A STUDY OF AIR QUALITY CONDITIONS INCLUDING EMISSIONS INVENTORY, OZONE FORMATION, PM_{10} GENERATION, AND MITIGATION MEASURES FOR MENDOCINO COUNTY, CALIFORNIA

FINAL REPORT

STI-998080-1816-FR

By:

Lyle R. Chinkin
Hilary H. Main
Siana Hurwitt
Tami L. Haste
Dana L. Coe
Naresh Kumar
Sonoma Technology, Inc.
Petaluma, CA

Prepared for:

Mendocino County Air Quality Management District
Ukiah, CA

November 1998

EXECUTIVE SUMMARY

Mendocino County has generally good air quality. However, on a few occasions each year, air quality monitoring locations in the county measure 24-hr average particulate matter (PM_{10}) concentrations at levels which exceed the State of California's air quality standard. In addition, in recent years (1997 being the exception) Mendocino County has experienced increasing ozone levels, with peak ozone concentrations in Ukiah approaching the California State Ozone Standard. Since the population of Mendocino County is expected to grow about 50% over the next 25 years, the Mendocino County Air Quality Management District (MCAQMD) sponsored this study to provide a better understanding of the ozone and PM_{10} sources impacting the county.

Ozone Formation

There are two types of ozone that the public hears about in the news: (1) ground-level ozone (i.e., tropospheric ozone) and (2) stratospheric ozone (i.e., the "ozone layer"). Ground-level ozone is of concern to human health and plant-life due to direct exposure, while the stratospheric ozone layer provides protection to the earth from the sun's ultraviolet radiation. This study is only concerned with ground-level ozone. Ozone is a secondary pollutant formed by the reaction of nitrogen oxides (NO_x) and volatile organic compounds (VOC). The precursors to ozone (i.e., NO_x and VOCs) have both anthropogenic (man-made) and biogenic (natural) origins.

Particulate Matter

Particulate matter (PM) can be categorized by size and the type of physical process that produces the PM. Particles less than 2.5 μm diameter (fine particles) are principally due to atmospheric reactions, combustion processes (e.g., residential fuel combustion, and internal combustion vehicles), and some industrial processes. Fine particles produced by atmospheric processes from gaseous emissions are referred to as secondary particles. Coarser particles (less than 10 μm and greater than 2.5 μm) are usually associated with mechanical processes, including wind blown dust, re-entrained road dust, crushing and grinding, and tire wear. All particulate matter smaller than 10 μm (PM_{10}) is considered to be a potential threat to public health.

In most communities, ozone and particulate matter problems are a function of two broad factors: (1) local pollutant emissions from area, stationary, and mobile sources; and (2) transported pollutant emissions from an upwind area. In more rural areas, mobile sources (e.g., road dust for PM, and VOC and NO_x for ozone) tend to dominate in importance, unless there is significant pollutant transport, or there is a particular plant or factory that contributes directly emitted PM or ozone precursors. In the wintertime in these areas, wood-burning stoves and fireplaces are significant contributors to PM_{10} problems, since road dust is reduced on both paved and unpaved roads due to the increased moisture.

ES.1 STUDY OBJECTIVES

To determine the influences on Mendocino County's ozone and PM air quality and to propose ways in which the county can mitigate the impacts of growth on air quality, this project took a three-pronged approach:

(1) a study of past, present, and future ozone formation (and transport) in the county was conducted,

(2) an evaluation of the current emission inventory and projections to future years was prepared, and

(3) identification of potential mitigation measures appropriate to Mendocino County for ozone and PM_{10}.

The study of air quality conditions included the characterization of the meteorological conditions conducive to high ozone concentrations in the Ukiah-Little Lake Air Basin (e.g., Willits and Ukiah) and PM concentrations in Fort Bragg as well as the Ukiah-Little Lake Air Basin. The evaluation of the current county-wide emission inventory for PM and ozone precursors (e.g., VOC and NO_x) included separate assessments of the representativeness of emission factors and associated information used by the California Air Resources Board (ARB) to estimate emissions in Mendocino County. Emission estimates for on-road motor vehicles were given special attention, with detailed estimates prepared for sub-sections of the county. Special attention was also taken to prepare seasonally adjusted emission estimates for summer and winter regimes. To identify appropriate potential mitigation measure options for the county for ozone and PM, existing control plans in a variety of communities were examined. The examination provided a range of potential control measures available to County officials.

ES.2 RESULTS

ES.2.1 Ozone

Key Findings:

- Ozone concentrations in the Ukiah Valley have been measured at or near the level of the State Ozone Standard. Though the frequency of peak concentration events has been decreasing, the number of hours of ozone above natural background levels are showing a distinct trend upwards.
- To limit the contribution of local emissions to the increasing ozone levels, controls on ozone precursors (e.g., NO_x and VOC) must be considered.

- Analyses of local ozone precursor emissions in Mendocino County show that biogenic emissions are by far the single largest VOC source county-wide, and biogenic VOC emissions are substantial when compared to man-made VOC emissions in the Ukiah Valley. Man-made NO_x emissions dominate natural sources. Currently, the largest source of NO_x emissions is on-road mobile sources.
- Using future year projected emissions, ozone levels from local emissions are expected to decline or remain the same, if regulatory control programs remain in effect.

Other findings are summarized below.

- **Comprehensive ozone precursor data are non-existent.**

Air quality stations established to monitor compliance with air quality standards do not provide sufficient data to fully understand the causes of ozone formation and transport. For example, the ozone precursors, hydrocarbons and NO_x, are not adequately measured in Mendocino County. Currently, as in all but the most highest populated urban areas of the State, no hydrocarbon samples are collected in Mendocino County.

