SUMMARY AND CONCLUSIONS

The liquid effluent from Bhilai Steel Plant (BSP) is diverted through two effluent channels. One channel joins river Kharoon, while another channel joins river Sheonath. A part of this effluent is used for irrigation. The effluent discharged into Kharoon river was analysed from two sampling points at about weekly to monthly intervals. The average temperature of about 27°C and pH of about 7.5 indicate effluent's quality similar to typical natural water. Oxidation reduction potential, total dissolved solids, electrical and specific electrical conductivity, osmotic pressure and degradation ratio all were found to have comparatively very low values, as compared to several other industrial effluents. Free carbon dioxide concentration, as
compared to total carbon dioxide concentration was very low similarly chloride concentration also never exceeded 91.0 mg l$^{-1}$. The concentration of sulfate, nitrate nitrogen, ammonia nitrogen, iron and phenol, having average values even more than 4400 mg l$^{-1}$, 2800 mg l$^{-1}$, 5300 mg l$^{-1}$, 5300 mg l$^{-1}$ respectively indicate that, these ions and substances are released in very high concentrations from integrated steel plants. BOD value was very low but COD value was comparatively higher.

Quality of the effluent changed with its passage along the discharge channel. The travel of effluent to a distance of about 15 km distance increased very significantly, the oxidation - reduction potential, residual sodium carbonate dissolved oxygen, % oxygen saturation and BOD while there was significant decrease for total dissolved solids, electrical conductivity, osmotic pressure, degradation ratio, specific electrical conductivity, chloride, Langelier calcium carbonate saturation index, nitrite-nitrogen, hardness including calcium and magnesium concentrations, magnesium hazard index and residue. However, the magnitude of decrease was very high with respect to sulfate, nitrate nitrogen, ammonia nitrogen and iron.

The constituents of the sediment deposited along the effluent channel were not found to have much correlation with
the similar constituents of the effluent. Almost all the investigated parameters were found to have lesser concentrations in the sediment, as compared to their concentrations in the effluent. In the sediment, sulfate with an average value even more than 1900 mg.g\(^{-1}\) and dilute acid soluble iron with average concentration of more than 106 mg.g\(^{-1}\) indicated that these were deposited preferentially, probably due to their higher concentration in the effluent. Exception for degradation ratio, alkalinity, calcium and magnesium all other investigated variables were found to have lower values in the sediment collected some 15 Km downstream than the values at first sediment collection site, nearer to the origin point of effluent.

The average values for the BSP effluent sample collected for seven continuous days, at site 2, was found generally not to be much significantly different from the average value of effluent sample, collected at weekly or monthly intervals from both the sampling sites, but had significant differences with the values for tap water which was used as control as well as dilutent to the effluent.

In the soil, sulfate was found to be the only variable which was found to have increased with steel plant effluent irrigation, under plantation with all the eight experimental species, while dilute acid soluble iron either increased or remained unaffected. All the other investigated
parameters of the soil exhibited varied effects, showing either increase with the growth of some sp. or decrease with the growth of some other species. The concentrations of pigments and protein in the leaf exhibited much variable effects showing increase in concentration with four of the investigated species and decrease with other four species. The steel plant effluent irrigation to the plants resulted in increase in ash and iron content in the plant parts of all the species. However, steel plant effluent had generally inhibitory effects on seed germination. Out of eight species investigated the germination percentage, germination value and speed of germination index was prompted in only one of the species while germination relative index was promoted in only two of the species. Fresh weight, dry weight and moisture percentage in seedling was increased in three species with the germination of their seeds in steel plant effluent, but the effluent had inhibitory effects on seed germination of remaining five species. Calcium and magnesium concentration increased in only three and four of the species respectively, while magnesium, phosphate, iron, total nitrogen and crude protein increased in the seedlings of five of the eight species germinated in steel plant effluent.
Raphanus sativus was grown in Kanhar soil with distilled water, tap water and BSP effluent irrigation. Simultaneously R. sativus was grown also in effluent channel sediment with BSP effluent irrigation. The growth of R. sativus was found to have very drastic effects on changing the quality of the sediment. The sediment initially had very high values for conductivity, total salt concentrations, sulfate, total nitrogen, dilute acid soluble iron and ferric iron but their concentration was reduced very significantly, with the growth of R. sativus in this effluent sediment, even with BSP effluent irrigation.

At sampling site 1 which was nearer to the origin of effluent from steel plant area, only Oscillatioria chlorina was found to be occurring while at site 2, about 15 Km downstream to the sampling site 1, several algal species, mostly organic pollution tolerant ones, were observed, indicating increase in organic matter with the flow of effluent along the channel.

The steel plant effluent thus shows quality indicating its acceptability for irrigation with respect to most of the parameters investigated. However, with respect to some of the qualities it can not be recommended for its use, as such for irrigation. The effects of this effluent on
soil, on plant parts, on seed germination and seedling characteristics appear to be far less effective as compared to almost any other industrial effluent investigated for such effects. The effects of steel plant effluent presently observed on soil and plants, were due to pure or raw effluent and thus it suggests that with a very slight advancement in treating this effluent, can make it suitable for irrigation. Thus at a very cheaper cost the integrated steel plant effluent can be utilized for irrigation which will also augment some nutrients.