reductions in 2017

Pollutant	**Short tons/year**
NOx	35.07
VOC	36.37
	2017 VMT Reduction (miles)
	55,299,140

d. Regional Voluntary Programs

1. Clean Cities Program

Clean Cities is a voluntary program of the U.S. Department of Energy (DOE) which works with local businesses and governments through its Clean Cities Coalitions to provide guidance for establishing alternative fuel markets. The Tucson Regional Clean Cities' program is managed by PAG and there are approximately 40 members. Its goals are to encourage the use of clean fuels in vehicles and promote the expansion of refueling infrastructure for these vehicles.

The Clean Cities program submits an annual report highlighting the program's achievements and quantifying the regional air pollution benefits. Emission savings are calculated using the DOE/Argonne's AFLEET 2016, model and the EPA's MOVES model to estimate tailpipe air emissions.

The data shown in Table 7 tallies air pollution reductions from alternative fuel usage and hybrid vehicles and VMT reduction projects only; it does not include benefits derived from fuel economy, idle reduction, or off-road projects nor emissions from electric power plants, refineries, or biofuel feedstock farms.

Table 7. Tucson Regional Clean Cities Program 2017 Emission Reductions by Vehicle Fuel Type

Fuel type	**NOx**	**VOC***
	Short tons/year	
Compressed natural gas (CNG)	23.78	0.0005
E-85	0	0.012
Electric	.0005	0.0005
Hybrid (conventional)	0.0195	0.0495
Plug-in Hybrid	0.0005	0.001
Propane	2.42	-0.171
TOTALS	**26.22**	**- 0.108**

* Negative values indicate an increase in emissions

Source: Tucson Regional Clean Cities, 2018

2. Voluntary Vehicle Repair Program

The goal of the ADEQ's Voluntary Vehicle Repair Program (VVRP) program is to reduce air pollution produced by older vehicles that have failed inspection. If a vehicle meets the requirements, and the vehicle owner provides the first $150 toward repairs, they can receive up to $550 for gasoline vehicles and up to $1,000 for heavy-duty diesel vehicles to make the improvements needed to pass an emission inspection. This program was reinstated in Pima County in November 2017 and is funded through a registration fee collected from diesel powered vehicles [A.R.S. § 49-551(B)]. Pima County's emission reductions from participation in the program are shown in Table 8.

Table 8. Pollutant Reductions from Pima County FY 2017/18 Voluntary Vehicle Repair Program

FY 18/19 Quarter	**Number of Vehicles**	**NOx (short tons/year)**	**VOC (short tons/year)**
Quarter 1	n/a	n/a	n/a
Quarter 2	16	0.04	0.04
Quarter 3	22	0.05	0.05
Quarter 4	60	0.13	0.15
TOTALS	**98**	**0.22**	**0.24**

3. Transportation Network Measures

- *Regional Traffic Signal Systems*

  Partnerships between the City of Tucson, Arizona Department of Transportation (ADOT), Pima County, Marana, Oro Valley, Sahuarita, the City of South Tucson, the Pascua Yaqui Tribe and the Tohono O'odham Nation have resulted in the interconnection of traffic signals into a coordinated operation center. This system has been expanded to encompass all the traffic signals in the greater Tucson metropolitan area. To date, over 600 traffic signals are actively monitored and controlled from a City of Tucson control center. (Casertano, P. Personal communication, 2018). This results in improved traffic flow and reductions in idling and vehicle emissions.

These improvements tend to be most effective in locally congested areas, where progressive flows can reduce stops and signal delay. Recent retiming efforts of 133 traffic signals have resulted in about a 10 percent reduction in vehicle delay and 3 percent drop in fuel consumption. (PAG, 2017)

- *PAG's Congestion Management Process (CMP)*

  The CMP serves as an effective tool to address traffic congestion throughout the region by enabling PAG and its partners to define, identify and measure congestion and develop strategies to reduce it.

- *Performance Management*

  Performance metrics track progress toward transportation goals such as safety, alternate transportation choices and environmental improvements. This metric was established as part of progress toward goals established in PAG's long range transportation plan, the 2045 Regional Mobility and Accessibility Plan. These goals closely follow the National Performance Goals established by the Federal Highway Administration's Moving Ahead for Progress in the 21st Century (MAP-21).

e. Other Programs

1. Pima County Government

In 2014, Pima County developed a second five-year Sustainable Action Plan to reduce energy, water and fuel use in its internal operations. In its most recent report, the County demonstrated significant progress towards reaching its renewable energy and energy efficiency and water use reduction goals (Pima County Office of Sustainability and Conservation, 2017).

