CHAPTER 5: ONGOING WORK AND FUTURE INITIATIVES

The Texas Commission on Environmental Quality (TCEQ) continues to work towards reducing ozone precursor pollutants. Texas is investing resources into technological research and development for advancing pollution control technology, improving the science for ozone modeling and analysis, and refining quantification of volatile organic compound (VOC) emissions. Additionally, the TCEQ is working with local area leaders to identify new methods for reducing ozone precursor pollutants. This chapter describes ongoing technical and regulatory work that will be beneficial to improving air quality planning, and thus air quality, in Texas.

5.1 TEXAS AIR QUALITY STUDY II (TexAQS II)

The original Texas Air Quality Study (TexAQS 2000) was a comprehensive air quality study that combined the efforts of over 40 research organizations and more than 250 scientists. It provided a large part of the scientific basis for reassessing ozone formation in the Houston-Galveston-Brazoria (HGB) area, and its findings were included in the recently approved HGB one-hour ozone attainment demonstration state implementation plan (SIP) revision. The success of this study, and the outstanding questions that it raised, provided the foundation for planning for the second Texas Air Quality Study (TexAQS II).

TexAQS II was conducted between the spring of 2005 and the fall of 2006, with an intensive study period occurring between August 15 and September 30, 2006. Many unanswered questions remained after TexAQS 2000, and the TexAQS II is designed to help answer questions in several areas, including inventory validation (especially highly-reactive volatile organic compounds (HRVOC)), ozone and particulate matter transport, planetary boundary layer dynamics, nighttime chemistry, and model improvement. While a great deal of interest remains in the HGB area, the TexAQS II broadened the geographic extent of the study area from the upper Texas Coast to now encompass all of eastern and central Texas (see Figure 5-1: *TexAQS II Study Area*).

