Indicator: Ozone and PM Concentrations for U.S. Counties in the U.S./Mexico Border Region (280R)

The Border between the United States (U.S.) and Mexico spans approximately 2,000 miles, from the Pacific Ocean to the Gulf of Mexico. The area is subjected to a unique blend of increased industrial development (especially on the Mexico side of the border), intense pressures because of the shifting and growing population related to this development, and an arid climate that can exacerbate many air quality problems. Ozone and particulate matter are air pollutants of particular concern.

Ground-level ozone is harmful to both human health and the environment (see Indicator 004). Although some industrial sources release ozone directly into the environment, most ground-level ozone forms from chemical reactions involving nitrogen oxides (NOx), volatile organic compounds (VOCs), and sunlight. Ozone levels are typically highest during the afternoon hours of the summer months, when the influence of direct sunlight is the greatest (EPA, 2003). Inhalation exposure to ozone has been linked to numerous respiratory health effects, including decreases in lung function, airway inflammation, and cough and pain when taking a deep a breath. Ozone exposure can aggravate lung diseases such as asthma, leading to increased medication use and increased hospital admissions and emergency room visits. Though people with respiratory problems are most vulnerable to ozone, even healthy people who are active outdoors can suffer from ozone-related health effects. Elevated concentrations of ozone can also affect vegetation and ecosystems, as Indicator 115 describes further (EPA, 1996).

Particulate matter (PM) is the general term used for a mixture of solid particles and liquid droplets found in the air (see Indicator 008). Primary PM is released directly from emissions sources into the atmosphere, while secondary PM is formed in the air from reactions involving precursor chemicals (e.g., nitrogen oxides, sulfur dioxide). Ambient air monitoring stations measure air concentrations of two size ranges of particles: PM2.5 (fine particles with aerodynamic diameter less than or equal to 2.5 micrometers (µm)) and PM10 (both fine particles (PM2.5) and coarse particles with aerodynamic diameters between 2.5 and 10 µm). Exposure to coarse particles is primarily associated with the aggravation of respiratory conditions such as asthma. Exposure to fine particles is closely associated with the most serious health effects, including decreased lung function, increased hospital admissions and emergency room visits, increased respiratory symptoms and disease, and premature death. Sensitive groups that appear to be at greatest risk to such PM effects include the elderly, individuals with cardiopulmonary disease such as asthma or congestive heart disease, and children (EPA, 2002). Fine particles also are the major cause of reduced visibility in parts of the U.S., including many of our National Parks and wilderness areas (see Indicator 006), and PM deposition affects vegetation and ecosystems by upsetting delicate nutrient and chemical balances in soils and surface water. PM also causes soiling and erosion damage to materials, including monuments, statues, and other objects of cultural importance.

This indicator shows trends in the mean design values for ozone and particulate matter in the U.S. counties at the U.S./Mexico Border area from 1986-2004 in comparison to U.S. national trends. (Figures 296R-1 and 296R-2) This indicator establishes a base line for measuring against future air quality levels. This indicator is based on all monitoring stations that operated on the US side of the border during this time period. Trends in the limited number of stations for which there are continuous data for the period are shown for comparison.

What the Data Show

Counties on the U.S. side of the US/Mexico Border have experienced increasing emissions from the Mexican side of the border and rapid population growth on both sides of the border. However, despite the additional pressures, these counties show a downward trend in ozone, PM2.5, and PM10, similar to the

trends in the rest of the U.S. (Figures 296R-1a,b,c and 296R-2a,b,c). The exception is the trend in PM10 in the Region 9 border counties (Figure 296R1-b). PM10 in the Region 9 border counties gradually increased over the period between 1992-1994 and 1999-2001, while PM10 trended downward over the same period in the nation as a whole. PM10 concentrations in the border counties have been higher than the national averages, notably so in the Region 9 Border counties. Also, localized along the Region 6 border, there are some monitors that show elevated PM 10 concentrations (Figure 296R-2b).

Comparison of the means of all border county air monitors with the means of the smaller number of sites in each region with continuous data over the entire period covered by the indicator shows that the shape of the trend curves are very similar, even though the means for the continuous monitoring sites tend to be higher (the exception is PM2.5 in Region 6). This suggests that the better characterization of the border region as the number of monitoring sites increases does not significantly bias the trends in the border counties.

