Emissions Inventories: An Overview

Office of Air, Air Quality Division

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Overview

- Brief air quality introduction
- Emissions inventory: role in air quality
- Emissions inventory improvement projects and results

Federal Air Quality Limits

The federal government mandates health-based concentration limits for six common air pollutants.

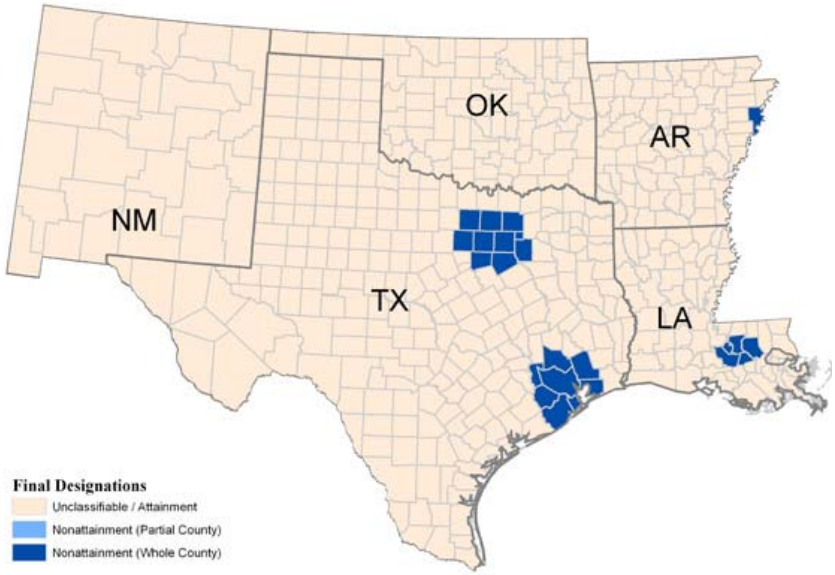
- The federal limits are called National Ambient Air Quality Standards (NAAQS).
- The pollutants involved are carbon monoxide, lead, nitrogen dioxide, ozone, particulate matter, and sulfur dioxide.

  Nitrogen oxides (NO_X) and volatile organic compounds (VOC) emissions are regulated ozone precursor emissions.

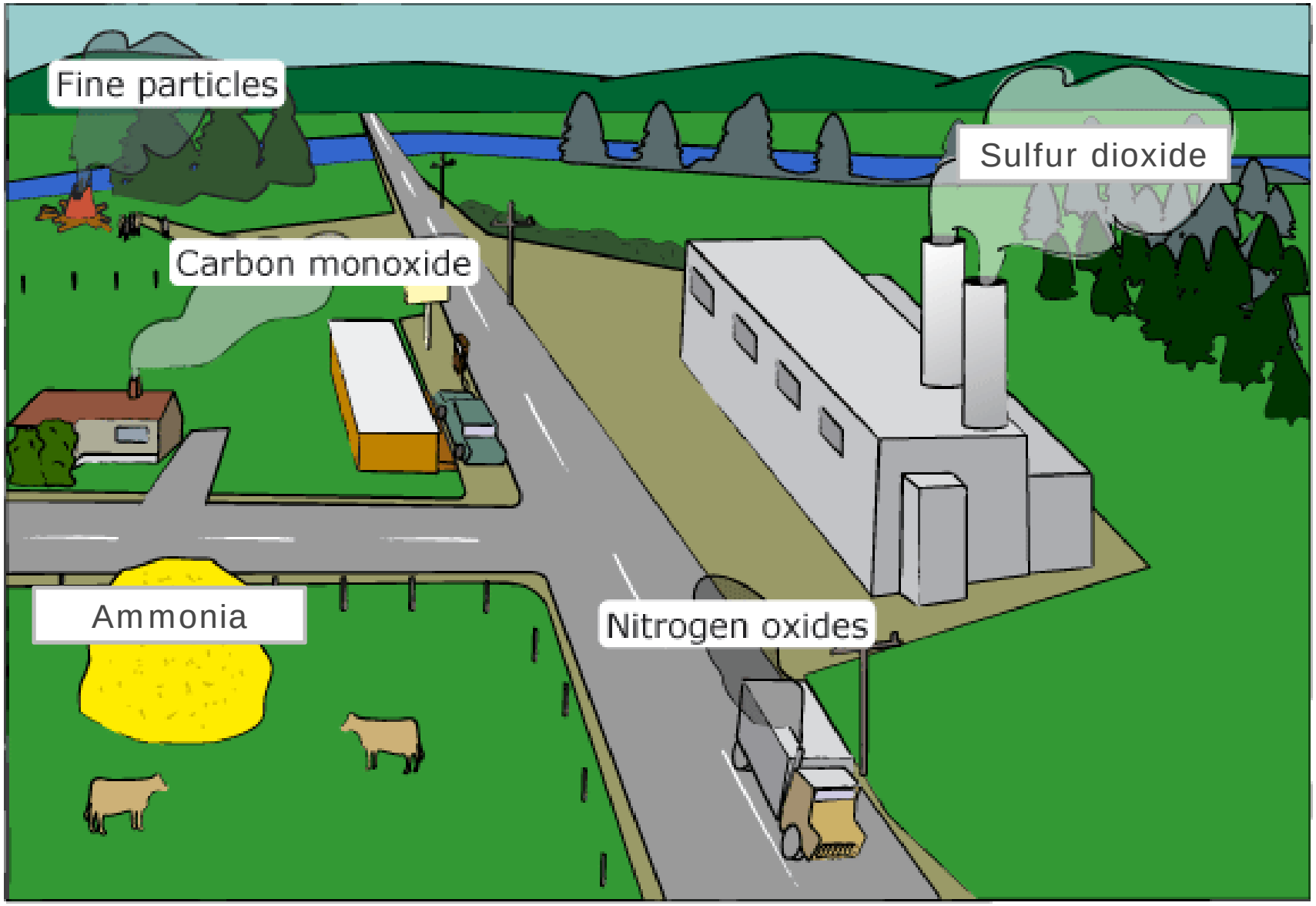
States Comply with Federal Limits

Compliance with the NAAQS limits are determined through ambient air monitoring concentrations.

- States perform the monitoring.
- Areas with monitoring values exceeding the limit for a given pollutant can be designated as “nonattainment areas.”
- For nonattainment areas, states develop plans to reduce air pollution.
  - Known as state implementation plans
  - States have best per-spective for handling challenges unique to each area (local industries, population, geography, meteorology, etc.).



Emissions Inventory



What is an Emissions Inventory?

- An emissions inventory accounts for the amount of air pollutants released into the atmosphere.
- It includes the following data:
  - Who: Sources creating air pollution
  - What: Chemical or physical identity of the pollutants
  - Where: Geographic area covered
  - When: Time period over which emissions are released
  - Why: Types of activities that cause emissions
  - How: Specific release information
    - Location
    - Height
    - Velocity
    - Temperature

How Does the TCEQ Use Its Emissions Inventory?

