CHAPTER 2

REVIEW OF LITERATURE

2.1 GENERAL

Review of literature is the first step in understanding and evaluating the gaps areas of research and development. Besides, it will also help in gathering information and to identify the current status of the problem to deal with. Review of literature is one of the important phases in any research work. Reviewing literatures would improve the knowledge in the particular topic of interest besides improving the skill in framing the methodology for the particular study. The various literatures related to groundwater modelling were collected and reviewed to frame the methodology that would best suit this particular study. Various research papers which deal with the Visual Modflow groundwater modeling software were also collected and reviewed.

Eagleson (1970), Legget (1962) and Scheidegger (1970) described a catchment in terms of size, topography, geology, vegetation cover and surface drainage pattern. The basis for the description can be geological viewpoint; information useful to the river engineer can be obtained from textbooks such as that written by Legget (1962).
2.2 SURFACE WATER MODELLING

Jenicek (2007) had focused on using different methods for runoff computation in different land use areas, with the help of deterministic lumped model HEC-HMS. As the main modelling technique the SCS-CN method was applied. The runoff hydrograph are generated for the study, the Evapo-transpiration loss is also considered in the runoff hydrograph. The author had observed that application of SCS-CN method in HEC-HMS appears to be a suitable model for this kind of studies based on land use pattern and for estimating the flood discharges.

Kafle et al (2006) had presented the results of a basin scale rainfall-runoff modelling on Bagmati basin in Nepal using the hydrologic model HEC-HMS in GIS environment. The model developed is a combination with the GIS extension HEC-GEOHMS, and used to convert the precipitation excess to overland flow and channel runoff. The Curve numbers are assigned based on the soil type and land use. The peak flow of the derived hydrograph was used as an input in hydraulic model to derive flood maps showing inundation area extent and flood depths.

Waichler (2005) measured and analyzed the ephemeral stream flows at upstream and downstream. In this paper, they have developed three models namely double triangle hydrograph, composite hydrograph and channel infiltration model. The composite hydrograph model is stated to be more preferable to the double triangle hydrograph model for quantifying base flow. They concluded that the cold and drier regions produce runoff much less frequently and has greater channel infiltration capacity.

Goswami (2000) studied five Rainfall Runoff models for continuous River flow simulation. The five rainfall runoff models which are used in this paper are simple linear model, seasonally based linear perturbation model,
wetness index based linearly varying gain factor model, artificial neural network model and conceptual soil moisture accounting and routing model. The authors used the Galway real-time river flow forecasting system software package to produce all the numerical results. They concluded that simpler models for continuous River flow simulation can surpass their complex counterparts in performance.

Ravines (2004) presented an analysis of runoff and rainfall data based on dynamic models. The effect of rainfall on runoff is modeled through a transfer function; where as the amount of rainfall is obtained after fitting a spatio-temporal model and dealing with the change of support problem. Besides, the conceptual effort to implement the proposed models some methodologies are also implemented by the authors. Model assessments, spatial interpolation and temporal predictions were part of their analysis. The results show that their approach is a promising tool for rainfall-runoff analysis.

Sarangi (2007) dealt with the predictability of unit hydrograph models that are based on the concepts of land morphology and isochrones to generate direct runoff hydrograph. The models which were used by them are Exponential Distributed Geomorphologic Instantaneous Unit Hydrograph (ED-GIUH), GIUH based Clark model and Spatially Distributed Unit Hydrograph (SDUH). Five distinct rainfall events are used to evaluate the three models. These three models are evaluated based on morphology, flow path probability and travel time responses over land surfaces and through channels. In this study, ArcGIS is used to estimate the watershed morphological parameters.

Kalin (2004) identified the sediment source areas using optimization methods for two watersheds. The question of non-uniqueness is addressed
first by them. KINEROS model is used. Assumption made in this study is that the flow is Hortonian. Sedimentographs are generated using 13 rainfall events. The generated sedimentographs and unit sedimentograph resulting from rainfall event were taken as the inputs to the optimization model. Outcomes of the model revealed that sediment source areas could be reasonably identified as long as the number of sediment generating area is less than eight. When the number of sources exceeds eight, the uncertainty of source identification increased due to the non-uniqueness problem.