Indicator Limitations

- Many counties along the U.S./Mexico Border do not have ambient air quality monitors; these counties are not characterized by this indicator; adequately characterized data are currently available for U.S. counties only.
- Short-term trends in PM2.5 concentrations are often highly dependent on meteorological conditions. This complicates efforts to interpret data for any given year; trends over the longer term are far less likely to be influenced by unusual meteorological conditions.
- The long-term ozone and PM-10 trends are derived from more and more monitors over the course of time from 1986-2004.
- Low mean air pollutant concentrations may mask higher values in some areas along the border and in the nation.

Data Sources

EPA Air Quality System (AQS) http://www.epa.gov/ttnairs1/airsaqs/index.htm

References

U.S. Environmental Protection Agency. 1996. Air Quality Criteria for Ozone and Related Photochemical Oxidants, EPA 600-P-93-004F-cF. Research Triangle Park, NC; US Environmental Protection Agency, Office of Research and Development, National Center for Environmental Assessment, July 1996.

U.S. Environmental Protection Agency. 2003. Border 2012: U.S.-Mexico Environmental Program. EPA-160-R-03-001. April 4, 2003.

U.S. Environmental Protection Agency. 2002. Air Quality Criteria for Particulate Matter, Third External Review Draft, Volume II, EPA 600-P-99-002bC. Research Triangle Park, NC; US Environmental Protection Agency, Office of Research and Development, National Center for Environmental Assessment.

Graphics

Figure 296R-1a: Region 9: U.S.-Mexico Border Ozone Concentrations
8-Hour Design Values