In 2017, the Pima County Board of Supervisors adopted Resolution 2017-39 and Resolution 2017-51, stating that the County government will align its operational efforts to meet the goals of the Paris Agreement on Climate Change.

The County's goal is to reduce GHG emissions by 40 to 42 percent by 2025. The County plans to accomplish this through the following measures:

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- Installing 41 MW of solar at county facilities

- Improving energy efficiency in buildings and operations by 20 percent in 10 highest energy use buildings

- Improving fleet fuel efficiency by 10 percent (in nonelectric vehicles)

- Replacing 120 gasoline sedans in its fleet with electric vehicles

- Implementing low impact development principles and installing green infrastructure for stormwater management

- Planting 10,000 desert-adapted low VOC-producing trees.

These measures were embedded in the 2018-25 Sustainable Action Plan for County Operations which was adopted by the Board of Supervisors on Oct. 16, 2018 (Resolution 2018-66).

Although these measures are directed at reducing GHG emissions, they will also reduce NOx and VOC emissions by reducing energy use and vehicle emissions.

2. City of Tucson programs

In its voter-approved 2013 *Plan Tucson*, several policies and goals were included that could reduce ozone precursor emissions. Programs to encourage new and existing energy efficiency in government and privately-owned buildings, strategies to increase the use of low carbon and renewable energy sources, high fuel efficiency vehicles and non-motorized transportation were all included in the Plan. Programs promoting increased use of solar power and other renewable energy sources for City infrastructure, facilities, and operations are also listed in the plan.

3. Sun Tran

SunTran has an ongoing program to replace its biodiesel transit buses (B-5) with compressed natural gas (CNG) buses. Currently, 45 percent of its fleet uses CNG and the remainder of its buses are a combination of B-5 and B-5/electric hybrid. In general, CNG and diesel/electric hybrid buses produce less NOx per mile than diesel buses (Bradley, 2013).

6. Analysis of Potential Ozone Control Measures

There are 37 nonattainment areas in the U.S. for the 2008 ozone standard (EPA, 2018c). In April 2018, the EPA announced the final designations for the 2015 ozone standard and 51 areas in 22 states have been designated as nonattainment for the 2015 standard (EPA, 2018d). Below is an overview of some ozone reduction measures employed in other areas to meet the 2008 standards. At the time of the report, the newly designated nonattainment areas for the 2015 ozone standard have not published their control strategies. The programs and measures mentioned below are by no means exhaustive but are used in a number of ozone nonattainment areas.

a. On-road Vehicle Programs

1. Reformulated Gasoline

In the U.S., 17 states and the District of Columbia use reformulated gasoline (RFG); about 30 percent of gasoline sold nationally is reformulated (EPA, 2018f). Reformulated gasoline is blended to burn more cleanly than conventional gasoline and to reduce smog-forming and toxic pollutants. The RFG program was mandated by Congress in the 1990 Clean Air Act Amendments in 2 phases. Phase I was from 1995-1999 and Phase II, started in 2000.

In Table 9, ozone precursor emission reductions are estimated for eastern Pima County from the adoption of reformulated gasoline. Estimates were calculated using the EPA's MOVES2014b model and gasoline properties similar to those used in the Phoenix nonattainment area.

Table 9. Estimated Reductions from Use of Reformulated Gasoline - Eastern Pima County

Pollutant	**2017**	**2022 BAU***	**2022 RFG**	**2022 RFG vs. 2022 BAU Percent change**
	Annual (short tons)			
NOx	7,205.6	4,311.9	4,252.8	**- 1.37**
VOC	5,226.7	3,627.4	3,464.2	**- 4.5**

* Business as usual; no changes to current procedures

2. Vehicle Inspection Programs

- Enhanced Inspection and Maintenance Program (I/M 240)

The I/M 240 tests for carbon monoxide (CO), hydrocarbons (HC) and oxides of nitrogen (NOx) during a simulated driving cycle on a treadmill-like device (dynamometer) while undergoing driving activities (idling, cruising, acceleration and deceleration). The 240 represents the length of the treadmill test in seconds (240 seconds, or four minutes). Pollutants are measured in grams per mile (gpm), and emissions limits are set by vehicle type and model year.