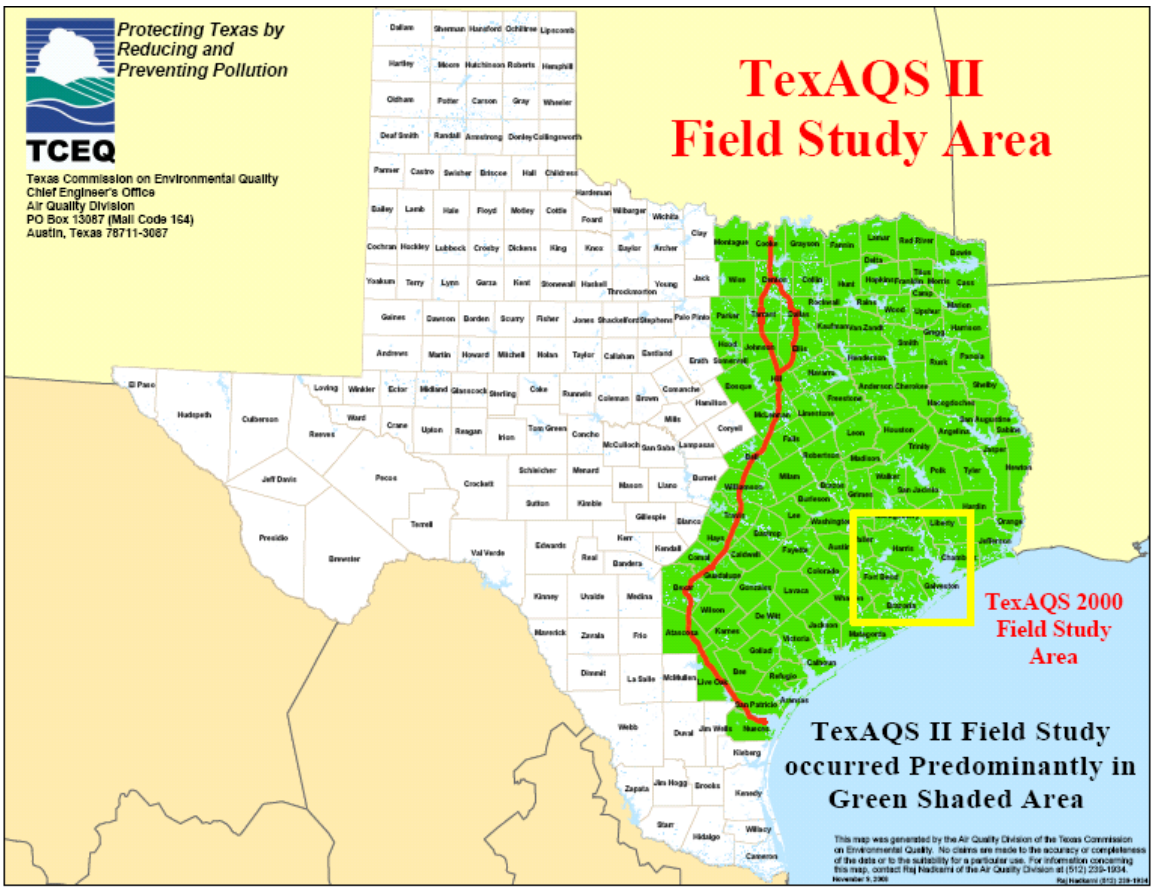

Figure 5-1: TexAQS II Study Area

5.1.1 Description of the TexAQS II

TexAQS II was one of the most extensive air quality studies ever undertaken and included participants from over a dozen federal, state, and local governmental bodies, including the National Oceanic and Atmospheric Administration (NOAA), the National Aeronautics and Space Administration, the United States Environmental Protection Agency (EPA), the National Center for Atmospheric Research, the Department of Energy, and the TCEQ. Other participants represented some thirty institutes of higher education, several research organizations, various corporations, and other organizations. In addition to the TCEQ's routine network of meteorological and air quality monitoring equipment, measurement platforms deployed for the study included five research aircraft, NOAA's research vessel Ronald H. Brown, a supersite atop a high-rise dormitory on the University of Houston's campus, a network of rural monitoring stations, a network of meteorological sites including eight radar profilers, ozone sonde and guided balloon launches, tethered balloons, enhanced hydrocarbon measurements at existing monitoring locations, and a mobile instrument to measure hydrocarbon flux. Targeted compounds include ozone, carbon monoxide (CO), carbon dioxide (CO_2), sulfur dioxide (SO_2), particulates characterized by both size and species composition (nitrates, sulfates, organic and elemental carbon, crustal matter), hydroxyl radicals (OH), nitrous acid (HONO), hydroperoxyl radical (HO_2), hydrogen peroxide (H_2O_2), nitrogen oxides (NO_X), nitrogen species (NO_Y), nitric acid, formaldehyde, acetaldehyde, mercury, hundreds of hydrocarbon species, including HRVOC, various peroxyacyl nitrates (PAN) compounds, and a long list of additional compounds. Figure 5-2: *The RV Ronald H. Brown and TexAQS II Instrumentation* and Figure 5-3: *The NOAA WP-3 Orion and TexAQS II Instrumentation* show, respectively, the Ronald H. Brown with a description of the instruments deployed aboard for TexAQS II, and the NOAA WP-3 Orion aircraft, also with a description of its instrumentation for the study.