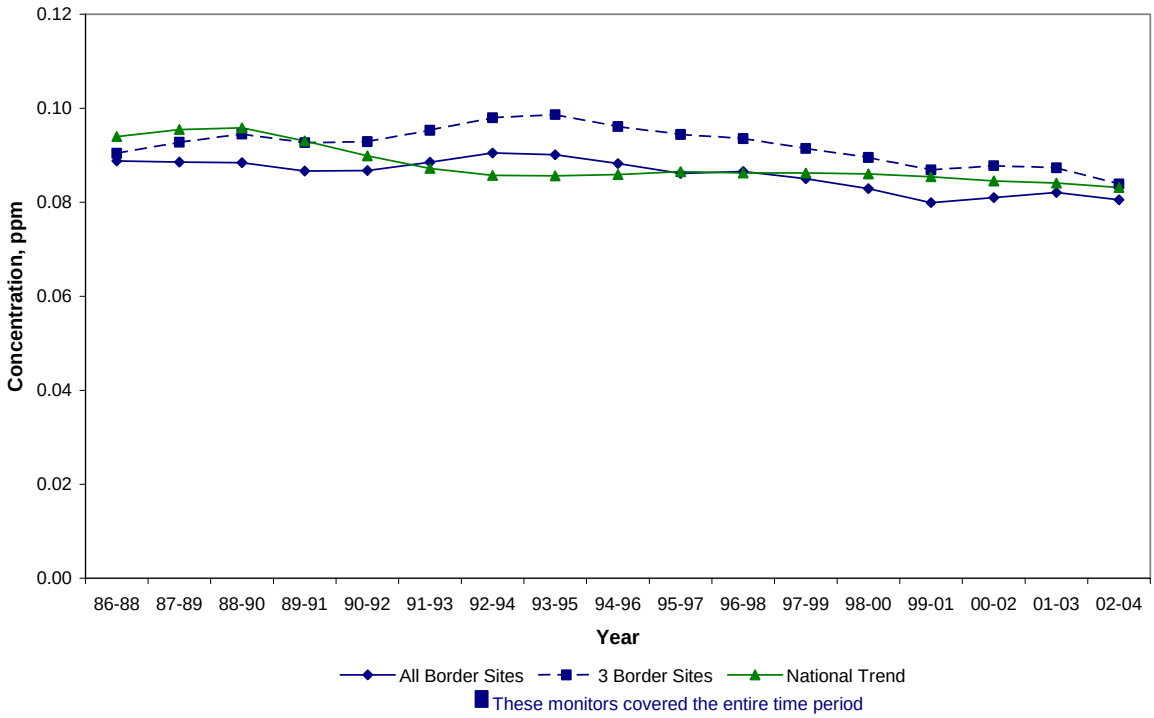


Figure 296R-1b: Region 9: U.S.-Mexico PM10 Concentrations Design Values

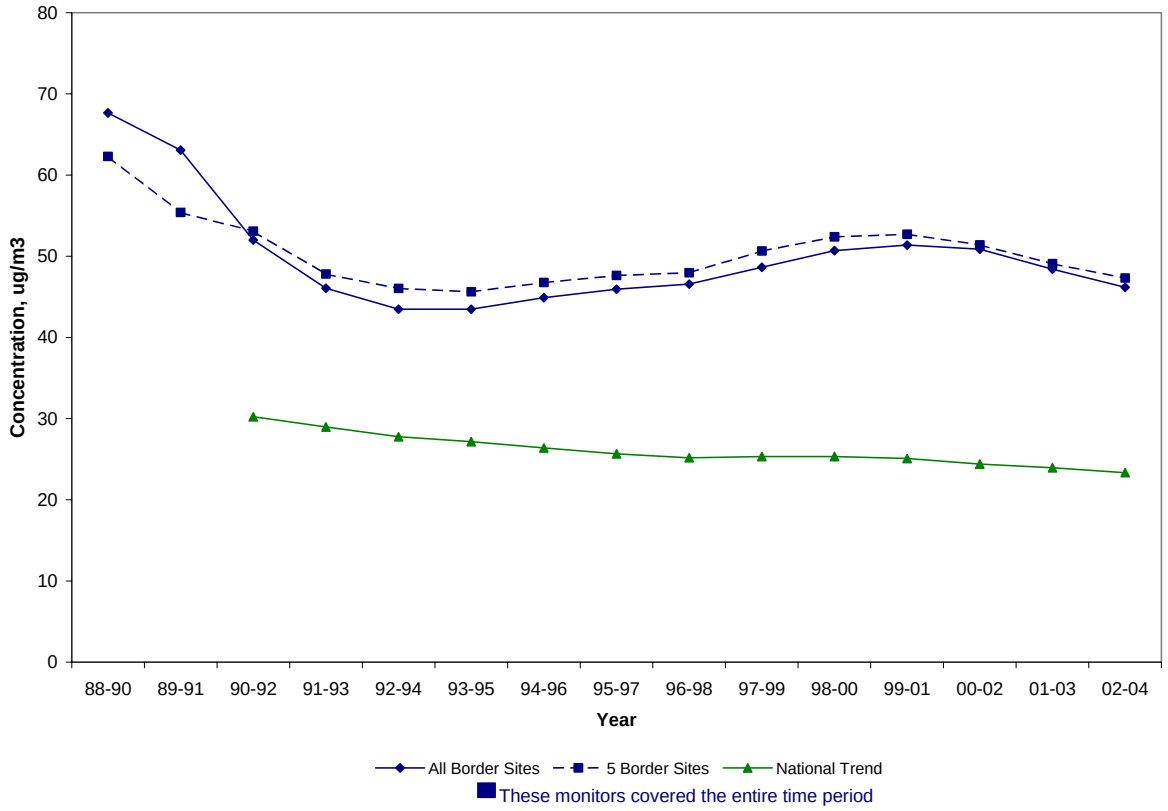


