SUMMARY

The work reported in this thesis was undertaken to measure a year long (2003-2004) seasonal variations in baseline air quality concentrations of various air pollutants at seven sites representative of industrial, commercial and residential areas in Lahore. The study established baseline levels and behavior of ambient airborne pollutants in urban centers with temporal and spatial parameters. Particulate matter was measured using high volume samplers and gaseous pollution was recorded with automatic analyzers. $PM_{2.5}$ level measured from Nov. 2005 to 10 March 2006 Punjab University New Campus area near Johar Town and from Nov.2006 to Dec 2007 at Johar Town have been presented. The analytical results of trace and toxic metals and anions and cations measured in $PM_{2.5}$ (Data from Nov. 2005 to Jan. 2006 at Johar Town) have been reported. To estimate the indoor concentration from out door level, we have utilized the studies of other researchers, as actual monitor to measure indoor pollution was not available. Ambient $PM_{2.5}$ concentration (Nov., 2005 to March 2006) was subsequently transformed to estimate indoor $PM_{2.5}$ level using the ratio 0.75 (Low case) and 0.96 (high case) based on evidence from India (Alena , 2005). The estimated indoor $PM_{2.5}$ level also exceeded the standard limit of 35 $\mu g/m^3$ of USEPA. The objective of this study was a presentation of an overall air quality picture of Lahore and subsequent comparison of pollutant concentrations with those reported by our predecessors for other cities of Pakistan and comparison of the computed values with the similar study carried out by JICA /EPD Lahore in March 2000. A bad ambient air quality in terms of very high TSP, PM_{10}, $PM_{2.5}$, CO and hydrocarbon (methane) was observed in Lahore. The situation is the matter of great concern especially when measured values are compared with US-EPA standards. It was observed that even the average concentration (24 hrs) of particles (TSP, PM_{10} and $PM_{2.5}$) was about 2 to 4 times higher than the prescribed limits. From high outdoor values, high indoor air pollutants level are expected as the air filter or any other remedial precaution from outdoor high levels, are not practiced in the building of the city. During summer highest levels for TSP, PM_{10} and gases were observed as compared to spring and autumn, while lowest pollution was observed in monsoon. However highest concentration of $PM_{2.5}$ was recorded in winter and spring. Gases such as NOx, SO_2, O_3, were found within the prescribed limits. At most of the sites the pollutants levels follow the vehicular density pattern. The major intersections such as Chowk Yateen Khana, Azadi

Chowk, and Ichra have the highest levels. The analytical results were distributed in five factors when Model Positive Matrix Factorization (PMF) PMF 1.1 was applied on short term data of daytime, evening and nighttime (Nov. 2005 – Jan. 2006). Factor 1 includes Al, Ca, K which refer to soil and road side dust. The overall contribution of road dust was 18 % in $PM_{2.5}$ that may be high in PM_{10}. Factor 2 comprises Co, Cr, Fe, Mo, Ni, and Sn referring to industrial emission originating principally from ferrous metal source. Industrial emissions (Industrial oil burning, smelting, steel industry) contributed to 26 %. PMF yields a separate factor, Factor 3, for Cd, Pb, Sb, and Zn indicating their common source as vehicular/traffic emission and contribute 5% to total load. Factor 4 with high percent of SO_4^{-2}, NO_3^- and NH_4^+ refers to secondary aerosols. The presence of secondary sulfates is identified by a high sulfate concentration. Factor 5, containing high percentage of V, As, Sr and Ba, refers to mixed urban source of Oil/Coal burning probably in brick kilns and industries. The source apportionment results showed the secondary products was the dominant one (51 %). The city is also badly affected by local and trans-boundary air pollution sources especially due to high levels of particulate pollution and secondary aerosols which contribute increasing $PM_{2.5}$ concentrations.