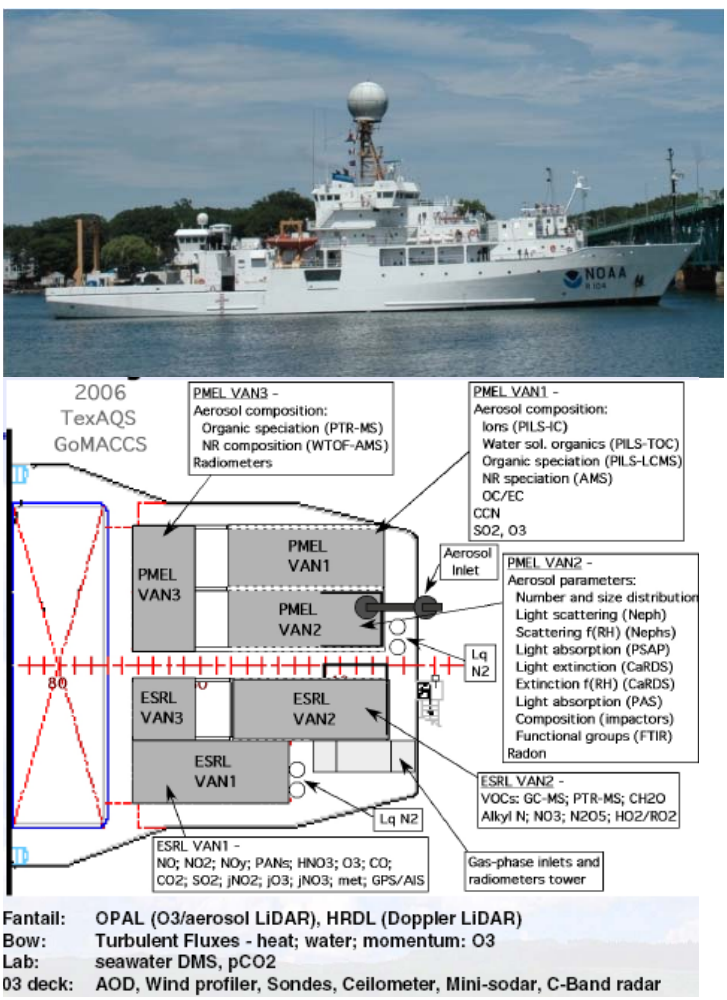

Figure 5-2: The RV Ronald H. Brown and TexAQS II Instrumentation

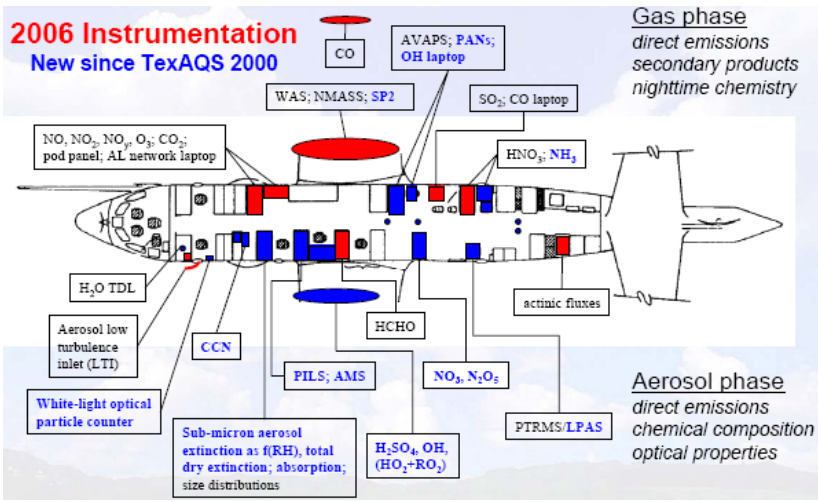

Figure 5-3: The NOAA WP-3 Orion and TexAQS II Instrumentation

5.1.2 Research Questions

The TexAQS 2000 advanced the understanding of the mechanics of ozone formation along the upper Texas coast, yet a number of questions remain unanswered. The TexAQS II was specifically designed to address SIP-related questions, including the following.

- Which local emissions are responsible for the production of high ozone in Houston, Dallas, and eastern and central Texas? Are different kinds of emissions responsible for transient high ozone and eight-hour-average high ozone (i.e., ≥ 84 parts per billion (ppb))?
- How do the structure and dynamics of the planetary boundary layer and lower troposphere affect ozone and aerosol concentrations in Houston, Dallas, and eastern and central Texas?
- Are HRVOC and NO_X emissions and resulting ambient concentrations still at the same levels in Houston as they were in 2000? How have they changed spatially and temporally? Are there specific locations where particularly large quantities of HRVOC are still being emitted? Are those emissions continuous or episodic? How well do the reported emissions inventories explain the observed concentrations of VOC and NO_X?
- What distribution of anthropogenic and biogenic emissions of ozone and aerosol precursors can be inferred from observations?
- Are there sources of ozone and aerosol precursors that are not represented in the reported emissions inventories?
- How do the mesoscale chemical environments (NO_X-sensitive ozone formation vs. radical-sensitive ozone formation) vary spatially and temporally in Houston, Dallas, and

eastern Texas? Which mesoscale chemical environments are most closely associated with high ozone and aerosol?

- How do emissions from local and distant sources interact to determine the air quality in Texas? What meteorological and chemical conditions exist when elevated background ozone and aerosol from distant regions affect Texas? How high are background concentrations of ozone and aerosol, and how do they vary spatially and temporally?
- How do areas within Texas affect the air quality of nonattainment areas within Texas? How do areas outside of Texas affect the air quality of nonattainment areas within Texas?
- Why does the Statewide Air Pollution Research Center chemical mechanism give different results than Carbon Bond-IV? Which replicates the actual chemistry better?
- How well do forecast air quality models predict the observed ozone and aerosol formation? What are the implications for improvement of ozone forecasts?
- How can observation and modeling approaches be used for determining (i) the sensitivities of high ozone in the HGB nonattainment area to the precursor VOC and NO_X emissions, and (ii) the spatial/temporal variation of these sensitivities?
- What existing observational databases are suitable for evaluating and further developing meteorological models for application in the HGB area?

