Introduction

The study area (Figs 1 1 and 1 2, Encl 1) is a part of the Calcutta Metropolitan District and lies on both sides of the Hugli River, in and around Calcutta and Howrah Municipal Corporations. The area, bounded by latitudes 22°26'54" - 22°39'6" and longitudes 88°15'35" - 88°26'55", being the centre of trade, commerce and industry is poised for growth and expansion with rising tempo of industrial and related activities. With these activities, significant growth of population is also expected.

With the expansion of urban complexes, industrial development, and increase in population, the total demand for water will increase manifold. Currently, water supply is being met from two sources - groundwater and surface water. The total water requirement of Calcutta Municipal Corporation (CMC) area (187 sq km) is 1165 million litres per day (mld) out of which 277 mld is met from groundwater resource while on the western bank of the Hugli, in Howrah Municipal Corporation (HMC) area (62 sq km), about 18 mld of water is being extracted from the groundwater reservoir. Due to excessive withdrawal of groundwater, there has been tremendous stress on the groundwater resource.

In the coming decades, both population and developmental activities are expected to increase and the demand of water would also concomitantly increase. Thus, more intensive groundwater exploitation to meet the additional demand will be inevitable. This would perhaps lead to additional stress on the sub-surface reservoir of groundwater which may cause adverse impact on the economics of water supply. This, in turn, may also pose a problem of land subsidence which is likely to affect various structures built in the area. Apart from these problems, excess withdrawal of groundwater may lead to depreciation of groundwater quality. These problems thus call for an in-depth study and careful management of the groundwater resource for the long-term interest of these two municipal
corporation areas. This doctoral research was, therefore, taken up with the following specific objectives.

**OBJECTIVES**

(a) To understand the nature of geological control and mode of occurrence of groundwater in and around CMC and HMC of the Calcutta Metropolitan Area

(b) To determine the behaviour and status of the piezometric surface in this area

(c) To assess critically the potentiality (both quantity and quality) of groundwater of the area

(d) To decipher the groundwater flow pattern in the aquifer under CMC and HMC areas

(e) To develop a computerised database for groundwater of the area, to determine quantitatively the input and output parameters of the groundwater and to estimate the groundwater balance of the area over the last 5-10 years

(f) To evolve a realistic water management policy based on conjunctive use of surface water and groundwater

**PLAN OF WORK**

The work was divided into four stages as follows

(I). Geology of the Area

(a) Study of the subsurface geological features of the Calcutta and Howrah Municipal Corporation areas from deep boreholes

(b) Study of the borehole logs to reconstruct the lithology of the area as obtained from tubewells drilled in different parts of the study area

(c) Construction of representative subsurface geological profiles of the area and identify the water bearing strata
(II) Population and Demand/Supply of Water

(a) To determine the present demand of water in the two municipal corporation areas on the basis of 1991 population and to estimate the present supply on the basis of optimum use of the existing tubewells

(b) To formulate a development plan for optimum use of both groundwater and surface water for a period extending to 2021 A.D.

(III). Hydrological study

(a) Observation of the piezometric level in tubewells from direct measurements twice a year i.e. pre-monsoon and post-monsoon periods

(b) Preparation of maps showing depth to piezometric surface, contours of the piezometric surface for both pre and post-monsoon periods and also fluctuation between the two periods to ascertain the nature of the aquifers.

(c) Collection of aquifer performance test data generated by different agencies for interpretation of the cardinal aquifer parameters

(d) Collection of aquifer material for determining grain size distribution and aquifer parameters

(e) Ascertain as far as practicable, the decline/recession of the piezometric surface over the period 1956 - 1993/94. This would indicate the effect of withdrawal of groundwater by pumping over the time span considered

(f) Study the effects of lowering the piezometric level on the general environment of the area, in particular, and its effect on land subsidence and related phenomenon in general

(g) Evaluate the hydrochemistry of the area through chemical analysis of the major cations and anions of the groundwater. The effect of excess withdrawal on the pollution of groundwater will also be studied

(h) Study the bacteriological contamination of the groundwater from natural and anthropogenic sources
(i) Explore the possibilities for increasing groundwater reserve through artificial recharge

(IV) Modeling of Groundwater Flow

To formulate a mathematical model of groundwater flow in the area by determining the distribution pattern of fluid potentials and to draw a comprehensive management plan of groundwater development in Calcutta and Howrah Municipal Corporation areas.