Table 10. Estimated Reductions from Enhanced Inspection and Maintenance Program - Eastern Pima County

Pollutant	**2017 baseline**	**2022 BAU**	**2022 I/M Enhanced**	**2022 I/M Enhanced vs. 2022 BAU Percent change**
	Annual (short tons)			
NOx	7,205.6	4,311.9	4,142.4	**- 3.9**
VOC	5,226.7	3,627.4	3,451.3	**- 4.9**

- Annual Inspections for Passenger Cars

According to an EPA analysis (EPA, 2012), if the biennial inspections of light-duty vehicles were replaced by annual inspections, additional VOC and NOx emission reductions could occur. In the Tucson metro area, inspection of light-duty vehicles is required biennially for model years (MY) 1981 onward. Newer vehicles are exempt from inspection for the first 5 years of registration. In 2017, 97 percent of Pima County's light-duty vehicles were MY 1981-2017. Table 11 estimates emission reductions if light-duty vehicles were inspected annually.

Table 11. Benefits of Annual Vehicle Inspections for Light-Duty Cars and Trucks - Eastern Pima County

Pollutant	2017 Baseline	2022 BAU	2022 Annual Inspections	2022 Annual Inspections vs. 2022 BAU Percent change
	Annual (short tons)			
NOx	7,205.6	4,311.9	4,236.3	**- 1.8**
VOC	5,226.7	3,627.4	3,533.1	**- 2.6**

- Expansion of the area where I/M vehicle inspections are required

Expanding the geographic area requiring vehicle inspections can also reduce emissions by ensuring that more vehicles comply with emission standards.

- Gross Polluter for I/M Waivers

A waiver is an official document allowing qualified owners of failing vehicles to register their vehicle without further repair, after showing proof of qualifying repairs. Currently in Pima County, vehicles can receive only one repair waiver, valid for the current vehicle registration cycle.

Legislation could be passed that restricts waivers to failing vehicles (those emitting more than twice the emission standard) until the owner repairs the vehicle sufficiently to lower emission levels to less than twice the standard.

3. Green Fleets

This measure targets on-road light, medium, and heavy-duty vehicles and consists of three subprograms: a green fleet certification program for businesses, promotion of best practices for green fleets through outreach to local governments and business groups, and grant funding to purchase fleet vehicles meeting GHG performance standards. This measure could further reduce ozone precursors along with other pollutants.

4. Smoking Vehicle Assistance Program

The program targets older, polluting vehicles to encourage repairs by offering buy-back options. PDEQ managed a voluntary hotline through which citizens could report high polluting vehicles. A follow-up letter was then sent to the owners stressing the need for repair. Funding was discontinued for this program in 2009, but with additional resources it could be reinstated, possibly at a level to allow for even greater financial incentives for repairs.

5. Alternative Fuels for Heavy Duty Vehicles

An alternative fuel replacement program for heavy-duty vehicles could include different vehicle types (refuse trucks, school/transit buses) and a variety of programs. Plans to promote alternative fuel vehicle conversions or hybrid school/transit buses, public and private sector clean fuel fleets and alternative fuels tax credit programs could be used to reduce emissions.

For heavy-duty vehicles, the EPA estimated that benefits from these programs could be up to a 60 percent reduction in NOx and 13 percent reduction in VOC emissions (EPA, 2012).

6. Truck stop electrification

The EPA's Diesel Emission Quantifier tool estimates the benefits of various diesel emission strategies (EPA, 2018e). Using a truck stop in Pima County as an example, approximately 21.79 tons of NOx and 5.38 tons of VOC could be reduced per year.

7. California Emissions and Zero Emission Vehicle (ZEV) Rules

As of March 2017, thirteen states and the District of Columbia have adopted ZEV regulations (Green Car Reports, 2017). Although the details of the various programs vary, they generally have at least three components: (1) emissions regulation, (2) ZEV mandate, and (3) carbon dioxide regulations. The first two parts of the program address ozone-forming emissions.

Emission regulation provisions stipulate that all vehicles sold in a state be certified to meet the emission standards in the California Low-Emission Vehicle rules. The details of the ZEV mandate are different in each state. Each year a state has a percent ZEV vehicle target and manufacturers generate credits toward this target for each ZEV vehicle produced. Manufacturers reach this target using a mix of partial ZEV, advanced technology (ATZEV), transitional (TZEV), and ZEV [7].

b. Nonroad Vehicles and Equipment

1. Lawn and Garden Equipment Trade-In Program

This program's goal is to remove gasoline-powered engines from circulation by providing vouchers to purchase manual or electric-powered equipment. Residential lawn mowers and backpack-style leaf blowers used by professional gardeners and landscapers are the primary target for the program. Maricopa County Air Quality Department staff estimated that by replacing 2,500 gas mowers, 21 tons of ground-level ozone-causing pollution could be avoided (ABC15.com, 2018).