5.1.3 Rapid Science Synthesis

Because of the time requirements imposed by the EPA's eight-hour ozone implementation guidance this proposed SIP revision needed to be finished by late 2006. However, the TexAQS II intensive field study needed to be conducted during August and September when the historically highest and most frequent ozone exceedances occur in the HGB area. Additional scheduling difficulties pushed back the arrival of NOAA's best-equipped airborne platform, the WP-3 Orion, until the end of August, and its mission was not completed until mid-October. Consequently, there was an extremely short period of time to analyze, interpret, and assimilate the TexAQS II data into meaningful, SIP-relevant findings that could be incorporated into the both the DFW and HGB SIP proposals.

To accelerate the synthesis of the field study data, a team of scientists was formed to provide rapid analysis for each of the SIP-relevant questions above. This project, funded by the TCEQ and led by Ellis Cowling of North Carolina State University and David Parrish of NOAA, provided an early analysis of the most important questions on October 31, 2006, and will provide additional information about the research questions through August 31, 2007, with a final report to be issued on that date. The next section summarizes the preliminary results as of October 12, 2006.

Rapid Science Synthesis Findings as of October 12, 2006

Preliminary results of the 2006 TexAQS II intensive field study were presented at the Rapid Science Synthesis Meeting on October 11-12, 2006; some of these results are presented below. The following preliminary results indicate that while the magnitude of the ozone concentrations in the HGB area has been reduced, the principle cause of the highest ozone episodes remains unchanged. Further analyses of the TexAQS II data may produce more detailed conclusions and may indicate appropriate future direction for research, monitoring, and modeling.

- Ozone production efficiency from Houston industrial emissions seems to be at approximately the same level as in 2000. The industrial areas of Houston still generally produce more ozone than the urban areas of Houston.
- Measurements of the ratios of carbon monoxide to NO_X seem to indicate a discrepancy between the MOBILE6 emissions model and the observed ratios.
- Direct emissions of formaldehyde seem to be minor compared to the secondary formation of formaldehyde.
- Concentrations of NO_X in power plant plumes in Houston and eastern Texas seem to be lower than in 2000, in some cases by a factor of 3.

- Concentrations of ethene in the industrial areas of Houston and Brazoria County seem to be substantially lower than in 2000. Propene concentrations downwind of the Houston industrial areas in 2006, however, have not decreased as much as ethene.
- Peak ozone on episode days in 2006 was lower than in 2000.
- Background concentrations of ozone can vary greatly in Houston, depending upon the transport conditions, ranging from 15 ppb to > 80 ppb. Higher background ozone seems to be related to several consecutive days of transport from the east, which occurred only for a few days during the study period.
- Ozone formed in Houston was observed to be transported within Texas to other nonattainment or near-nonattainment areas.
- On a number of days, the peak ozone in the Houston area was found outside the TCEQ Houston monitoring network. This pattern occurred on days with relatively strong winds (greater than 11.2 mph) and no flow reversal.

5.1.4 More Information on TexAQS 2000 and TexAQS II

For more information on the TexAQS 2000 go to http://www.utexas.edu/research/ceer/texaqs/.
For more information on TexAQS II see:
http://www.tceq.state.tx.us/implementation/air/airmod/texaqs-files/TexAQS_II.html,
http://www.utexas.edu/research/ceer/texaqsII/, and
http://esrl.noaa.gov/csd/2006/.

5.2 ONGOING EFFORTS TO IDENTIFY AND CONTROL VOC EMISSIONS

5.2.1 Infrared Gas Imaging Technology

The TCEQ is supportive of using optical gas imaging technology to detect leaks of VOC. Optical gas imaging technology has the potential to advance leak detection and repair (LDAR) work practices and enable monitoring of components that are difficult to monitor with traditional LDAR methods. The technology may also be useful in identifying sources of VOC emissions that are under-reported, unreported, or previously unregulated. However, the commission has technical and enforcement concerns associated with the potential regulatory implementation of this technology. A standardized method or performance specification is necessary to ensure consistent and reliable application of optical gas imaging instrumentation. Methods and specifications are also necessary to set minimum standards of performance to evaluate different potential technologies. The commission does not seek to prescriptively limit optical gas imaging to certain technologies or manufacturers. As with all new and developing measurement technologies, optical gas imaging technology has some limitations that are not completely understood at this time. Application of any optical gas imaging technology across the board to any source of VOC is not appropriate at this time. Based on TCEQ staff experience with gas imaging instruments, the technology can yield highly questionable results when applied to some sources of VOC.