Fu (2007) developed and implemented a methodology to estimate the impacts of global climate change on hydrological regimes using ArcGIS Geostatistical Analyst. The methodology was applied to the Spokane River Watershed. From the results, they indicated that a 30% precipitation increase causes a 50% increase of stream flow when the temperature is normal. When the temperature is 1.5% higher than normal, then they indicated that only a 20-30% increase in stream flow. The results obtained by them can be used as reference conditions for long-term water management strategies under global warming scenarios.

Hea, Thomas E. Croley (2005) analyzed the application of a spatially distributed large basin runoff model. They discussed about the four essential components of operational hydrologic model development such as model structure, model input, model calibration and GIS model interface. The results obtained by them indicated that large scale operational hydrologic models that are based on mass continuity equations and include land surface, soil zones and groundwater components require fewer parameters and are less data demanding.

Angelica and Gutiérrez-Magness (2005) dealt with an Automatic calibration of complex models, which includes continuous hydrograph
models, requires sophisticated calibration methods. The authors also dealt with this model-independent-parameter estimator which requires complex objective functions to ensure that the final parameter values reflect the hydrologic flow components surface runoff, interflow and baseflow that the models are designed to represent. They also showed that a multicomponent objective function should include components to represent each of the important physical processes represented in the model. The goal of the investigation was to develop a weighted multicomponent objective function and a method that can be used to provide estimates of the weights. For best calibration accuracy, the weights of the objective function should reflect the flow proportions of the streamflow record.

Mullem (1991) used the Green-Ampt infiltration model to predict runoff from 12 rangeland and cropland watersheds in Montana and Wyoming. Soil parameters derived from standard USDA soil surveys are used, and 99 rainfall events are modeled. The runoff distributions obtained from the model are then used with a hydrograph model to predict the peak discharge from the watershed. Procedures are applied that adjusted the Green-Ampt infiltration parameters for various cover and condition classes. The runoff volumes and peak discharges are compared with the measured values and with those predicted by the Soil Conservation Service (SCS) curve-number procedure. By using this model they have predicted both the runoff volume and peak discharge better than the curve-number model.

McCuen (2006) used the Nash–Sutcliffe efficiency index ($E_f$) which is a widely used and potentially reliable statistic for assessing the goodness of fit of hydrologic models. The factors that contribute to poor sample values are not well understood by the authors. Their research focused on the interpretation of sample values of $E_f$. The objectives were to present an approximation of the sampling distribution of the index; provide a method for
conducting hypothesis tests and computing confidence intervals for sample values; and identify the effects of factors that influence sample values of $Ef$. They have concluded that the Nash–Sutcliffe index can be a reliable goodness of-fit statistic if it is properly interpreted.

Uhlenbrook (1999) investigated the uncertainties arising from the problem of identifying a representative model structure and model parameters in a conceptual rainfall-runoff model. In this paper a conceptual model, the HBV model, was applied to the mountainous basin. In a first step, a Monte Carlo procedure with randomly generated parameter sets was used for calibration. For a ten-year calibration period, different parameter sets resulted in an equally good correspondence between observed and simulated runoff. A few parameters were well defined (i.e. best parameter values were within small ranges), but for most parameters good simulations were found with values varying over wide ranges. In a second step, model variants with different numbers of elevation and landuse zones and various runoff generation conceptualizations were tested. They found that in some cases, representation of more spatial variability gave better simulations in terms of discharge. However, good results could be obtained with different and even unrealistic concepts. The computation of design floods and low flow predictions illustrated that the parameter uncertainty and the uncertainty of identifying a unique best model variant have implications for model predictions.

Demmak (1984) analyzed a large amount of data on suspended solids transport in Algerian rivers. In this paper the author enabled a general study of erosion, sediment transport and silting of dams. The object of his study is to improve the understanding of erosion and sediment transport phenomena in a Mediterranean semi-arid climate, and to develop simple and practical methods
for the data analysis necessary for planning, construction and management of water resources. This case study demonstrated the need to approach the problem at the level of individual flood events; to study the variables of suspended solids concentration and stream flow separately; and to relate a map of erosion forms and geomorphological factors to the hydrological analysis. The study also showed that a correlation exists between lithology and erosion forms, an average suspended solids content can be related to individual erosion forms, sediment transport primarily takes place in spring during floods which originate from the whole, saturated, basin; the contribution from autumnal localized storm floods.