Emission inventories are developed for a variety of purposes, including:

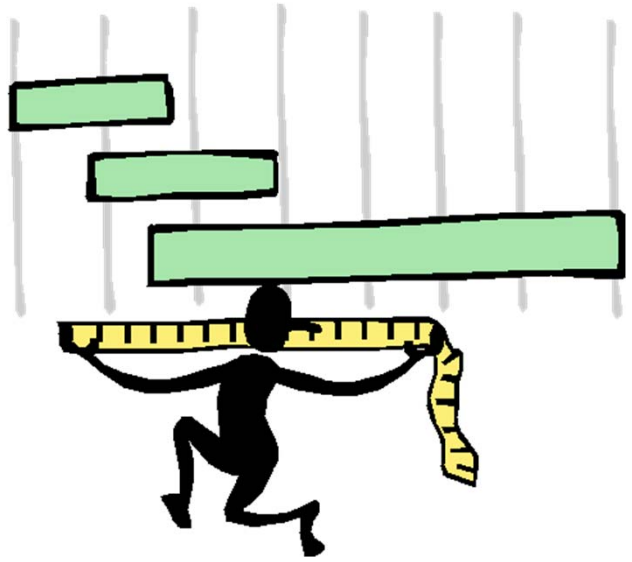
- Developing strategies and policies
  - Analyze largest emitters of ozone precursor emissions in ozone nonattainment areas to assess control strategy implementation
  - Model predicted emissions reductions to determine whether ambient monitors would see a reduction in ozone concentrations
- Evaluating the environmental costs and benefits of different policies

  Use emissions inventory data to obtain a cost per ton of pollutant reduced

How Does the TCEQ Use Its Emissions Inventory? (cont.)

Emission inventories are developed for a variety of purposes, including:

- Tracking progress of air quality standards
  - Compare emissions trends to ambient air monitoring data
- Establishing compliance with authorized (permitted) emission rates
- Fee assessment
- Providing emissions information to public and private entities
- Other air quality planning efforts



Types of Emissions Inventories

- Point source

  Refineries, power plants, cement plants

- Area source

  Dry cleaners, agricultural activities, gas stations

- Mobile source
  - On-road mobile

    Motorcycles to 18-wheelers
  - Non-road mobile

    Lawnmowers, trains, airplanes

- Biogenic
  - Trees, plants
  - Soil (primarily microbes), lightning strikes

What is the Difference Between a Point Source and an Area Source?

- Point sources
  - Typically encompass large, stationary sources of pollutants
  - Typically represent distinct locations that can be identified and monitored
  - In a dispersion model, can be treated as though pollutants emanate from a single fixed point in space

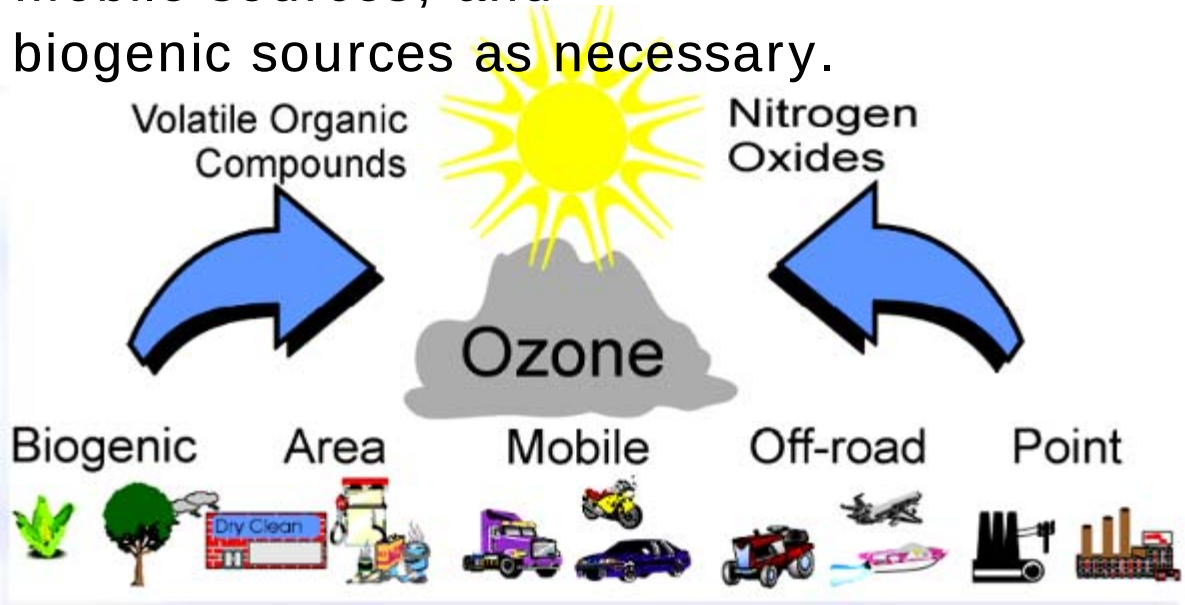
    Example: smokestack
- Area sources
  - Numerous smaller or more diffuse sources of pollution that are not required to submit a point source inventory
  - Estimates are provided on area basis, such as counties
  - Collectively, these sources can have significant emissions
  - In a dispersion model, treated as an aggregate pollutant release from a defined area at a uniform rate

How are these Inventories Developed?

- Companies report emissions data for large stationary sources.

  TCEQ tracks approximately one million (1,000,000) tons of emissions each year from large stationary sources.

- TCEQ develops emissions inventories for:
  - area sources;
  - mobile sources; and
  - biogenic sources as necessary.



How Does a Company Develop Its Point Source Inventory?

- Determine emissions in accordance with TCEQ guidance (see references on last slide)
- Industry reports emissions for individual emissions units and supplies relevant data for these sources:
  - capacity or throughput
  - operating conditions
  - location
- Preferred methods to determine emissions are based upon source measurements
- Not possible to measure emissions from all sources; emissions factors often used instead
  - Emissions factors are generally emissions rate estimates tied to a particular activity (e.g., pound of NO_X released per million standard cubic feet of natural gas combusted)
  - Can be average of measurements from multiple sources

How Does the TCEQ Develop Area and Mobile Source Inventories?

- Inventories developed at the county level for different source categories, such as:
  - gas stations;
  - construction equipment; and
  - passenger vehicles.
- Emissions determined using emissions factor, activity data, and control factors (if applicable)
- Activity data
  - Activity: process, product, or material that is the primary cause of emissions
  - Examples: amount of fuel burned, number of miles traveled on roadways, barrels of oil produced
  - Data obtained from various sources, including surveys and other government agencies

How Does the TCEQ Assess the Accuracy of the Emissions Inventory?

- Uncertainty is inherent to emissions measurements and activity data
- Emissions inventory development methods attempt to use representative data to determine emissions for a population of sources
- Variety of methods used to assess accuracy of emissions inventory development methods:
  - TCEQ-sponsored surveys
  - TCEQ special emissions inventories
  - TCEQ-managed emissions inventory improvement studies
  - Air quality studies (often in collaboration with other research partners)

Background: Texas Air Quality Studies

- 2000 Texas Air Quality Study

  Identified certain highly reactive volatile organic compounds (HRVOC) react more readily to form ozone.

- 2006 Texas Air Quality Study II
  - Emission inventories underestimate ethylene emissions by approximately an order of magnitude.
  - NO_X emissions inventories appear to be relatively accurate.