The commission is soliciting comments on ways to advance the use of optical gas imaging technology. Specifically, the commission solicits comments on the appropriate instrument specifications necessary in order to use the technology to detect VOC leaks. The commission is also seeking ideas regarding the development of a method or performance specification to evaluate potential optical gas imaging instruments. In addition, the commission is aware that a number of companies are using optical gas imaging instruments to detect VOC leaks in their facilities. The field experience of these companies with optical gas imaging technology would be valuable in determining initial source categories for applying the technology in any potential regulatory implementation. Therefore, the commission is seeking comment and supporting information on source categories for potential application of optical gas imaging technology, as well as those source categories that the technology should not be applied to.

5.2.2 Remote Sensing VOC Project

When the TCEQ and its research partners began TexAQS II in May 2005, one of the study's primary goals was to identify VOC emission sources that have been historically unreported or under-reported in the EI and could potentially be contributing to the discrepancy between measured and reported emissions.

The Remote Sensing VOC Project, one of the first TexAQS II projects, used an infrared imaging camera to observe VOC plumes from various locations around the HGB area during July 2005. The imaging was conducted from a helicopter, a boat, a passenger vehicle, and the San Jacinto Battleground Monument. The significant findings from this observational project indicate that emissions from landed floating roof storage tanks, barges, and oil field tanks generally have been unreported in the TCEQ EI.

One result of this project was increased agency scrutiny on the landing loss emissions that occur whenever the tank is drained to a level where its roof lands on its legs or other supports. Tank-for-hire bulk terminal facilities (source identification codes 4225, 4226, and 5171) often land floating roof tanks because they empty their tanks relatively frequently. Figure 5-4: *2004 Reported VOC Emissions in the Houston Ship Channel and Surrounding Area* shows the radius around the ship channel in which the average total annual reported VOC emissions from 2002 to 2004 was reported to be approximately 14,000 tpy. TCEQ efforts to improve unreported landing loss emissions increased the reported emissions 6000-7000 tpy in the Houston Ship Channel area alone. Companies that were previously not accounting for tank landing VOC emissions have now submitted plans to decrease landing loss emissions. These companies are in the process of revising permits to reflect both changes in work practices and permitted emissions resulting from tank roof landings.

The TexAQS II also found that barges are emitting VOC when in transit. The commission currently regulates barges while they are at dockside. In addition, Section 4.2.2 describes new rules, to be adopted concurrent with this SIP revision, that more stringently regulate VOC emissions from barges. In addition to dockside regulations, the TCEQ has been working with the Texas Waterway Operators Association's Tug and Tow Division to revise and improve work practices to minimize barge emissions while in transit. The Louisiana Department of Environmental Quality has also identified barges as a previously unidentified source of VOC emissions, and is working to address the problem.

Oil field storage tanks were also found to be a potentially under-reported source of VOC emissions. Plumes were observed coming from 10 percent of the approximately 50 oil field storage tanks observed between Beaumont and Houston. As a result, the Houston Advanced Research Center (HARC) sponsored a project, H-51C, which measured both the flow and concentration of VOC emissions from 33 tank batteries in oil fields located in nonattainment areas around the state. Historically, oil field tank VOC emission factors have been estimated using emission models. Using the measured data, emission factors were derived that represent the losses that occur during production. The factors, in pounds of VOC per barrel produced, account for emissions from flash, working, and breathing/standing losses. The goal is that upstream oil and gas operators may use these emission factors to more accurately estimate VOC emissions. The results of this study are currently being analyzed by staff and additional research in this area is expected.

Another observed source of under-reported VOC emissions was from pressure tank railcars, which are railcars designed to hold gas under pressure. HARC project 51A sampled fittings on these railcars to derive a VOC emissions factor. This new factor will be included in the TCEQ point source guidance for estimating emissions from tank railcars for use in the 2006 emissions inventory. Although these emissions have been historically unreported, they are relatively small compared to emissions from other unreported source categories.