Figure 296R-1c: Region 9: U.S.-Mexico Border PM2.5 Concentrations Design Values

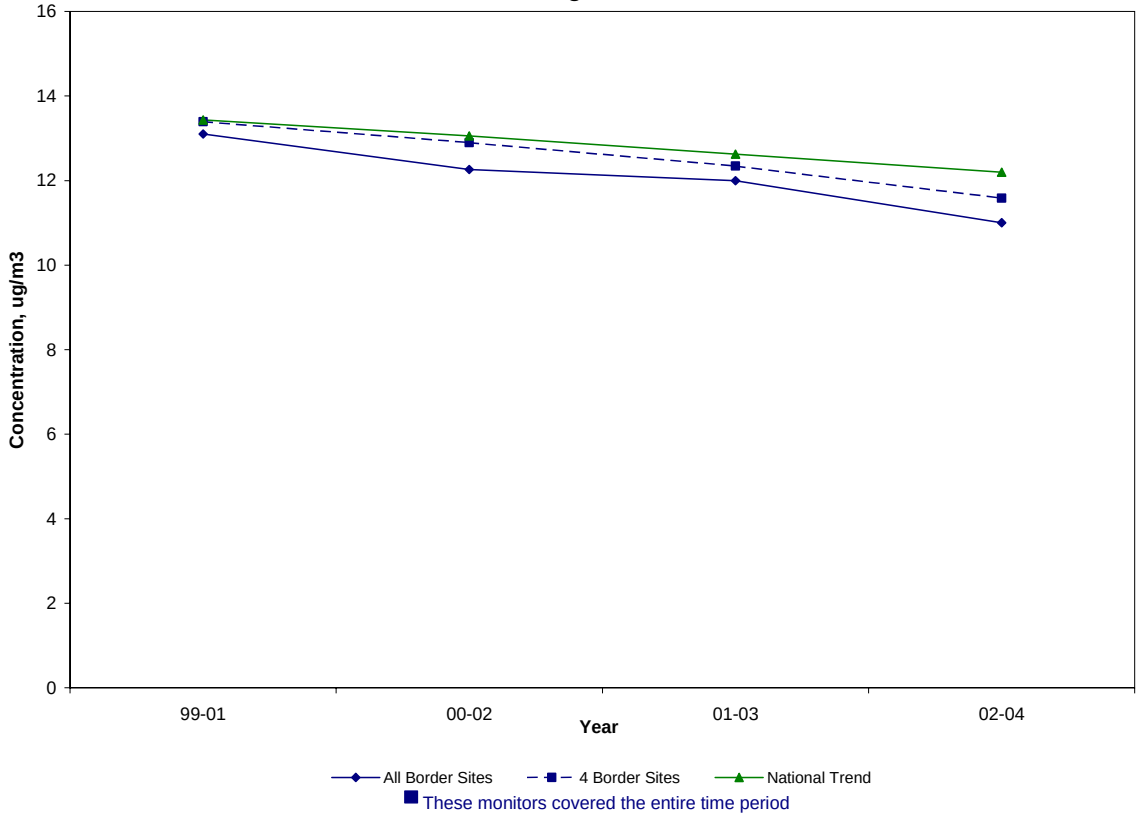


Figure 296R-2a: Region 6: U.S.-Mexico Border Ozone Concentrations 8-Hour Design Values

