Chapter 7

Findings and Conclusions

The key results/conclusions of the MATES II Study are:

7.1 Monitoring Program

1) The estimated carcinogenic risk in the Basin from ambient measurements is about 1,400 per million people. It ranges from about 1,120 in a million to about 1,740 in a million among eight fixed sites.

2) The sites with the greatest risk levels, based on measurements, were in the south-central and east-central portions of Los Angeles County. At these locations, the dominance of mobile sources is even greater than at other sites. The sites with the lower risk levels were mostly in the other three counties.

3) The contribution to risk is dominated by mobile sources (e.g., cars, trucks, trains, ships, aircraft, etc.). About 70% of all risk is attributed to diesel particulate emissions; about 20% to other toxics associated with mobile sources (including benzene, butadiene, and formaldehyde); about 10% of all risk is attributed to stationary sources (which include industries and other certain businesses such as dry cleaners and print shops.)

4) The differences in carcinogenic risk from one site to another are much more driven by the influence from mobile sources than from stationary sources.

5) The carcinogenic risk from one site to another, as ascribed to stationary sources, is rather uniform across the Basin. In this respect, there is not much difference among the four counties.

6) There are strong seasonal variations to the levels of toxic air contaminants, primarily with those pollutants associated with mobile sources. Elemental carbon (a surrogate for diesel particulates), benzene, and butadiene – all have seasonal peaks in the late fall and winter months. The lowest levels are observed during the spring and summer months.

7) The seasonal variations with respect to toxic air contaminants from stationary sources are generally small. Levels are quite consistent across all months of the year.

8) Levels of risk are, for the most part, consistent with the long-term downward trends evident in the ARB data since 1990. Noticeable improvements have occurred for three major elements of toxic risk: hexavalent chromium, benzene, and butadiene. (Note: trends for diesel particulates are not available from the ARB data, however recent studies (Christoforou, et al., 2000) show a decrease of about 32% over a decade.)

7.2 Modeling

1) Model results show similar levels of carcinogenic risk across the Basin on an annual basis, as does the monitoring data. Models also show the strong domination of mobile sources contributing to risk, and support the findings from the monitored data that diesel particulates are the most significant contributor to carcinogenic risk.

2) The model results, which are more complete in describing risk levels across the Basin than is possible with the monitored data, show that the higher risk levels occur in the south-central Los Angeles area and in the harbor area. Model results also suggest that the basinwide cancer risk levels may be 16 percent lower than the corresponding risk levels estimated from the monitoring sites.

3) Overall, the UAM and UAM-TOX model perform within $\pm$ 50 to 80 percent of measured annual values. However, the model performance varies significantly on short-term averaged concentrations. In addition, given that mobile source emissions are most likely under-estimated with the current ARB mobile source emission factor models, the model performance would improve somewhat with the latest versions of the mobile source models.

4) The spatial concentration fields show that higher concentrations generally occur near their emission sources. Higher concentrations of compounds that are emitted primarily from stationary and area sources tend to be highest within a few kilometers from the source location. Mobile source related compounds such as benzene and 1,3 butadiene tend to be generally high throughout the Basin. However, spatial variations are estimated by the models with higher concentrations occurring along freeway corridors and junctions. In addition, higher levels of mobile source related compounds are estimated near major mobile source activities such as airports and other areas with major industrial activities such as south central Los Angeles County, and the industrial areas of Orange, Riverside, and San Bernardino counties.

7.3 Microscale Program

1) Thirteen pairs of sites (microscale vs. fixed) were analyzed (and limited to the same period of time in which sampling occurred at each pair).

2) Statistical significance at the 90% confidence level were calculated between the mean concentrations (for each of 24 toxic gaseous compounds and 5 toxic metals) at each microscale site and its geographically closest fixed site.

3) Most of the statistical differences were for carbonyls, including formaldehyde and acetaldehyde. Differences in measurement techniques may account for these observations.

4) Aside from the carbonyls, of 325 pairs of data between microscale and fixed site concentrations, only seven were shown to be significantly higher at the microscale sites. Of those seven, six were comparable to levels found at other fixed sites across the basin.

5) Styrene (a compound which currently has no assigned carcinogenic risk factor) measured at Anaheim indicates substantial influences from a local source or sources. Three nearby sources emitting styrene were located from the emission inventory data base. These sources were upwind of the monitoring site and contributed to the levels observed. Such levels are still well below established health limits.