Subsequent agency efforts to identify and control unreported or under-reported industrial VOC sources identified the following potential sources of concern: liquid heel, tank degassing, wastewater, vacuum cleaning, stored liquid temperature, and sumps.

A liquid heel refers to stock liquid remaining in the bottom of a storage tank after it has been emptied. Liquid heels are responsible for numerous cases of under-reported VOC emissions. Degassing a tank with a liquid heel results in unreported VOC emissions because the liquid remaining in bottom of the tank continues to vaporize after the degassing process is completed and those VOC emissions vent to the atmosphere. Cleaning a tank with any liquid heel typically involves rinsing the tank with soap and water. The cleaning process produces wastewater with a significant VOC content and this wastewater typically goes to a wastewater treatment facility where the VOC emissions may evaporate to the atmosphere. Similarly, vacuum cleaning a tank with a liquid heel may result in unreported emissions. These emissions are difficult to quantify.

Typically sites estimate their storage tank emissions using ambient temperature, usually 68 degrees Fahrenheit (F). The temperature of a liquid is the biggest variable affecting the emissions from a storage tank. For example, gasoline at 100 degrees F emits significantly more VOC than gasoline at 68 degrees. Therefore, the TCEQ has revised its emissions inventory guidance to ensure that accurate temperatures are used in emissions calculations.

Sumps at marine loading facilities are a potentially significant source of under-estimated, unreported, or under-reported VOC emissions. Left-over liquid in flexible loading lines is often pumped to a sump that is linked to a slop tank (a VOC storage tank). Usually the sump is equipped with an automatic switch that empties the liquid into the slop tank when a predefined volume is reached. If the automatic switch does not engage, then the liquid evaporates out of the sump. This can be remedied by a change in work practice. The TCEQ is addressing under-estimated, unreported, or under-reported emissions from this source in the 2006 Emissions Inventory Guidelines.

This SIP revision contains a rulemaking that addresses sources of under-estimated, unreported, or under-reported VOC emissions. Section 4.2.2, Control of VOC Emissions from Storage Vessels and Degassing/Cleaning of Vessels, fully describes the rulemaking that will, among other measures, address unreported VOC emissions from tank landings; from flash emissions; and from degassing storage tanks, transport vessels, and marine vessels with liquid heels.

The TCEQ will work to continue to improve the emissions inventory in an effort to improve all aspects of the SIP.