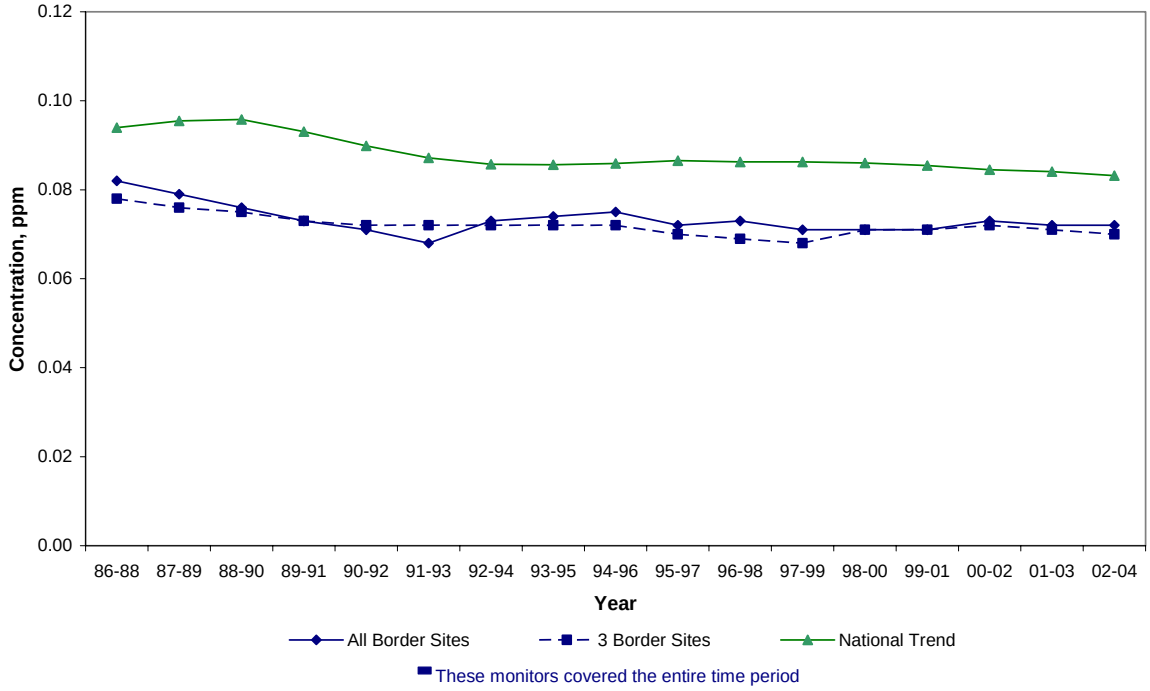


Figure 296R-2b: Region 6: U.S.-Mexico Border PM10 Concentrations Design Values

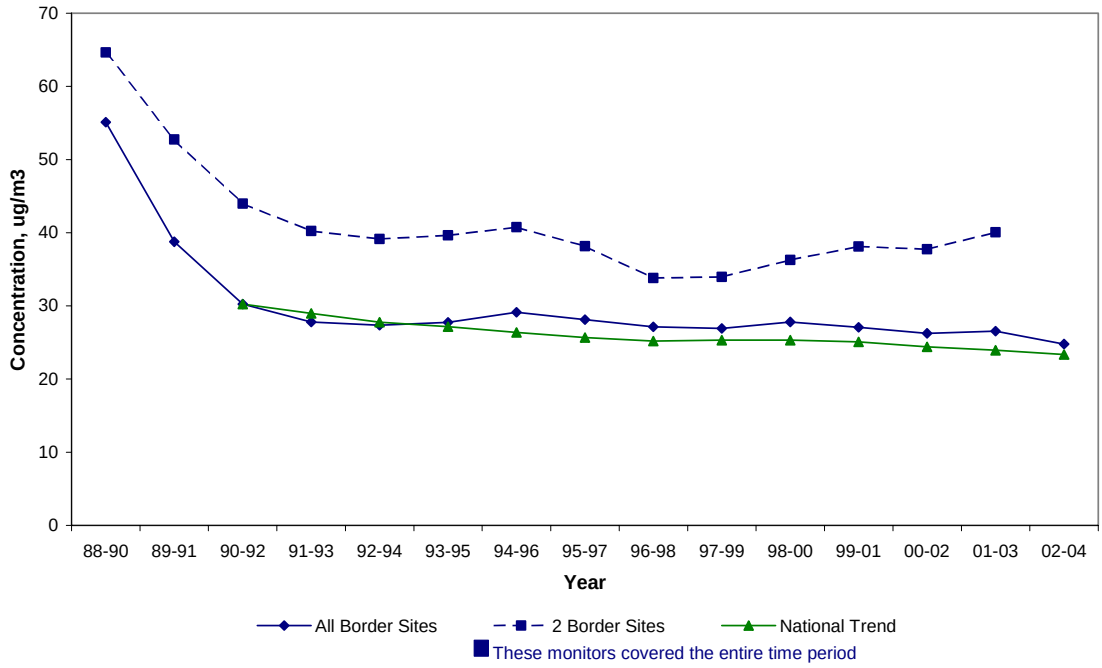
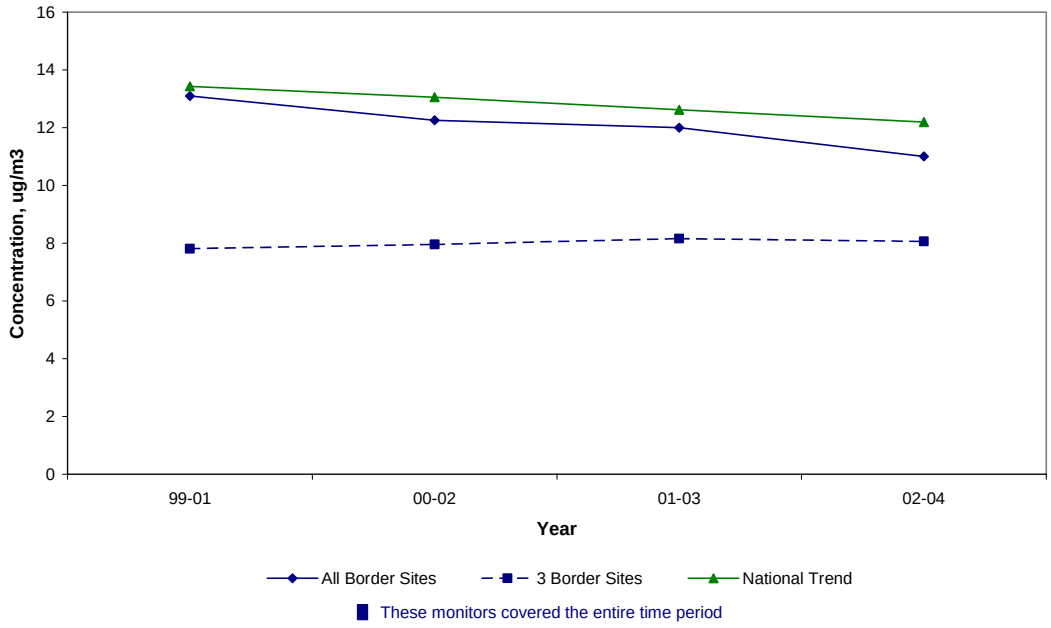