2.3 GROUNDWATER MODELLING

Groundwater model is the simplified version of the real system that approximately simulates the input/output stresses and the response relation of the system. Groundwater models make use of mathematical and digital tools for analyzing and predicting the behavior of aquifer system on local regional scale, under varying geological environment. Basic differential equations that govern the flow of groundwater and solute transport through saturated and unsaturated porous medium are solved through the models.

Haitjema (1992) describes about the regional groundwater flow in fulton country using analytical method. The model shows that regional flow direction were in north east regardless of any uncertainties in hydro geological parameter. It shows that the aquifer underneath the fulton country appeared to be well connected with each other.

Kumar (2003) explains about how to identify the groundwater retrieval and storage sites in the study area. This helped in understanding the behavior
of unconfined aquifer system with various varying parameters. Aquifer system in hard rock area consists of weathered and fractured system which has been taken for the study excluding the top layer. The outcome of model helped in identifying suitable area for groundwater augmentation in long term and optimization of rates of new wells has been attempted. The model has been simulated up to the level to the near real field condition.

Balasubramanian (2000) describes the groundwater models as mathematical and digital tool for analyzing and predicting the aquifer system on local and regional scale. His paper contains the description and steps involved in modelling and explain about the different types of model used in groundwater modelling. The author explains the data requirements of groundwater modelling such as information pertaining to physical units, model domain, aquifer parameters, time varying inputs and boundary conditions.

Senthilkumar (2000) explains that the numerical simulation of groundwater flow is an effective management tool to assess the components of the hydrological processes, understand the hydrodynamics of a basin and provide a mechanistic description of the flow of water in an aquifer. In this paper, simulation study has been carried over in the lower Palar river basin. The Palar river flows only for a few days in a year and groundwater has been extensively used to meet the increasing demand for domestic, irrigation and industrial requirement. It includes the extraction of water for Chennai atomic power station. The finite difference computer code MODFLOW with groundwater modelling system as pre and post processor was used to simulate the groundwater flow in this study to understand the aquifer system.

Bharathi (2004) simulated groundwater flow for Nandanam area in Chennai using Visual MODFLOW. Two layers were modelled, the first layer
is unconfined aquifer followed by an impervious clay layer. The volumetric budget for the model was checked and the changes in storage of groundwater system were assessed. The calibrated model was used in determining the quality of recharge and the optimal location for the recharge sites to improve the groundwater storage. The aquifer characteristics were obtained from the MODFLOW output.

Hassan (2004) reviewed the model validation studies that pertain to the groundwater flow and transport modelling. In his paper he emphasizes that the groundwater model validation strategy should consider the important factors such as certainty, diversity of data and evaluation test. He concluded that model validation is a process, not an end result by itself. It cannot ensure the acceptable model. It provides an important safe ground against faulty models or inadequately tested models.

Lowry et al (2006) describe the assessment of Aquifer Storage Recovery (ASR) using groundwater flow models. Three, representative groundwater flow models have been created to assess the impacts of hydrogeologic and operational parameters on recovery efficiency of ASR systems. Hydraulic factors can be classified into physical factors and operational factors. Physical factors are a function of the groundwater flow system and cannot be changed by the operators these factors include hydraulic gradient, effective porosity, storage coefficient, dispersivity etc. Operational parameters include storage period, volume of injected water and injection/recovery rates which can be changed at the well head. Flow tracking and solute transport models had been used for tracking the movement of water during injection, storage and recovery. In using particle tracking model higher recovery efficiency had occurred because mixing of injected water and native water had been neglected.
Vijayalakshmi (2007) has made an attempt to characterize the aquifer system across the river Adyar, Chennai and determine the optimum levels of utilization of groundwater for sustainable yield. In this study, model has been simulated for hard rock, river alluvium and flood plains.