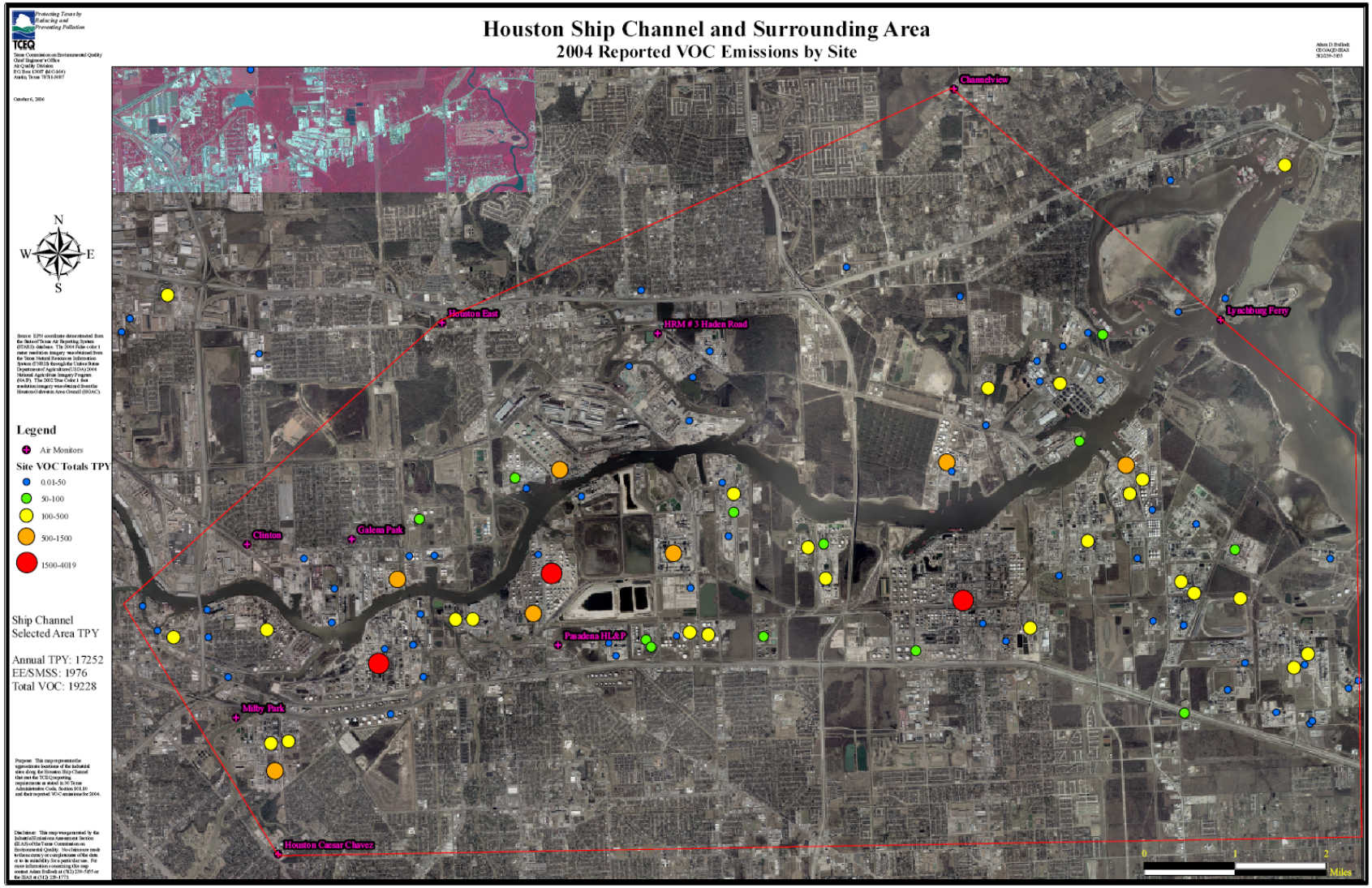

Figure 5-4: 2004 Reported VOC Emissions in the Houston Ship Channel and Surrounding Area

5.3 EFFORTS TO REDUCE NO_X FROM PREEMPTED SOURCES

5.3.1 Routine Vessel Study

The TCEQ, with the assistance of EPA grant funds, initiated a project to identify and count marine vessels that function exclusively in the HGB area or visit the HGB via the Gulf Coast or Intracoastal Waterway at least seven times over an 18-month period. These vessels are collectively referred to as routine vessels. Once the routine vessels are identified, the study will estimate emissions and quantify potential emission reductions from the routine vessel fleet. The study is scheduled to be completed by the end of November 2006. By identifying routine vessels, the EPA, the TCEQ, other states or local stakeholders could pursue actions to reduce NO_X, VOC, and particulate matter pollution. The first such action is to identify a "national routine fleet" to target pollution reduction efforts. This would aid EPA's Blue Skyways program by identifying the national marine fleet that visits the HGB area and other United States ports on a regular basis. The second action is to pursue joint business, interstate, and federal partnerships to reduce pollution from routine vessels.

Draft Study Findings to Date

Preliminary estimates indicate that 46 percent of the routine vessels visiting the HGB area also visited other United States ports. This tells us there may be an opportunity to collaborate with other nonattainment ports to identify the national routine fleet and work with these vessels for emission reductions that benefit several areas. The EPA could play a significant role in these efforts.

A convenient categorization of marine vessels is ocean-going vessels and harbor craft. Ocean-going vessels include tankers, offshore service vehicles, cargo or container ships, and cruise ships. Harbor crafts include tug and tow boats and ferries. Study results may be broken down by these categories and types.

Ocean-Going Vessels (OGV):

- Tankers
  Tankers are, by far, the most frequent OGV routine vessel. 227 tankers visited the Houston Ship Channel 3,045 times in an 18-month period. These vessels primarily visit private petrochemical terminals or "for hire" tank terminals. Preliminary research indicates that many of the routine vessels in this category are oil/product tankers that may visit many HGB terminals on a single trip thus "dwelling" in the ship channel; as dwelling increases, so do emissions. In 2009, oil/product tankers are projected to represent 26 percent of NO_X marine emissions (11.24 tpd).
- Offshore Service Vessels
  The draft report identifies 174 offshore service vessels that visited HGB 7 or more times in the 18-month window.
- Cargo/Container Ships
  The general cargo and container ships category includes approximately 50 routine vessels making a combined total of 1,423 port calls over the same 18-month period.
- Cruise Ships
  Seven cruise ships called on the Galveston Port collectively 245 times. Each ship spent an average of 432 hours in port over the 18-month period.