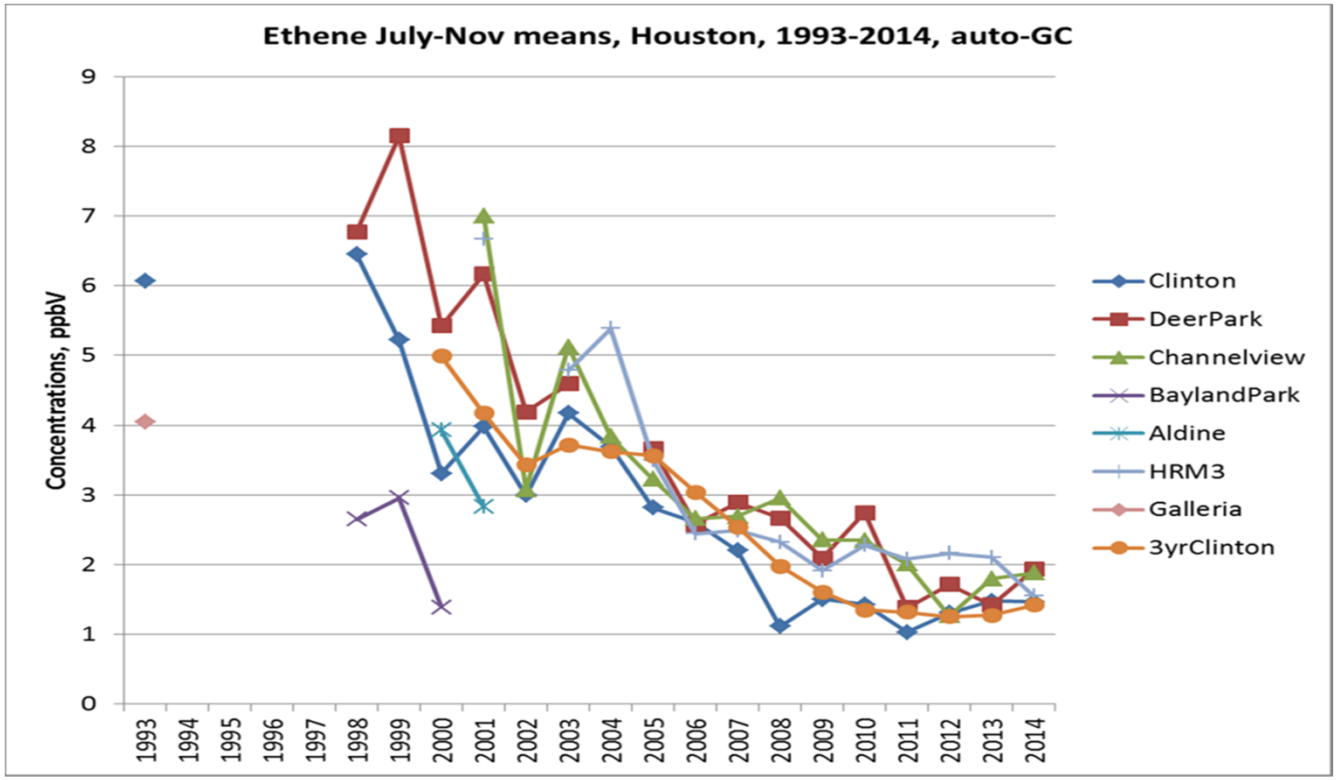
Background

VOC emissions sources typically have fugitive-type emission points, which makes monitoring or measuring emissions often impractical.

- Difficult to measure or monitor using conventional testing techniques for stacks.
- Emissions factors or material balance methods are typically used to determine emissions.
- Chapter 115 HRVOC monitoring regulations have contributed to VOC emissions inventory improvement in the Houston-Galveston-Brazoria (HGB) ozone nonattainment area.

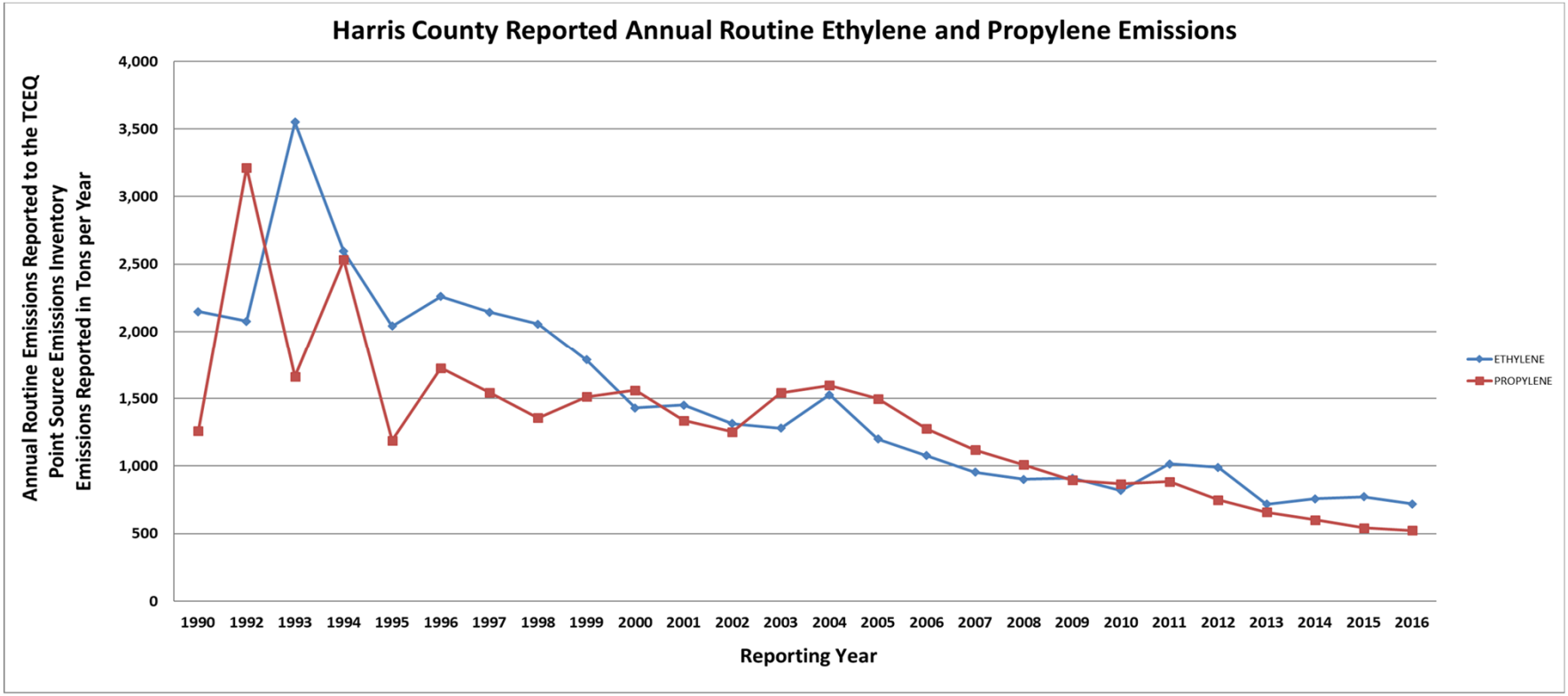
Emissions Inventory and Ambient Monitoring Reconciliation

- Chapter 115 regulations have directly resulted in reduced ambient concentrations of HRVOC.
- Measured mean concentrations of ethylene in Houston have decreased over past 15 years



Emissions Inventory and Ambient Monitoring Reconciliation (cont.)

- Reported emissions of HRVOC now more closely align with ambient concentrations.
- Harris County ethylene and propylene emissions have decreased over the past 15 years.



Work is Not Over: Necessary to Continue Improving Emissions Inventory

- Reported emissions do not always correspond to measured concentrations.
- To reconcile these data sets, need to:
  - Identify under-reported VOC emission sources,
  - Quantify under-reported emissions,
  - Revise current emissions inventory estimates, and
  - Assess whether current emissions determination methods and models for common sources require improvement or revision.

Emissions Inventory Improvement

- TCEQ uses state-of-the-science remote sensing technology to discover potentially under-reported or unreported point sources.
  - Visualization technology such as GasFindIR or HAWK camera
  - Direct measurement techniques such as **di**fferential **a**bsorption **l**ight detection and ranging
- Specialized passive infrared (IR) camera projects
  - Began in 2005
  - First occurred in HGB:
    - Ground surveys at area refineries and petrochemical plants
    - Aerial survey of Houston Ship Channel
  - TCEQ continues to conduct aerial surveys of specific areas across the state periodically

Emissions Inventory Improvement (cont.)