Figure 296R-2c: Region 6: U.S.-Mexico Border PM2.5 Concentrations Design Values



R.O.E. Indicator QA/QC

Data Set Name: OZONE AND PM FOR US COUNTIES IN THE US/MEXICO BORDER REGION
Indicator Number: 296R (89383)
Data Set Source:
Data Collection Date:
Data Collection Frequency:
Data Set Description: Design Value for Ozone, PM2.5 (annual mean), PM-2.5 (24-hour), PM10 (annual mean), PM-10 (24-hour) for US/Mexico border counties
Primary ROE Question: What are the trends in outdoor air quality and their effects on human health and the environment?

Question/Response

T1Q1 Are the physical, chemical, or biological measurements upon which this indicator is based widely accepted as scientifically and technically valid?

Yes, the ambient air quality data are based on data retrieved from the Air Quality System (AQS) in November 2004. These are direct measurements of pollutant concentrations at monitoring stations operated by state and local governments throughout the U.S.-Mexico border zone. The monitoring stations are generally located in larger urban areas. The monitoring network along the U.S.-Mexico border zone conforms to uniform criteria for monitor siting, instrumentation, and quality assurance. All data reported through these indicators are from EPA Federal Reference Monitors. The measurements collected were from monitors following all requirements of the National Air Monitoring Stations (NAMS)/State and Local Air Monitoring Stations (SLAMS) network. A description of this network includes: " 40 CFR 50 - National Ambient Air Quality Standards (NAAQS) and reference methods for determining criteria air pollutant concentrations in the atmosphere " 40 CFR 53 - Process for determining reference or equivalent methods for determining criteria air pollutant concentrations in the atmosphere " 40 CFR 58 - Ambient air quality surveillance (monitoring) requirements

T1Q2 Is the sampling design and/or monitoring plan used to collect the data over time and space based on sound scientific principles?

Yes. The border sites consist of NAMS, SLAMS, and other special-purpose monitors. NAMS were established to ensure a long-term national network for urban area-oriented ambient monitoring and to provide a systematic, consistent database for air quality comparisons and trends analysis. SLAMS allow state or local governments to develop networks tailored for their immediate monitoring needs. Special purpose monitors follow all NAMS/SLAMS reporting and design criteria but may not be deliberately sited to remain in the same location for long periods. This is desirable in order to respond to changing emissions characteristics in the border area The measurements collected were from monitors following all requirements of the NAMS/SLAMS network. The monitoring objectives for the NAMS/SLAMS network are found in: " 40 CFR 58,

Appendix D http://www.epa.gov/ttn/amtic/ " 40 CFR 58.2(c) " EPA 454/R-98-004, Part I, Section 3.2 http://www.epa.gov/ttn/amtic/cpreldoc.html

T1Q3 Is the conceptual model used to transform these measurements into an indicator widely accepted as a scientifically sound representation of the phenomenon it indicates?