Harbor Vessels:

Harbor vessels include tugs, tows, and ferries. In 2009, these vessels will account for 29 percent of NO_X marine emissions (12.5 tpd). Harbor vessels may remain in the HGB area 100 percent of the time, or alternatively, they may move throughout the Texas Gulf Coast area or even interstate via the Gulf Coast or the Intracoastal Waterway. The study identified at least 530 tugs and tows that remain in the HGB area most of the time. The TCEQ, together with the Texas Environmental Research Consortium (TERC), is working with the Texas Waterway Operators

Association to identify emission reductions to date, areas, and technologies where we can best reduce NO_X and/or VOC from the routine vessels in this sector.

Harbor vessels also pull product barges in the HGB area. These product barges have been identified by the agency as a potential source of VOC. As mentioned in Section 5.1.2, the American Waterway Operators' Tug and Tow Division implemented a project to encourage industry best management practices (BMP) to reduce VOC emissions from barges. Identification of harbor vessels could also aid in recruiting these vessels to participate in the BMP program.

5.3.2 New Technology Research and Development (NTRD) Program

Texas funds the NTRD Program to fund research and advances in NO_X control technology for on-road and non-road sources. The TCEQ's NTRD Program provides incentives to encourage and support research and to develop and commercialize technologies that reduce pollution in Texas. The primary objective of the NTRD Program is to commercialize technologies that will support projects that are eligible for funding under the TERP Emissions Reduction Incentive Grants Program, which may ultimately provide additional SIP credit for new, innovative, and creative technological advancement.

5.3.3 Anticipated Federal Emission Standards on Marine and Railroad Engines

The EPA is considering locomotive and marine diesel engine emission standards modeled after the 2007/2010 clean highway and non-road diesel engine program, with an emphasis on achieving large reductions in PM emissions as early as possible through the use of advanced emission control technology. These standards, which could apply as early as 2011, would be based on the application of high-efficiency catalytic aftertreatment enabled by the availability of clean diesel fuel with a sulfur content capped at 15 parts per million. The EPA estimated that the 2007/2010 clean highway and non-road diesel engine programs could reduce NO_X and PM by 90 percent. The EPA expects that similar levels of NO_X and PM reductions could be achieved by applying similar technologies to locomotives and marine diesel engines. The EPA is expected to propose the rule by the end of 2006.

5.4 ONGOING EFFORTS TO CONTROL NO_X EMISSIONS

The existing NO_X point source controls are among the most stringent in the country. These controls include the Mass Emission Cap and Trade Program, which has an emissions cap that declines annually until 2008, have resulted in the utilization of highly effective post-combustion controls like selective catalytic reduction. The TCEQ continues to examine possibilities for appropriate additional technically and economically feasible NO_X control measures for point and area sources. In addition, the TCEQ and local governments are interested in potential control measures for on-road and non-road mobile sources that can help reduce NO_X.

5.5 FUTURE ATTAINMENT DATE

This chapter outlines ongoing efforts to improve air quality in the HGB nonattainment area. The beginning of Chapter 4 outlines the challenges to meeting attainment in HGB by 2009. Huge reductions in precursor emissions are needed in a relatively short amount of time, and while the phased implementation of federal on-road and non-road engine and emission standards will advance attainment, these federal-level standards are likely not enough to significantly advance attainment by the end of the ozone season in 2009. Section 2.8 outlines an analysis of 2018 with existing one-hour and proposed eight-hour ozone control measures and federal on-road and non-road standards. Section 2.9 discusses the development of a new modeling base case episode, and work that will follow the completion of the new base case. Chapter 3 demonstrates that, despite a rapidly growing population, great strides have been made in improving the air quality in the HGB nonattainment area. The TCEQ will continue to work with the EPA to explore feasible and practical methods to continue making progress toward attainment of the eight-hour ozone NAAQS. The TCEQ believes that, with the ongoing efforts described in this chapter, the development of a new modeling episode, the continued implementation of increasingly lower engine emission levels for on-road and non-road mobile sources, and further research and

consideration of additional control strategies, 2018 is a reasonable target year for attainment of the eight-hour ozone standard in the HGB area.