Specialized Passive IR Camera

Emissions from Floating Roof Storage Tanks

Emissions from Barges

Barnett Shale Natural Gas Production Site

Passive IR Camera Project Results

- Identified under-reported or unreported emissions

  Example: landed floating roof storage tanks
  - Revised emissions inventories
  - Collected emissions fees
  - Revisited storage tank authorizations
- Increased internal and external awareness of potential emissions issues
- Encouraged emissions reductions
- Focused agency resources:
  - Permitting
  - Field inspections/investigations and enforcement
  - Emissions inventory improvement
  - Control strategy development
  - Pollution prevention

Emissions Inventory Improvement

- Improved upstream oil and gas area source emissions inventories for several source categories, including storage tanks
  - Barnett Shale special inventory
  - Tested VOC emissions from upstream oil and across Texas
  - Assessed VOC emissions from produced water storage tanks
  - Developed drilling rig emissions inventories
- HGB area landing loss emissions inventory
- Assessed VOC emissions from barges in transit

Emissions Inventory Improvement (cont.)

- TCEQ 2010 Flare Study
- Supplemental flare operations training based upon TCEQ 2010 Flare Study Results
- Assessed HRVOC emissions from pipelines

Emissions Inventory Improvement (cont.)

- 2006 upstream oil and gas storage tank project
  - Measured emissions from tank batteries in HGB
  - Developed an emissions factor that includes working, breathing, and flash losses
  - Increased statewide area source emission estimates by more than 700,000 tons per year of VOC

- Subsequent upstream oil and gas storage tank project revised these emissions estimates
  - Measured emissions from upstream oil and gas tank batteries across Texas
  - Conducted surveys to gather additional information, such as level of control
  - Resulted in improved basin-specific emissions factors for crude oil and condensate storage tanks

Emissions Inventory Improvement (cont.)

Barnett Shale

- Rapid growth in upstream oil and gas sources in urban or suburban areas traditionally inventoried as area sources
- TCEQ needed more specific data to accurately assess emissions, confirm operating authorizations, and prioritize investigations.
- Inventory contains more than 8,500 sites and 50,000 emissions sources
- Results used to improve area source emissions inventory estimates
  - Compressor engines
  - Storage tanks
  - Equipment leak fugitive components

Emissions Inventory Improvement (cont.)

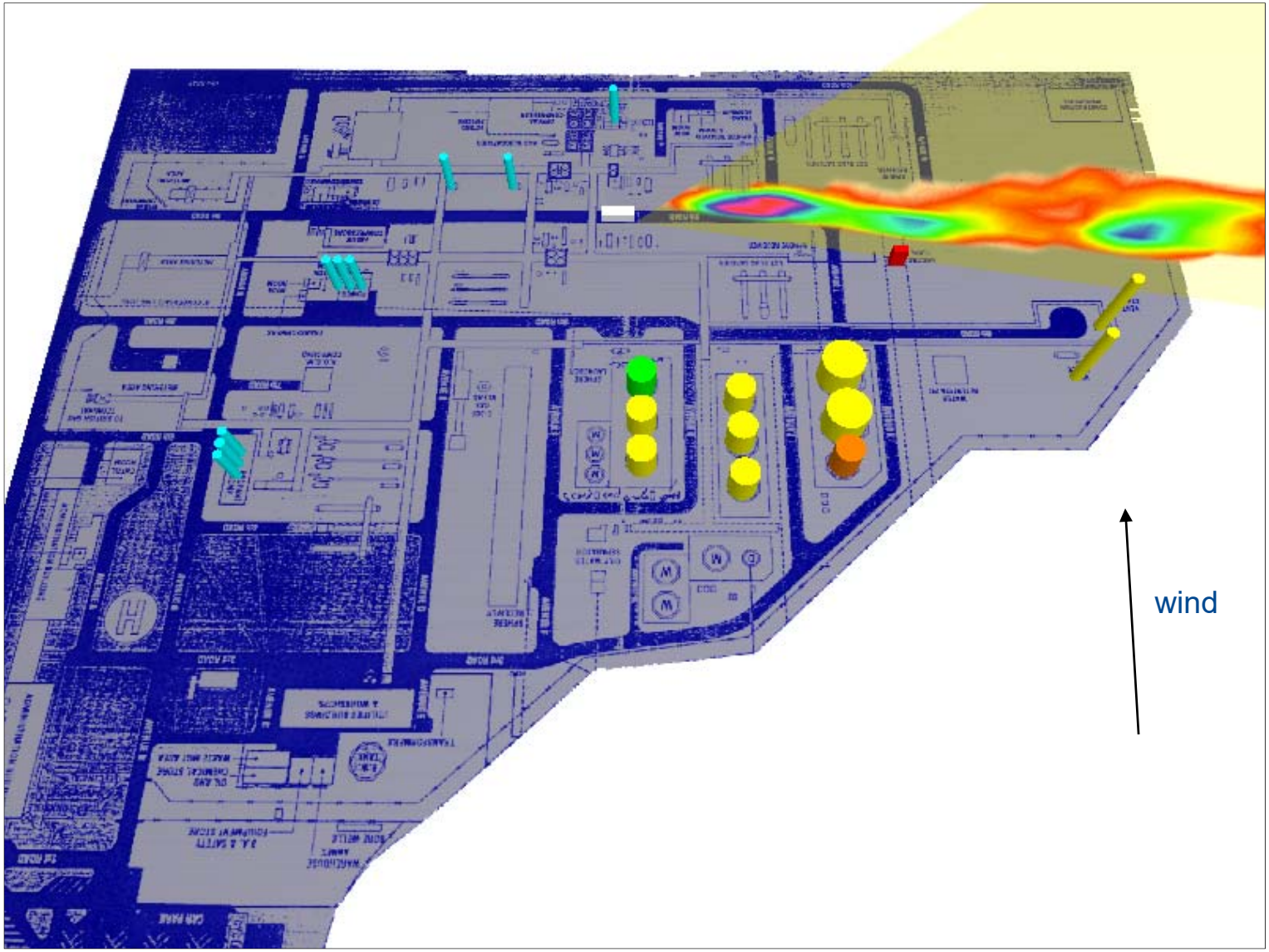
Differential absorption light detection and ranging (DIAL) project

- TCEQ was the first regulatory agency in the United States to conduct field study using DIAL technology
  - Advanced remote sensing system from the United Kingdom
  - Measures air pollution concentrations using IR and ultraviolet lasers
  - Five week study that measured emissions from storage tanks, flares, wastewater operations, and coker units
  - Compared the measurements with traditional United States Environmental Protection Agency emissions estimation techniques
- Results guided direction of subsequent emissions inventory improvement projects and research efforts

Emissions Inventory Improvement (cont.)

DIAL Project: Instrumentation Trailer

DIAL Measurements at an Industrial Site



TCEQ 2010 Flare Study

- Directly resulted from TCEQ DIAL project conclusions
- $2.2 million study evaluated the efficiency of emergency flares under routine, low flow operating conditions

  Results published August 2011
- Assessed flare destruction and removal efficiency (DRE) using extractive and remote sensing measurements
- Quantified particulate matter emissions from flares at various DRE values
- Air- and steam-assisted flare configurations were tested

How Well Do Flares Burn Waste Gas?

The TCEQ 2010 Flare Study investigated how well flares burned waste gas under different operating conditions.

Flare burning over 99% of waste gas.

As more steam is supplied, the flare burns less waste gas. The flare burns 90% of the waste gas in this case. Note the flame is disappearing.

