5.1 SUMMARY

The study on the distribution of heavy metals in the water and sediments of river Adyar revealed the following:

a) Distribution in water and sediment

1. The stations in the upstream of the river (SW 2, 3, 4, 5, and 6) reported high concentrations for most of the metals. These stations were located near the industrial zones, where many metal-based industries were situated.

2. Cr and Mn were found to be the most abundant element in the river.

3. The concentration of Cd and Ni were found to be high in the estuarine region.

4. The seasonal fluctuation in the river indicated that during monsoon period the concentration increased indicating that the monsoon floods which washed the city was the major source of pollution.
5. The redox potential played a major role in the distribution of metals between water and sediment phases. Mn, a redox sensitive metal, precipitated under oxidising conditions and dissolved under reducing conditions.

6. Cd and Ni showed a definite positive correlation in water; Mn and Zn showed a high positive correlation between themselves while Cr and Mn showed a moderate negative correlation.

7. In sediment all the metals exhibited a positive correlation among themselves.

8. The pollution load index indicated that most of the riverine stations exhibited higher anthropogenic stress than the estuarine region.

9. The stations located near the industrial estate showed high values of contamination factor and pollution load index indicating that the industries were contributing to the pollution in the river.

b) Penetration

1. The study of penetration of heavy metals within the sediment cores revealed that Cd, Mn and Ni were highly mobile. The conditions in the deep layers of most of the cores revealed that the metals were easily mobilized by the environmental conditions.
2. Cr, Cu and Zn were found enriched in the surface layers. They had high affinity to the organic content, which prevented them from penetration into the deep layers.

3. The penetration of heavy metals in the deep layers of the sediment core SC2, SC3 and SC6 revealed that these cores were highly permeable.

4. The core SC4 was found less polluted than others due to the low permeability of the sediment core.

5. The Igeo classification also indicated that the surface layers were more enriched than the deeper layers revealing the recent anthropogenic contamination.

c). Speciation

1. The fractionation study of metals indicated that most of the metals i.e. Cr, Cu, Pb and Zn were present in the reducible phase.

2. The exchangeable fraction of Cr, Cu, Pb and Zn were very low except Ni which exhibited a high extractability.

3. The residual phase was very low indicating that the input of metal from geological sources was very little.

4. The bioavailability of all the metals appeared high (Cr = 87.9-94.2 %, Cu = 81.5-87.9 %, Ni = 82.1-84.9 %, Pb = 46.4-77.6 % and
Zn = 88.9-94.8 %) indicating that they were likely to be mobilized under different environmental conditions.

5. The bioavailability of heavy metals in sediment followed the order Zn > Cr > Cu > Ni > Pb.

d) Ground water contamination

1. The ground water station GW1 exhibited significant contamination in the ground water. Since the permeability of the core was very low, the high concentration in the wells might be due to the crevices or fissures in the impermeable layer.

2. The ground water station GW2 indicated that the pollutants have crossed the sediment layers and contaminated the ground water. The permeability of this core was very high.

3. Ground water station GW4 reported very low pollution since this region had an impermeable layer.

4. In most of the stations, it was observed that wells close to the river had high concentration than the wells far-off. This indicated the infiltration of the river water to the ground water body.

5. Some times the wells showed higher levels of metal concentration than the infiltrating river water. This may be due to the leaching of the highly contaminated sediment layers into the ground water.
6. The wells close to the river and the contaminating sources indicated that they were the major sources of contamination.

5.2 CONCLUSION

The city of Chennai is densely populated and has a tremendous growth, development and industrialization. It has many small and large scale industries whose production meets the requirements of both the National and International markets. It ranks in fourth position at National level in the rapid industrial revolution. Along with its development the pollution has also increased affecting the water ways of the city to a great extent.

River Adyar, a short and a non-perennial river, is highly affected by the release of industrial effluents and domestic sewage. The heavy metals discharged into the river get precipitated and settle with the sediment. During monsoon the excess input of oxygen in the river system has mobilized the metals in the deep layers of the sediment and has affected the ground water body. The stations which had high permeable sediment showed high pollution due to easy percolation.

As the city of Chennai is experiencing water scarcity by the inadequate surface water sources, the pressure on the ground water resources for the domestic and industrial usage is increasing. But, the available ground water is observed to be contaminated by the industrial and domestic wastes. Hence, this problem has to be addressed immediately by suitably treating the domestic and industrial wastes before discharging into the river.
5.3 SUGGESTIONS AND SCOPE FOR FOLLOW UP WORKS AND FUTURE STUDIES

- The intensive heavy metals pollution in river Adyar and its basin is caused by industrial effluents. It is suggested that the industries, irrespective of their production scale, should adequately treat their effluents and the efficiency of the treatment should be checked periodically.

- The sediments are highly contaminated by toxic heavy metals. The dredging or excavation of these sediments facilitates oxidation, leading to acidification which in turn causes the mobilization of metals. Hence, the sediments should not be disturbed for removal and land fill.

- The discharge of domestic wastes or other wastes which might produce anoxic conditions should be avoided.

- The ground water in the affected areas should not be used for drinking purposes. Even gardening of edible plants with this water should be avoided because it is likely to lead to accumulation of heavy metals in edible parts of the plant.

- To avoid contamination of the ground water, sewers or the wastewater channels should be lined suitably to prevent seepage of the effluents.
• The metals present in the sediment can be recovered. This is practised in a company situated in Hamburg, Germany, where the metals are extracted from the excavated sediments of the highly polluted River Elbe.

• As the population of Chennai is highly dependent on the ground water for its domestic and industrial needs the wells should be continuously monitored.

• The effect of elevated levels of heavy metals on the life processes of organisms living in the river may be studied.