- **Ozone concentrations measured in Ukiah may not represent the highest concentrations in the Ukiah Valley.**

The ozone data collected at the E. Gobbi site in Ukiah appear to be somewhat titrated by fresh emissions of NO. Although the ozone measured at the E. Gobbi site are probably representative of the Ukiah urban core, they are probably not representative of the highest ozone values for the Ukiah Valley. Since a large percentage (i.e., 69 percent of the County total according to the 1996 U.S. Census Bureau) of Mendocino County's population lives outside of the urbanized areas of Ukiah, Fort Bragg, and Willits, ozone levels measured at downtown sites are probably under-representing the region's population exposure to ozone.

- **Ozone concentrations at the borders of the Ukiah Valley are not known.**

The air quality assessment in this report showed that transport of ozone and ozone precursors into the Ukiah Valley may be a significant contributor to ozone levels in the Valley. However, with monitors only in downtown Ukiah and Willits, the contribution of upwind ozone to the Valley cannot be quantified. One of the likely paths for transported ozone and precursors into the Ukiah Valley is via aloft transport.

ES.2.2 PM_{10}

Although no sites have exceeded the State standard for the annual geometric mean of 30 $\mu g/m^3$, there have been exceedances of the State 24-hr PM_{10} standard of 50 $\mu g/m^3$ in every year between 1993-1997. However, the median values show no declining trend. The median is consistently in the 10 to 20 $\mu g/m^3$ range for Ukiah and Willits, and between 10 and 30 $\mu g/m^3$ in Fort Bragg.

- **Rural population exposure to PM should be measured.**

PM measurements at Fort Bragg, Ukiah, and Willits may be under-estimating the regional PM_{10} air quality. All three sites are located adjacent to paved roads. However, as discussed above, nearly 70 percent of Mendocino County's population lives outside of the urbanized areas of Ukiah, Fort Bragg, and Willits and many of the rural Mendocino County roadways are unpaved. Thus, the concentration of particulate matter may be under-represented, since the monitoring sites are not impacted by as much fugitive road dust as is common outside of the urbanized areas.

- **Speciation of the PM mass is not available.**

As is typical of most rural Districts in the State, little or no speciated PM data is routinely available. Only under special circumstances, such as a special regional air quality field study, are such data available for all but the most highly populated urban areas of the State. Contributors to PM exceedances in Mendocino county include: unusual emissions events, fire activity (e.g., wildfires, control burns, urban fires, etc.) in and outside of Mendocino County, residential wood combustion for fuel and space heating, sea-salt spray (Fort Bragg), mobile source-related emissions, fugitive dust, and point sources. However, due to the lack of chemical speciation of the PM_{10} samples, source contributions cannot be quantitatively assessed.

ES.3 RECOMMENDATIONS

Recommendations for improved monitoring to address the key issues discussed above are described next for ozone and PM separately.

ES.3.1 Ozone Air Quality

We recommend that Mendocino County consider the following actions to provide better data with which to characterize and assess ozone conditions:

- Add an ozone monitor at the southern boarder of Mendocino County to assess concentrations entering the County when winds are from the south.
- Add an ozone monitor at a more rural location (i.e., away from fresh NO_x sources) in the Ukiah Valley in order to better assess the exposure of the predominantly rural population to ozone.
- Collect a few fully speciated ambient VOC samples during the summer at the Ukiah site, collocated with the NO/NO_x monitor and an enhanced sensitivity CO monitor (i.e., concentrations reported in ppb, rather than ppm).
- Enhance the surface meteorological measurement network in the Ukiah Valley to better assess ozone transport and recirculation.

- Add aloft meteorological measurements at the upwind boundary of the Valley in order to better assess the possibility of transport and recirculation.

ES.3.2 PM Air Quality

We recommend that Mendocino County consider the following actions to provide better data with which to characterize and assess PM conditions:

- Chemically speciate PM samples from historical episodes, if available, or from current samples above the standard.
- Add a PM monitor at a more rural location (i.e., near unpaved roads) in Mendocino County in order to better assess the concentrations in predominantly rural areas.
- Co-locate meteorological stations with sampling locations at Willits and Ft. Bragg to improve probability of pin-pointing any point source contributors.

ES.4 EMISSION INVENTORY ISSUES AND RECOMMENDATIONS

The current emission inventory and future-year projections are matters of great uncertainty. Much of the emission inventory is based on highly uncertain emission factors, statewide or regional averages, and extrapolated or interpolated estimates. Future projections are based on fundamental underlying assumptions regarding future socio-economic growth patterns in Mendocino County, which are highly uncertain by their nature. Furthermore, the assumptions are built on state-wide averages, whereas Mendocino County will likely be quite different than the state-wide average for many growth factors.

ES.4.1 Recommendations for Improving Emission Estimates

- Emission factors and activity data indicators used by the ARB to estimate area sources of ozone precursor emissions for commercial landscape equipment and cutback asphalt appear to be inaccurate for Mendocino County and should be updated.
- The ARB on-road motor vehicle emissions model should be re-run, accounting for the much higher than normal unregistered vehicle fleet in Mendocino County.
- If, in the future, speciated PM filter samples identify road dust as a significant contributor to PM exceedances, PM emissions from unpaved road dust should be re-calculated using revised estimates of unpaved roadway mileage.

Lastly, to more fully understand the uncertainties in Mendocino County's emission inventory, a detailed bottom-up inventory assessment should be performed. The bottom-up approach examines in detail the number, type, size, and activity of various emission sources within a county.