As even more steam is supplied, the flare burns even less waste gas. The flare burns 27% of the waste gas in this case. Note the flame has disappeared.

TCEQ 2010 Flare Study (cont.)

Results:

- Flares can burn waste gas effectively.
- All flares tested were operated in compliance with federal regulations.

  - However, when too much steam or air is added under certain conditions, flares do not burn waste gas as effectively as previously assumed.
  - Operating in compliance with federal regulations does not necessarily guarantee the flare is burning waste gas effectively.
- If excess steam or air is supplied to the flare, the flare will burn waste gas less efficiently.
- A visible flame is an indicator that the flare is burning waste gas effectively.

TCEQ and University of Texas at Austin Flare Supplemental Operations Training

- https://sfot.ceer.utexas.edu/
- Focus on elevated, assisted flares
- Provide tools to facilitate more effective operation of flares during routine operations using existing on-site resources
- Share knowledge and understanding of flare operations from the TCEQ 2010 Flare Research Project and recent consent decree flare projects
- **Clearly explain the impact of supplying too much steam- or air-assist during routine flaring operations**
- More than 1,000 registered users to date

Current Inventory Improvement Projects

- Oil & Gas Compressor Engine Study

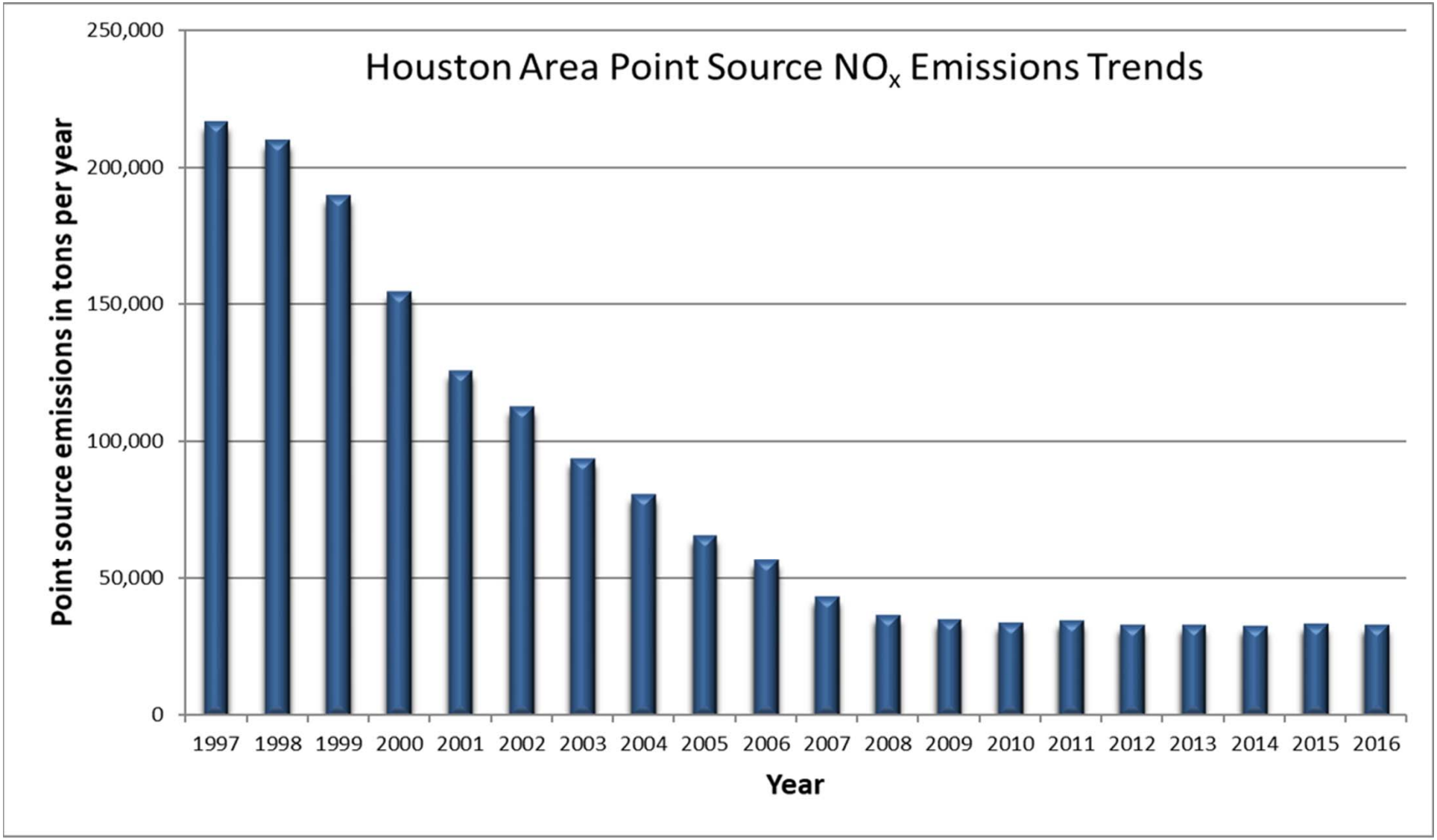
  This project will develop updated Texas basin-specific compression requirement factors that are used to estimate area source upstream oil and gas compressor engine emissions.

- Texas NONROAD to MOVES Utility Development:

  This project will develop a utility that allows for use of the Motor Vehicle Emission Simulator (MOVES) model to develop non-road mobile emissions estimates while using Texas-specific data.

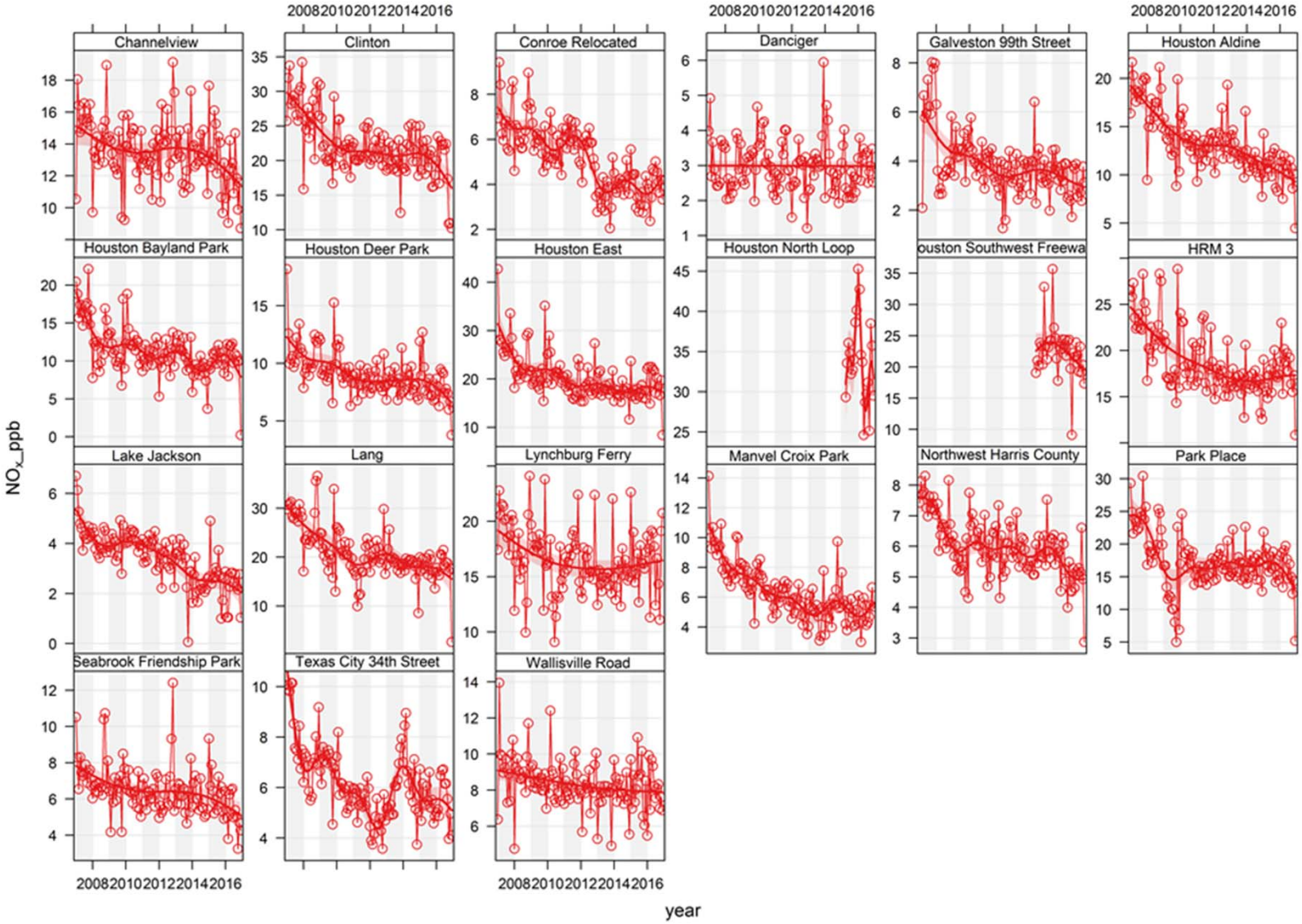
- Aviation Environmental Design Tool (AEDT) Aircraft Emissions Inventory Development:

