Final Report

DALLAS – FT. WORTH TRANSPORT PROJECT

Prepared for

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EXECUTIVE SUMMARY

BACKGROUND

Ozone concentrations in the Dallas – Ft. Worth (DFW) area have exceeded the National Ambient Air Quality Standard (NAAQS) for many years. Tarrant, Dallas, Denton, and Collin counties (the four "core" counties) were originally classified as "moderate" nonattainment with respect to the 1-hour ozone NAAQS in 1991. This four county region is currently designated as a serious 1-hour ozone nonattainment area with an attainment date of 2005.

In 1997, EPA promulgated a new, 8-hour average ozone standard which is generally more stringent than the previous 1-hour standard. Texas is currently developing a Transitional SIP which will address attainment of both the 1-hour and 8-hour standards. This SIP is due to be submitted in 2004. Texas and EPA are currently in discussions concerning the boundaries of the new 8-hour DFW nonattainment area. EPA proposed including all twelve counties that constitute the DFW Consolidated Metropolitan Statistical Area (CMSA) in the new nonattainment area whereas Texas recommended excluding five of the outlying CMSA counties from the new nonattainment area.

High ozone events in the DFW area are influenced by NOx and VOC emissions from sources within the four core county region, by emissions from counties just outside of this region, and by transport of ozone and ozone precursors from other parts of Texas and neighboring states. Modeling of the August, 1999 high ozone episode conducted in support of the current SIP revision demonstrated the importance of NOx sources and regional transport. Transport from sources located in counties surrounding the central DFW area may or may not be subject to nonattainment area controls such as emission offset requirements depending on where the nonattainment area boundary is ultimately drawn. In addition, transport from upwind locations will change in future years in response to economic growth and implementation of emission control measures affecting those locations. Due to their potential significance, additional information is needed on the relative impacts of transport from these sources on violations of the ozone NAAQS in DFW.

A series of data analysis and photochemical modeling studies were reviewed to evaluate the impact of ozone and ozone precursor transport on ozone violations in DFW. The objectives of these analyses were:

- To assemble the available technical information relevant to the role of transport in DFW ozone nonattainment.
- To develop quantitative valuations of the contributions of sources located outside the four core counties to exceedances of the ozone standard using a variety of methods applied to the most recent available ozone modeling database for the DFW area (the 13-22 August 1999 episode period).
- To review results from the various technical approaches applied in this study and their relative strengths and weaknesses so as to provide guidance and assistance to policy-makers in setting the new nonattainment area boundaries and, subsequently, in developing local and regional emission control strategies.

DATA ANALYSES

Exploratory analyses of emissions, meteorological, and air quality data considered for this study included:

- Examination of ozone precursor emission budgets and ozone monitoring data in counties that are part of the DFW CMSA.
- Comparisons of historical trends in emissions and ambient ozone levels in DFW.
- Comparison of the frequencies of ozone exceedances by day of week.
- Examination of aircraft data from flights over DFW and vicinity and other portions of East Texas.
- Examination of back trajectories indicating the paths taken by air parcels arriving at DFW on the afternoons of high and low ozone days during the ozone season.
- Application of the Trajectory Mass Balance (TrMB) method for estimating source contributions to ozone to selected receptor sites in DFW.
- Examination of animated point source plume trajectories for selected days.

Results from these analyses clearly indicate the important contribution to peak 1-hour and 8-hour ozone levels of NOx emissions from sources located upwind of the four core DFW counties (Dallas, Denton, Collin, and Tarrant). Specifically, the analyses show that:

- Under prevailing wind directions during high ozone events, upwind sources lie to the east, southeast, and south of the core urban area, consistent with the spatial pattern of measured ozone design values.

- Trajectory analyses show that high ozone events in DFW are associated with slow moving air parcels originating primarily from east, southeast and south of the metropolitan area.

- Quantitative estimates of the relative contributions of different source regions within and outside of Texas to ozone concentrations in DFW obtained from the TrMB method are difficult to interpret because of technical limitations of the technique.

- Animated plume trajectories show plumes from sources just upwind of the four core DFW counties traveling over the urban area during high ozone episodes but provide no quantitative estimates of the contribution of a source to observed ozone levels.

- Comparisons of trends in ambient ozone concentrations with trends in VOC and NOx emissions and comparisons of weekday versus weekend ozone levels both indicate that ozone levels in DFW are sensitive to changes in NOx emissions and relatively insensitive to changes in anthropogenic VOC emissions.

- Data from aircraft measurement programs show that conditions in some parts of eastern Texas are favorable for formation of ozone in plumes from large isolated (point) sources of NO_x: ozone increases of 30 – 35 ppb have been observed in such plumes. These large industrial facilities are important sources of NOx emissions outside of the core urban area.

- Aircraft data also show that transport of elevated regional background ozone into the DFW CMSA is significant, approaching 80 - 90 ppb under certain conditions and

typically amounting to about 50% of the ozone measured in the center of the urban plume downwind of the city.

- Examination of 1999 emission budgets for counties in the DFW CMSA reveals that large NOx point sources are present in several outlying counties. Ellis Co. had the highest point source NOx emissions of any CMSA county and total NOx emissions from all sources in Ellis Co. were the highest of any county outside of the four "core" counties.

When considering the above results, it is important to keep in mind that high emissions do not necessarily produce high ozone impacts: the emissions must be upwind of the ozone impact area of concern and the emissions, when mixed with those from other sources, must have the right mix of precursors (VOC and NOx) to form ozone. Our results show that Ellis Co. is frequently upwind of DFW on high ozone days, and aircraft data show that point source NOx emissions can produce ozone in eastern Texas when VOCs are available from biogenic sources. Large biogenic VOC source regions are upwind of Ellis Co. and DFW under southeasterly winds.