6) Unusually high levels of formaldehyde were observed at San Pedro. Analyses of the patterns of the data strongly suggest a very localized influence, and it is suspected that contamination of the sampling equipment caused this result.

7) No significantly higher levels of key mobile source toxic compounds, benzene and 1,3 butadiene, were found at any of the microscale sites, including those sited near freeways specifically for mobile source influences.

8) A comparison of risk-weighted concentrations of toxic compounds at each of the 14 microscale sites indicates that mobile sources are the dominant contributor to toxic risk at 11 of these sites. At two sites, Torrance and Costa Mesa, stationary sources are dominant due to low levels of mobile source emissions. A determination for San Pedro is questionable because of the concerns about formaldehyde.

9) Of the fourteen microscale sites, at four sites (Anaheim, Norwalk, Hawthorne, and Riverside), no emissions of toxic compounds emitted by stationary sources were found within an approximate one kilometer upwind distance of each site.

10) Local-scale modeling was applied to each of the fourteen microscale sites using two different annual meteorological scenarios: (1) calendar year 1981; and (2) April 1998 to March 1999.

11) Model-estimated cancer risks at every microscale monitoring site, based on local upwind emission sources, was less than 5 in a million, with the greatest risk value of 4.5 in a million at Boyle Heights.

12) Model-estimated cancer risk maxima were generally found to be very close to the source(s), rather than at the monitoring sites. There are only three locations where modeled maximum risk levels were greater than 10 in a million: Boyle Heights (588); Torrance (44) and Pacoima (21).

13) The modeling results indicated that there are most likely locations other than selected microscale sites that have concentration levels higher than the measured concentrations.

14) Because risk levels ascribed to nearby sources inventoried for the study are generally much lower than region-wide risk levels, region-wide risks tend to overwhelm any potential local "hot spots."

7.4 Caveats and Uncertainties

1) The caveats to consider in interpreting the above deal with the uncertainties associated with risk estimations, discussed in Chapter 3. In addition, improvements can be made in the development of emissions inventories. Specifically, the ARB is in the process of revising the mobile source emissions inventory; speciation profiles for VOC and PM can be updated; and stationary source emissions can be audited on a more frequent basis. Laboratory measurement techniques also can be improved to reduce uncertainties. None of the above improvements are expected to change the over-all conclusions of the report.

2) There is currently no technique to directly measure diesel particulates, the major contributor to basin-wide carcinogenic risk. Based on research results as reported by ARB, diesel particulates can be estimated by measuring elemental carbon, a black, sooty particulate. In essence, elemental carbon becomes a surrogate for diesel particulates. Although this estimating technique is likely to have uncertainties, the emissions inventory and modeling, which account for directly emitted diesel particulates, confirm that diesel particulates are the major contributor to carcinogenic risk.

3) The determination of risk values for each compound carries a level of uncertainty, which for some pollutants is large. Typically, the risk values are derived from animal or epidemiological studies of exposed workers or other populations. Uncertainty occurs from the application of individual results to the general population. When risk factors for specific compounds are determined, levels are usually established conservatively. There is considerable debate on appropriate risk values, and often the levels established by the USEPA and CalEPA differ. For the purpose of this study, California values are used.

4) There is further debate as to the appropriate levels of risk ascribed to diesel particulates. CalEPA, in recommending a cancer risk level of 300 in a million per microgram per cubic meter of diesel particulates, considered evidence which suggested diesel risks as low as 150 in a million to as high as 2,400 in a million. The USEPA has not yet declared diesel particulates as an air contaminant. Thus, the selection of a risk factor for diesel particulates can have a substantial effect regarding the importance of diesel exhaust in assessing cumulative risks. For purposes of this study, and to be consistent with the approaches used for other toxic pollutants, the CalEPA recommended value of 300 in a million is used.

5) There is an estimated uncertainty level of $\pm$ 25 percent associated with laboratory measurements of many toxic compounds. Part of this uncertainty is attributed to the fact that many of the toxic compounds measured are at extremely low concentration levels, at parts per billion (ppb) levels, and often near the detection limits of the instrumentation. A number of compounds cannot be detected at all. When non-detections occur, it is assumed that the actual levels are not zero, but are half of the instrument detection limit. In other words, if the detection limit is 1 ppb, and a compound is not detected at that level, it is assumed that the actual concentration is one-half of 1 ppb.