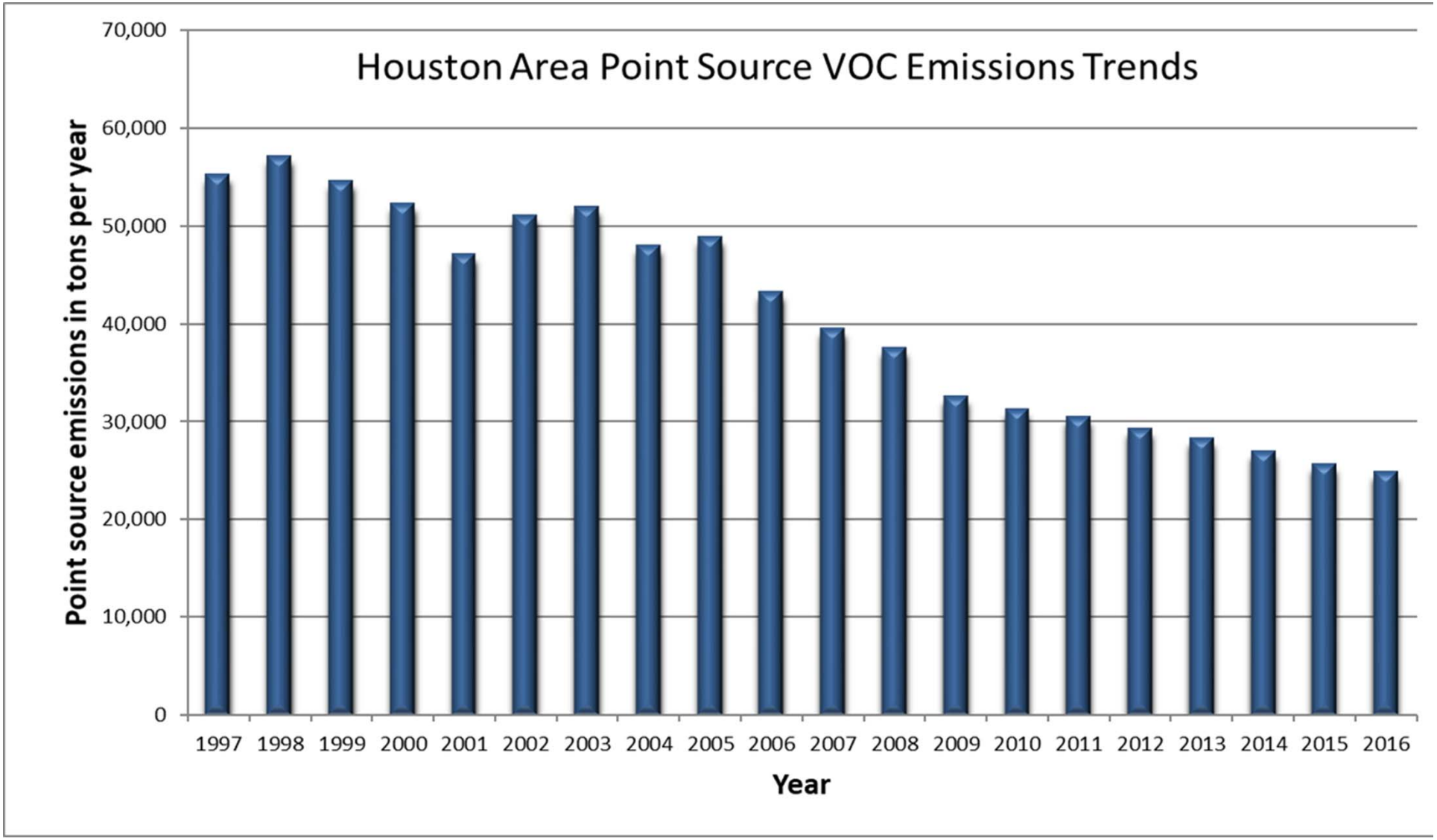
  This project will develop updated emissions inventories for aircraft and ground support equipment using the AEDT.



- HGB ozone nonattainment area NO_X emissions decreased 84% since 1997.
- 30 Texas Administrative Code (TAC) Chapter 117 NO_X rules went into effect in 1999.
- Emissions data reported by sites that met the TCEQ reporting requirements as stated in 30 TAC Section 101.10 for the given years.