Yes, PM-10, PM-2.5 and Ozone data are collected via EPA designated methods. Particulate Matter: PM-10 and PM-2.5 concentration data are collected via EPA designated methods in 24-hour, non-continuous fashion at a one, three or six day intervals depending upon the sampling frequency at each site. The daily measurements are obtained from monitoring instruments that produce one measurement per 24-hour period and typically operate on a systematic sampling schedule of once every 6 days, or 61 samples per year. EPA has determined that an every 6th day sampling schedule is sufficient to accurately characterize air quality for comparison to the NAAQS. A 75% minimal data completeness is required for trends purposes. The annual design value statistics presented in the indicators are the 3-year average annual mean for both PM-10 and PM-2.5. For PM-10, the 24-hour design value statistics presented in the indicators is the maximum concentration (rank of daily value based on number of samples) observed during a 3-year period [see 6.3.1 of the PM-10 SIP Development Guideline, EPA-450/2-86-001]. For PM-2.5, the 24-hour design value is the 3-year average 98th percentile concentration [see Chapter 4, Section 1 of the Guideline on Data Handling Conventions for the PM NAAQS, EPA-454/R99-008]. The rationale for use of these design values is presented in Guideline on Data Handling Conventions for the PM NAAQS, EPA-454/R99-008. Ozone: Ozone concentration data is collected via EPA designated methods from monitoring instruments which operate continuously. The ozone design value is used for this indicator and is defined as the 3-year average of the fourth highest annual 8-hour average concentrations at a given site. The ozone design value is a scientifically acceptable method of presenting ozone trends. EPA selected the design value concept in order to reduce variability in year-to-year changes in the ozone ambient concentrations so that one could make a more confident estimate of how ozone levels are changing. Ozone sites meet the annual trends data completeness requirement if they have at least 50 percent of the daily data available for the ozone season, which varies by state, but typically runs from May through September. Eight hour ozone concentrations are presented as running averages. For more information, see Guidelines on Data Handling Conventions for the 8-hour Ozone NAAQS, EPA-454/R98-017, December 1998.

T2Q1 To what extent is the indicator sampling design and monitoring plan appropriate for answering the relevant question in the ROE?

The design value indicators for PM-10 and PM-2.5 and Ozone are valuable measures of air quality trends in the border zone. The design values are valuable as indicators because they are designed to minimize temporal variability in concentrations, in particular, the variability due to meteorology. The air quality monitoring sites in the border zone were selected to address population exposure to pollution and, to a lesser extent, to reflect pollution levels within sensitive ecosystems. The data for these indicators were collected under a standard, national protocol of ambient air quality surveillance. All the sites were

either part of the NAMS/SLAMS network or are considered special purpose monitors, which nonetheless follow the NAMS/SLAMS monitoring sampling design. Furthermore, all sites collect data via EPA designated methods.

T2Q2 To what extent does the sampling design represent sensitive populations or ecosystems?

The prime rationale for siting the existing PM-10, PM-2.5, and Ozone monitors in the border zone was to determine air pollution concentrations in populated areas. A secondary rationale was to supply trends information for sensitive ecosystems. Additional rural monitoring in the border zone may help scientists assess transport and ecological effects; this is increasingly important with recent findings of significant long-range transport of PM-2.5 in North America (see "Big Bend Regional Aerosol and Visibility Observational Study Final Report, September 2004," http://vista.cira.colostate.edu/improve/Studies/BRAVO/Studybravo.htm).

T2Q3 Are there established reference points, thresholds or ranges of values for this indicator that unambiguously reflect the state of the environment?

Yes, the design value statistic is logically compared to the NAAQS. If the design value is below that of the NAAQS, the area is considered in attainment for a given NAAQS. Using such a robust statistic as the design value, one can track the progression of any changes with confidence to assess potential air quality threats. For more discussion about the establishment of the design value and its utility, see Guidelines on Data Handling Conventions for the 8-hour Ozone NAAQS, EPA-454/R98-017, December 1998.

T3Q1 What documentation clearly and completely describes the underlying sampling and analytical procedures used?

National Air Quality and Emissions Trends Report, 2003 Special Studies Edition - http://www.epa.gov/air/airtrends/aqtrnd03/ General Air Quality and National Monitoring Network - http://www.epa.gov/ttn/amtic/moninfo.html PM 2.5 Monitoring Information - http://www.epa.gov/ttn/amtic/amticpm.html Standard data documentation is available to support these data and can be accessed at: http://www.epa.gov/ttn/airs/aqs/index.html

T3Q2 Is the complete data set accessible, including metadata, data-dictionaries and embedded definitions or are there confidentiality issues that may limit accessibility to the complete data set?

Yes, the data used to calculate this indicator is available from EPA's Air Quality System (AQS) database. Information about this database, including how it may be accessed is found at http://www.epa.gov/ttn/airs/airsaqs/.

T3Q3 Are the descriptions of the study or survey design clear, complete and sufficient to enable the study or survey to be reproduced?