MODELING ANALYSES

A series of modeling analyses were conducted to supplement the data analysis results described above and provide quantitative estimates of the contributions of different sources to ozone levels in DFW. This included:

- Source apportionment modeling of the 15 – 22 August 1999 episode with CAMx using the OSAT and APCA methodologies.
- Zero-out modeling of selected source regions under the 15 – 22 August 1999 episode for comparison with the source apportionment results.

Due to nonlinear chemical mechanisms involved in ozone formation, there is no one unique or single "correct" way to apportion ozone among sources, but there are several approaches that can be used with the CAMx photochemical model: Ozone Source Apportionment Technology (OSAT); Anthropogenic Precursor Culpability Assessment (APCA); and Zero-out differences. OSAT and APCA represent two different ways of apportioning the total predicted ozone at a given place and time to groups of sources. The methods differ only in the manner in which biogenic sources are treated: under OSAT, attributions are based solely on what precursors were present when the ozone is formed. APCA modifies the OSAT method to account for the fact that biogenic emissions are not considered to be controllable, and therefore APCA attributes ozone to controllable (anthropogenic) emissions whenever possible. Zero-out differences are simply equal to the difference in predicted ozone between a model run with all sources included and a model run in which emissions from a selected group of sources have been set to zero.

Each of these modeling approaches has its own interpretation and associated strengths and weaknesses. Taken together, results from these analyses provide a variety of quantitative data on anthropogenic source contributions that can be used by policy-makers to inform decisions on nonattainment area boundaries and control strategy development. In interpreting these results, it is necessary to keep in mind that there is no unique way to assess the contribution to ozone exceedances of different sources of precursor emissions due to nonlinearities in ozone chemistry. For the same reason, ozone source contributions do not provide quantitative predictions of the impact of any specific emission control strategies. However, the APCA and zero-out modeling

do reveal consistent patterns in the relative contributions of source areas supporting the reliability of these results as a guide for control strategy development. Our results show that:

- OSAT results identify biogenic emissions as a major contributor to ozone formation, reflecting the high contribution of biogenics to total VOC emissions. APCA reduces the apportionment of ozone to biogenic emissions to near zero and increases the apportionments to anthropogenic (NOx) emissions to compensate.
- The APCA and zero-out results are consistent with one another in terms of rank ordering of source regions and the locations of maximum impacts and areas of influence.
- APCA results indicate that emissions within the 4 core counties are the largest anthropogenic emissions contributor and are responsible for about one third of elevated ozone levels in DFW. The continental ozone background (i.e., model boundary contributions) and transport from upwind areas each also contribute about one third of elevated ozone levels in DFW.
- The zero-out differences are smaller than APCA apportionments and do not sum to total ozone, thus emphasizing that zero-out run differences do not represent source apportionments.
- The zero-out ozone differences are always smaller in magnitude than the corresponding APCA ozone apportionments because zero-out does not account for the non-controllable nature of biogenic emissions, among other reasons. The zero-out results generally suggest slightly greater importance for local emissions (4 core counties) and lesser importance for distant sources (continental ozone background).
- APCA and zero-out both show that transport from upwind source areas is an important contributor to elevated ozone in DFW. Since aircraft data show that transported ozone can reach 80-90 ppb, reductions in ozone transport will likely be necessary for DFW to demonstrate attainment of the ozone standard.
- The APCA and zero-out results both indicate that Ellis Co. is the largest ozone contributor of the 12 counties surrounding the 4 core DFW counties. Outside of this 16 county region, Northeast Texas and Central Texas are the next most important source regions within Texas, followed by the Houston/Galveston/Beaumont/Port Arthur nonattainment area.
- Of the three neighboring states most frequently upwind on high ozone days (LA, AR, OK), Louisiana provides the largest ozone contribution.
- The APCA and zero-out results reveal plumes of ozone contributions from large industrial combustion sources in Ellis Co. that are shown to overlap regions of maximum ozone on more than one occasion during the 15 – 22 August 1999 episode.
- The APCA and zero-out results were analyzed to see how frequently source areas contributed more than 2 ppb to 8-hour ozone above 85 ppb in the 4 core counties. Of the surrounding DFW counties, Ellis Co. was the most frequent contributor above 2 ppb, contributing more than 2 ppb 26% of the time in the APCA results and 9% of the time in the zero-out results. Central Texas, Northeast Texas, and the Houston-Galveston/Beaumont-Port Arthur areas each contribute more than 2 ppb over 55% of the time in the APCA results and more than 46% of the time in the zero-out results.

In addition to the APCA and zero-out modeling described above, a sensitivity analysis was performed in which we modeled the potential impact of new industrial NOx sources on DFW ozone levels without regard to emission changes to existing sources which will occur in conjunction with operation at the new sources. A survey of new sources for which permits have

been issued in the DFW CMSA and surrounding counties indicates that these sources are estimated to emit approximately 30 tons/day of NOx which amounts to approximately 60% of the total point source NOx in the four core counties or, equivalently, 5% of total NOx from all sources in the four core counties in 1999. Results from a CAMx sensitivity run in which these new sources were added to the 1999 inventory show that ozone in the CMSA is sensitive to the additional NOx, with episode maximum 8-hour ozone increasing by as much as 4 ppb in some locations.

In summary, it is clear that NO_x sources located outside the four-core counties (Dallas, Collin, Denton and Tarrant) play an important role in ozone nonattainment in DFW. The impacts of these sources will need to be considered in the design of any attainment strategy, as will the influence of NO_x control strategies being implemented in other parts of eastern Texas and surrounding states.