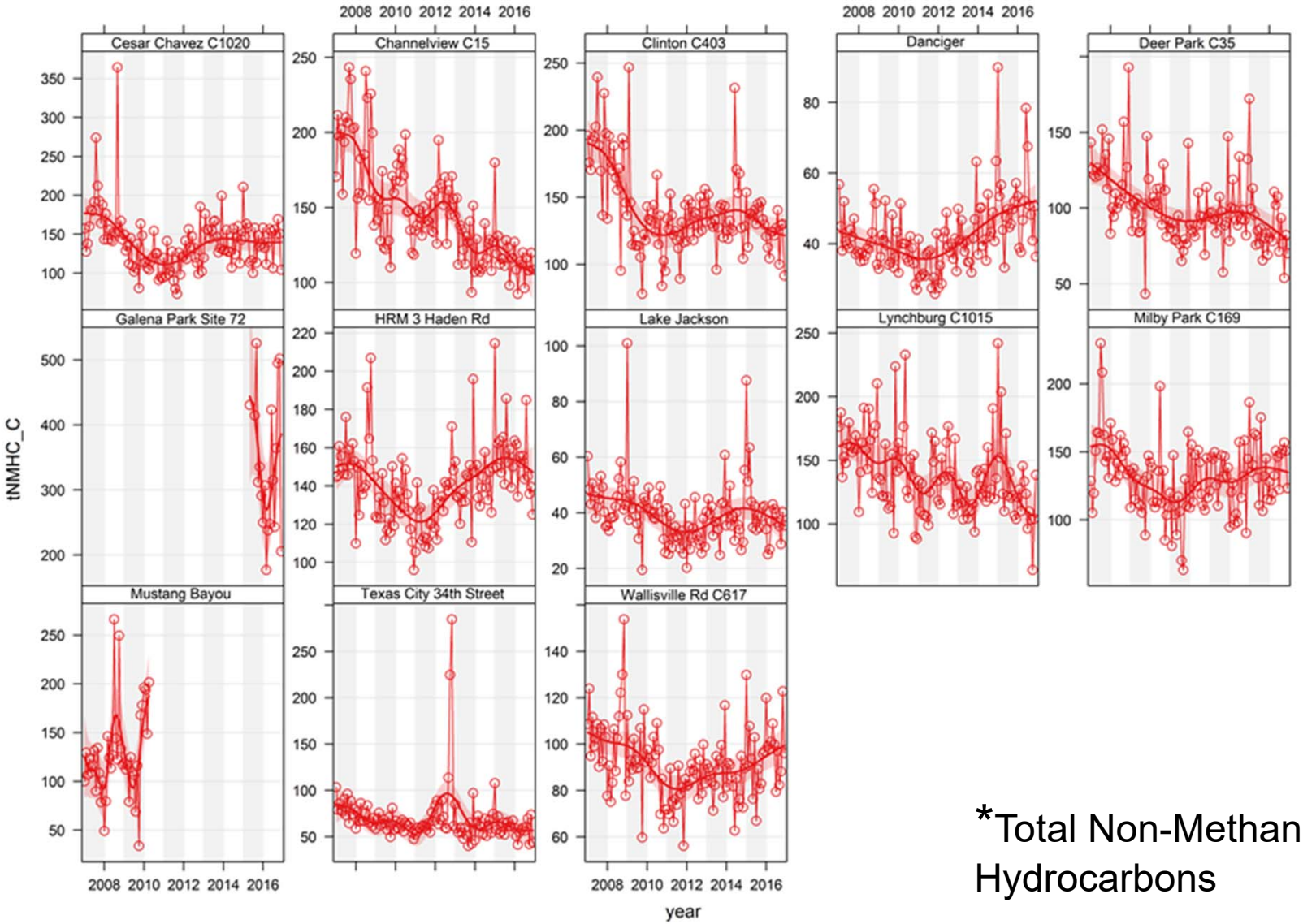
Mean Monthly NO_X Concentrations in the HGB Area





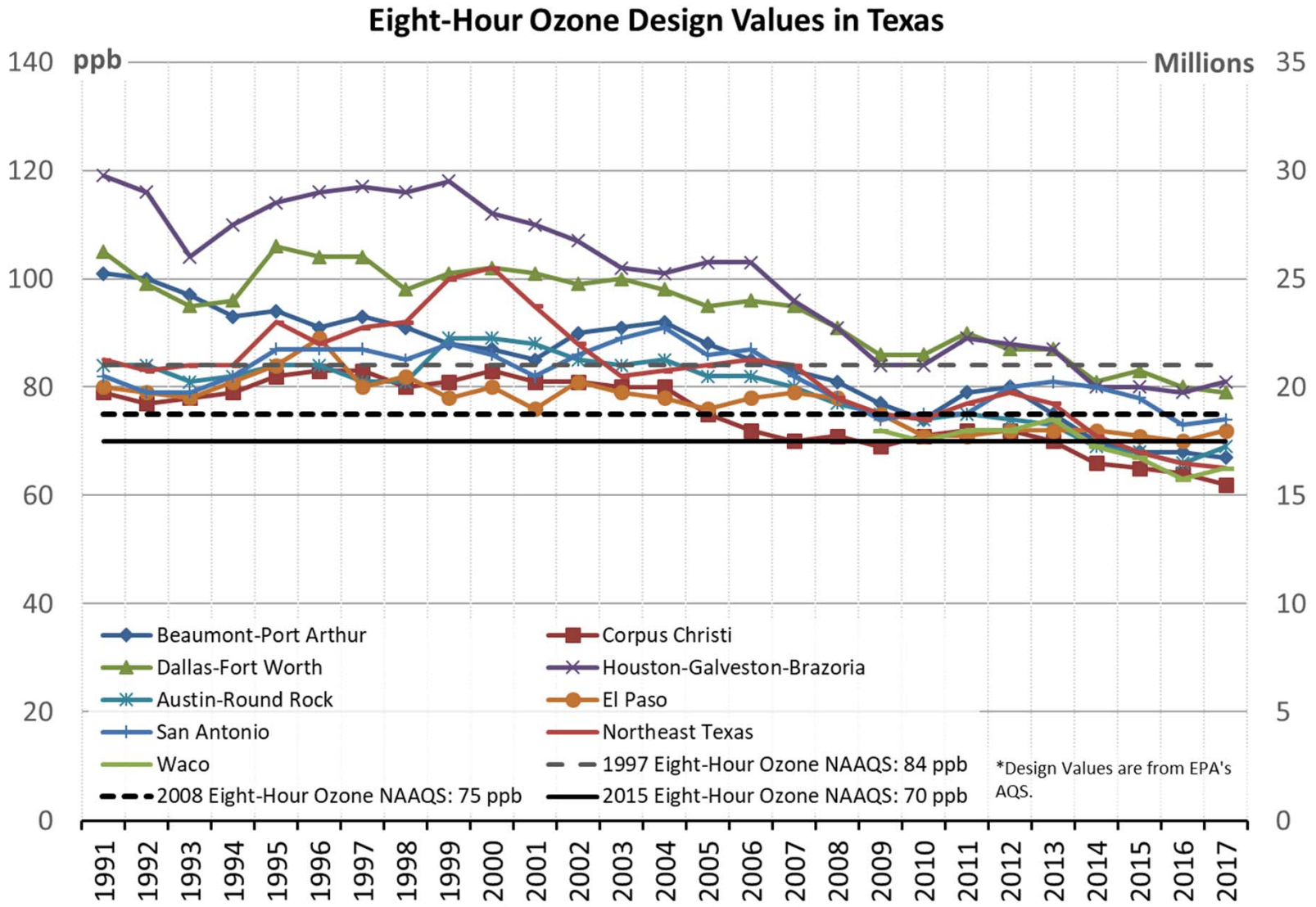
- HGB ozone nonattainment area VOC emissions decreased 54% since 1997.
- Emissions data reported by sites that met the TCEQ reporting requirements as stated in 30 TAC 101.10 for the given years.