The Ambient Monitoring Technology Information Center (AMTIC) contains information and files on ambient air quality monitoring programs (this includes information on ozone and particulate monitoring), details on monitoring methods, relevant documents and articles, information on air quality trends and nonattainment areas, and federal regulations related to ambient air quality monitoring. This information can be found at http://www.epa.gov/ttn/amtic/. The PM 2.5, PM 10 and Ozone monitoring network design for the U.S.-Mexico border used methods and approaches consistent with those used nationwide. EPA's AQS database (http://www.epa.gov/ttn/airs/airsaqs/) may be used to access monitoring information pertaining to the counties highlighted on the maps for this indicator.

T3Q4 To what extent are the procedures for quality assurance and quality control of the data documented and accessible?

The Quality Assurance (QA)/Quality Control (QC) of the national air monitoring program has several major components: the Data Quality Objective (DQO) process, reference and equivalent methods program, EPA's National Performance Audit Program (NPAP), system audits, and network reviews (Available on the Internet: www.epa.gov/ttn/amtic/npaplist.html) To ensure quality data, the SLAMS are required to meet the following: 1) each site must meet network design and site criteria; 2) each site must provide adequate QA assessment, control, and corrective action functions according to minimum program requirements; 3) all sampling methods and equipment must meet EPA reference or equivalent requirements; 4) acceptable data validation and record keeping procedures must be followed; and 5) data from SLAMS must be summarized and reported annually to EPA. Finally, there are system audits that regularly review the overall air quality data collection activity for any needed changes or corrections. Further information available on the Internet: http://www.epa.gov/cludygxb/programs/namslam.html and through United States EPA's Quality Assurance Handbook (EPA-454/R-98-004 Section 15) For ozone, There is a Quality Assurance Project Plan from each state or local agency operating a NAMS/SLAMS monitor meeting the AEPA Requirements for Quality Assurance Project Plans@, EPA QA/R-5. The quality assurance plans for specific sites are publicly available by request to the reporting agency or the corresponding EPA Regional Office. The plans are audited at least once every three years as required in 40 CFR 58, Appendix A, Section 2.5. In addition, the data repository itself (i.e. AQS) provides direct access to two of the more prominent quality assurance indicators (i.e., precision and accuracy).

T4Q1 Have appropriate statistical methods been used to generalize or portray data beyond the time or spatial locations where measurements were made (e.g., statistical urvey inference, no generalization is possible)?

Yes, the air quality statistics presented relate to the pollutant-specific NAAQS and comply with the recommendations of the Intra-Agency Task Force on Air Quality Indicators. A composite average of each trend statistic is used in the graphical presentations. All sites were weighted equally in calculating the composite average trend statistic. Only sites with complete data for a given year are used in calculation of

indicator values. The resulting data sets are statistically balanced, allowing simple statistical procedures and graphics to be easily applied. This procedure is conservative since endpoint rates of change are dampened by the interpolated estimates. Spatial statistics and interpolation were not employed to determine concentrations in areas the monitoring network is not intended to provide coverage.

T4Q2 Are uncertainty measurements or estimates available for the indicator and/or the underlying data set?

Yes, the underlying datasets for PM-10, PM-2.5 and Ozone found in AQS also contain Precision and Accuracy data., Two prominent quality assurance indicators.

T4Q3 Do the uncertainty and variability impact the conclusions that can be inferred from the data and the utility of the indicator?

No, the indicator is calculated from data collected via EPA designated methods. This data must meet completeness and QA/QC criteria to be included in the indicator calculation. The networks of monitors that gather the data are reviewed and approved by EPA based on their adequacy in characterizing the air pollution concentrations in a given area. The level of uncertainty is reduced to an acceptable level for the purpose of this indicator.

T4Q4 Are there limitations, or gaps in the data that may mislead a user about fundamental trends in the indicator over space or time period for which data are available?

No, the border monitoring network is designed to provide data for assessing public health consequences of the concentration of selected criteria pollutants. The monitors are concentrated in urban areas (not all border counties are currently part of the monitoring network), but there is also modest coverage in most rural areas. The Sampling design provides a finer scale monitoring (county level) than needed (regional and border-wide level). Therefore, sampling density is more than sufficient for the intended use. Pollutant specific guidance for establishing NAMS/SLAMS networks is provided in 40 CFR 58, Appendix D.