2. Reformulated gasoline in nonroad vehicles

According to the EPA, VOC and NOx reductions could result if reformulated gasoline were to be used in nonroad vehicles (EPA, 2012). Table 13 shows the estimated regional NOx and VOC reductions using reformulated gasoline in nonroad vehicles and equipment, based upon fuel parameters used in Maricopa County's nonattainment area.

[7] Partial ZEV: no evaporative fuel emissions and more stringent tailpipe emissions; Advanced Technology ZEV: meet the Partial ZEV requirements and incorporate some of the ZEV requirements; Transitional ZEV.

Table: 12. Emission Benefits of using Reformulated Gasoline in Nonroad Vehicles -Eastern Pima County

Pollutant	2017 Baseline	2022 BAU	2022 RFG	2022 RFG vs. 2022 BAU Percent change
	Annual (short tons)			
NOx	2,160.2	1,665.8	1,613.3	**- 3.26**
VOC	2,729.3	2,212.9	2,050.7	**- 7.33**

3. Retrofitting or rebuilding nonroad diesel equipment/engines

The EPA estimated that by retrofitting nonroad diesel equipment with control devices or rebuilding the engine with new diesel (or alternative-fueled) engines, nonroad NOx emissions could decline by up to 37 percent and nonroad VOC emissions would decrease by up to 49 percent (EPA, 2012).

4. Alternative fuels for aircraft ground support equipment

Based on EPA's estimates, replacing gasoline-fueled aircraft ground-support equipment with CNG/LPG could reduce NOx by 25 percent and VOC emissions by 50 to 70 percent. If CNG/LPG vehicles replaced nonroad diesel-powered equipment, EPA estimated a 65 percent reduction in NOx and a 30 percent reduction in VOCs (EPA, 2012).

Replacing either gasoline or diesel- powered vehicles with electric vehicles would reduce NOx emissions by 100 percent. An associated benefit of converting to electric vehicles would be the elimination of the noise and the fumes associated with gasoline or diesel machines (EPA, 2012).

7. Conclusions

For several years, regional ozone levels have hovered near the EPA's health standards. The 2015 standard, revised to be more protective of human health, emphasizes the need to reexamine local emission trends, sources and potential control measures. On-road motor vehicles are the major source of regional NOx emissions. Area sources are thought to be the major human-generated source of VOC emissions (ERG, 2017). The control measures evaluated in this report focused on on-road vehicle emissions and to a lesser extent, on nonroad vehicle sources. Point and area source control measures can be implemented and might also result in emission reductions.

Controls on the few point sources located in our region already exist and any further emissions controls would likely be handled through PDEQ's permitting process. Although area sources contribute to VOCs, these are difficult to estimate, and control is problematic due to their large number and their random distribution throughout the region.

In this preliminary evaluation of potential control measures, all of the control measures were estimated to provide some emission reductions. However, the full implementation of federal control measures for vehicle and equipment seem to offer the largest amount of both VOC and

NOx reductions and would require the least amount of local oversight and funding. The emission reduction resulting from a more vigorous vehicle inspection program and the adoption of reformulated gasoline might contribute additional reductions, but a more thorough analysis would be required to evaluate cost/benefits of these programs.

8. Future Planning and Research Efforts

The last, detailed ozone regional studies were conducted in the late 1990s /early 2000. Information gathered through the use of newer technologies and models to depict current emission and meteorological trends is essential. One possible area of research could be a re-evaluation of the NOx/VOC sensitivity by time and location. A complete reversal in pollutant sensitivity was documented in the Phoenix area when comparing 2011 with 2014 data (MAG, 2017). Knowing which pollutant is in limited supply by location, month and day type could be an important tool in shaping effective control measures.

The recent inventory conducted for Pima County (ERG, 2017) used a landmass- weighted EPA default value to estimate regional biogenic emissions. The last detailed research on the Tucson region's biogenic emissions was conducted in the early 2000s. Imaging technology and more accurate biogenics modeling tools are now available. Again, developing a better understanding of the factors that affect the quantity and timing of biogenic releases are important in developing anthropogenic emission control measures.

Knowing which strategy would result in the greatest reductions is not sufficient. The relative cost/benefit comparison of effective measures is important. Economic factors associated with both the relative cost of control measures and the regional costs of ozone nonattainment are also important issues that would benefit from further exploration.

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