Mean Monthly *TNMHC Concentrations in the HGB Area



*Total Non-Methane Hydrocarbons

Texas Ozone


Eight-Hour Ozone Design Values in Texas
ppb
Millions
140
120
100
80
60
40
20
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35
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5
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1991
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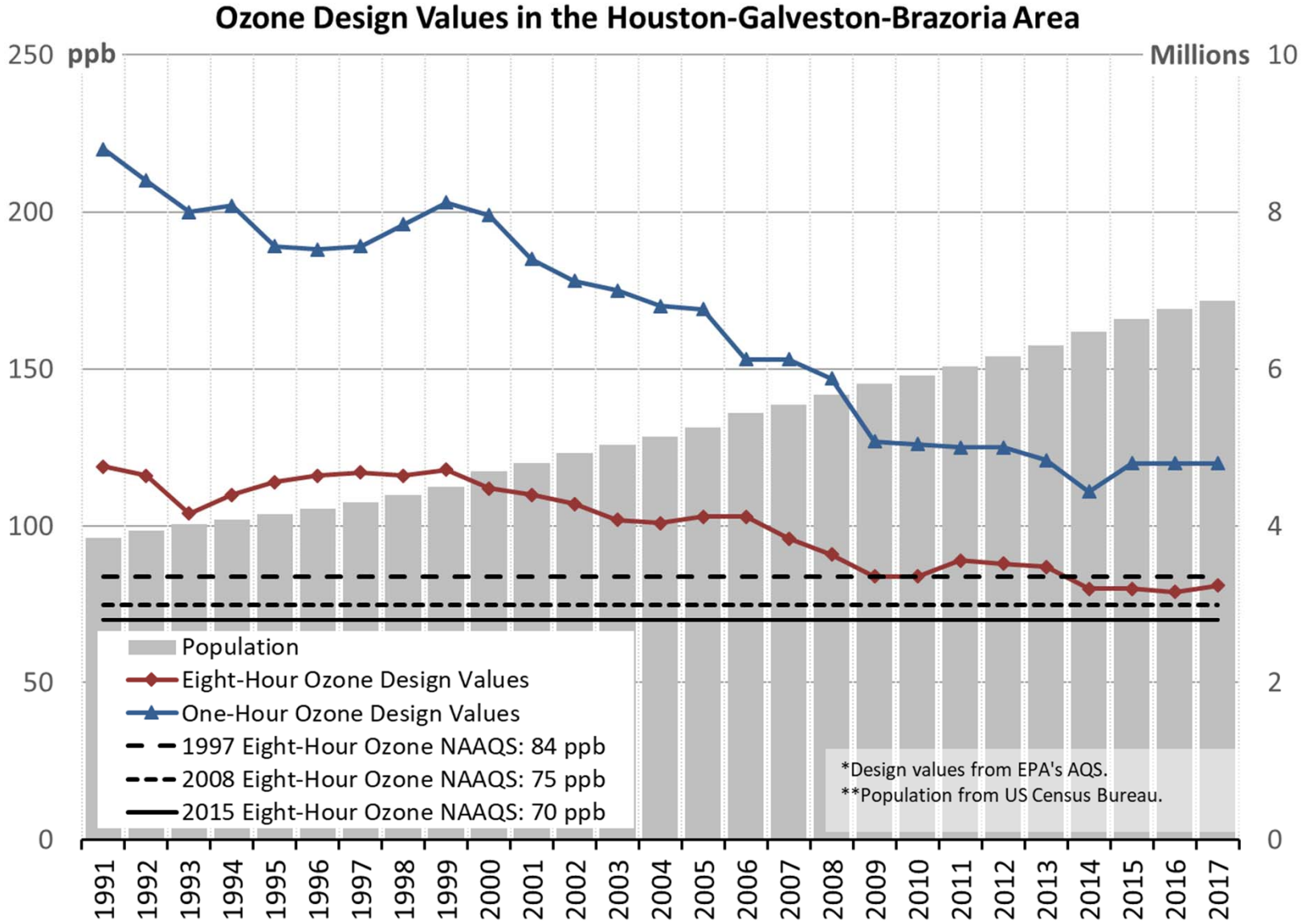
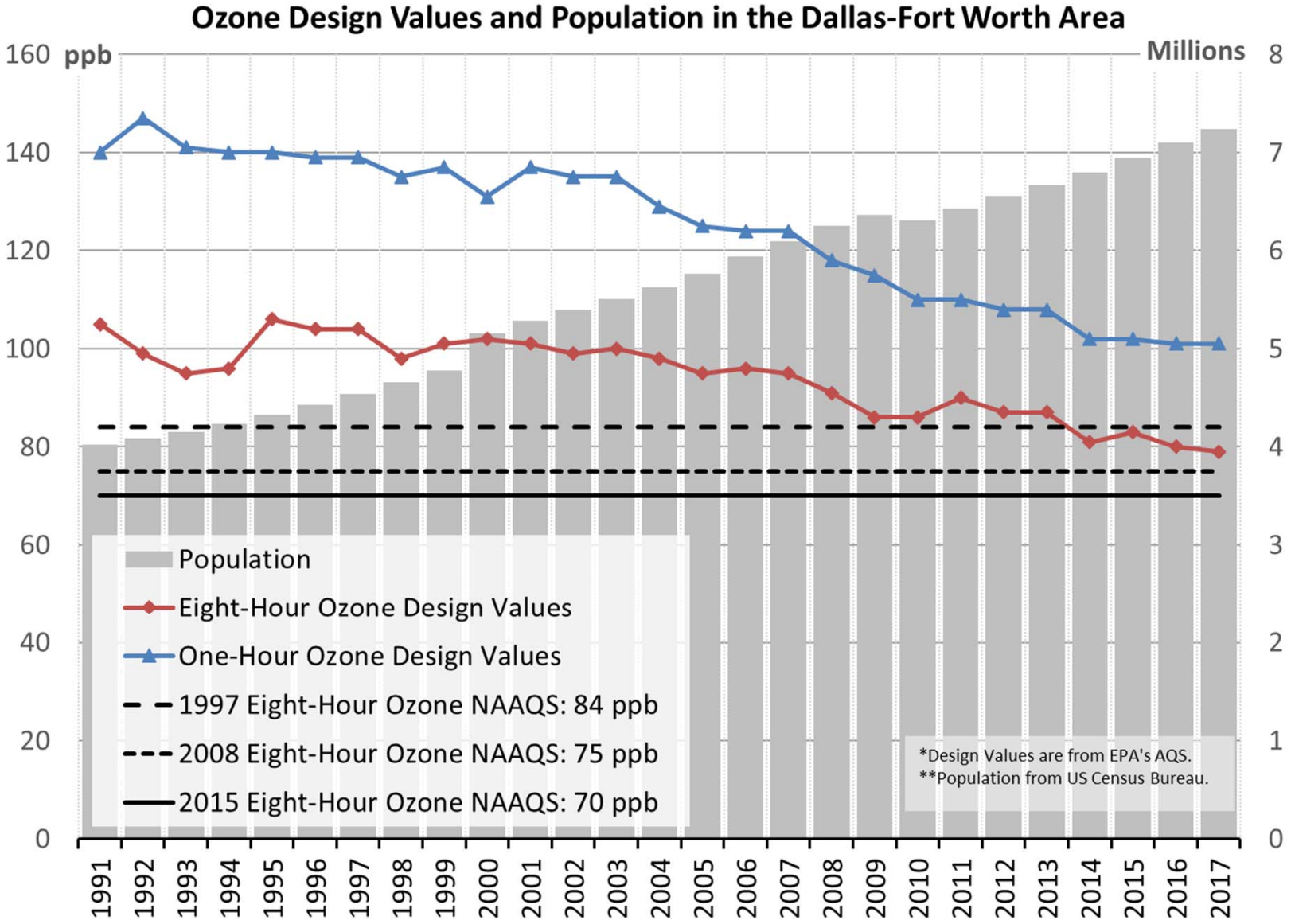
Beaumont-Port Arthur
Corpus Christi
Dallas-Fort Worth
Houston-Galveston-Brazoria
Austin-Round Rock
El Paso
San Antonio
Northeast Texas
Waco
1997 Eight-Hour Ozone NAAQS: 84 ppb
2008 Eight-Hour Ozone NAAQS: 75 ppb
2015 Eight-Hour Ozone NAAQS: 70 ppb
*Design Values are from EPA's AQS.

Air Quality Successes



Air Quality Successes



Contact Information and Resources

- Jill Dickey-Hull
  - jill.dickey@tceq.texas.gov
  - (512) 239-5912
- TCEQ point source emissions inventory guidance:
  https://www.tceq.texas.gov/publications/rg/rg360-17/
- TCEQ air quality research and contract project for point and area source emissions inventories:
  http://www.tceq.texas.gov/airquality/airmod/project/pj_report_ei.html
- TCEQ 2010 Flare Study:
  http://www.tceq.texas.gov/airquality/stationary-rules/stakeholder/flare_stakeholder.html#2010-flare-study