2.4 SURFACE – GROUNDWATER INTERACTION

Hemker (2004) explains that Duflow is a computer program for one-dimensional hydraulic modelling of surface water. MicroFem is a finite-element model that simulates saturated groundwater flow in multiple-aquifer systems. To demonstrate its use, a regional coupled model is built of a water-supply well field with induced surface-water infiltration. Compared to individual surface-water and ground-water flow models, coupled models have a surplus value in all situations where the flow systems have a significant mutual interaction.

Ivkovic (2009) states that the interconnections between groundwater and river systems remain poorly understood in many catchments throughout the world and yet they are fundamental in effectively managing the quantity and quality of water resources. Many of the techniques traditionally employed by hydro-geologists rely on characterizing the groundwater flow systems, topography, geology/aquifer systems, climate and/or the rainfall-runoff processes within a river basin. However, in many instances the findings are descriptive and the results are difficult to up-scale to the larger sub-catchment/catchment scale at which water is managed and allocated. An alternative approach is to collate a range of hydrometric data, that for many catchments may already be available, and to then analyse the data patterns and infer processes from the data without being overly concerned about the details of the physical processes driving the system taking a top-down approach. Catchments in Australia were characterized according to three levels of
information; namely:

1. presence of aquifer-river hydraulic connection
2. dominant direction of flux; and
3. the potential for groundwater extraction and its impact on river flows.

The methods used to characterize the river reaches included an analysis of

1. groundwater and river channel base elevations using a GIS/database
2. steam hydrograph data
3. flow duration data
4. vertical aquifer connectivity at nested piezomer sites; and
5. paired river and groundwater hydrographs.

The data patterns seen in the stream gauging station derived data for gaining, losing and variably gaining-losing river reaches were described together with general processes that operate in these systems. The potential for groundwater extraction to impact on river flows was also assessed and found to be a significant issue for the connected aquifer-river systems.

Chen et al (2009) said that land use changes have significant impacts on hydrologic processes at the watershed level. This paper combines an empirical land use change model and an event-scale, rainfall-runoff model to quantify the impacts of potential land use changes on the storm-runoff generation in the Xitiaoxi basin upstream of Taihu Lake watershed. The HEC-HMS rainfall-runoff model is calibrated and validated for 7 storm events in the study area and the results show good correlation between the simulated
and measured hydrographs at the outlet of the basin with Nash-Sutcliff efficiency ranging from 75% to 95%. Finally, the calibrated HEC-HMS model is applied for these future land use scenarios under designed storms with different recurrence intervals to assess the potential land use impacts on the storm-runoff generation. The results indicate that the future land use scenarios are projected to increase the total runoff as well as the peak discharge and that the magnitude of increment relates to the expansion rate of built-up area. It can be that the sensitivity of hydrologic response to the land use change tends to increase as the recurrence interval of rainfall events decreases. Additionally, remarkable spatial variations of the land use changes and its impacts can be observed at the sub-basin level and the most sensitive sub-basin is close-by the city. The results of this paper can provide useful support for land use planning and management and the methods applied here have proved a useful tool for land use impact studies.

Hea and Thomas E. Croley (2005) analyses the application of a spatially Distributed Large Basin Runoff Model (DLRBM) in the Great Lakes Basin of the United States and Canada and discusses four essential components of operational hydrologic model development viz., model structure, model input, model calibration and Geographical Information System (GIS)-model interface. The results indicate that large scale operational hydrologic models that are based on mass continuity equations and include land surface, soil zones and groundwater components acquire fewer parameters, are less data demanding and are particularly suitable for solving water resources problems over large spatial.

Chen et al (2009) A four layer groundwater model that included unsaturated zone was developed for the West Virginia Ordnance Works (WVOW) to predict the migration of TNT (2,4,6- trinitrotoluene) and DNT (2,4- and 2,6- dinitrotoluene) over time and space. The inflow and outflow of
the ponds, rainfall, evaporation and seepage to or recharge from groundwater were accounted for in the water balance. The stage changes over time were predicted for each pond to evaluate the impact of existing and potential pumping wells in close proximity in groundwater.

2.5 SURFACE - GROUNDWATER STATUS OF STUDY AREA

Tamil Nadu forms part of the peninsular shield and 73% of the total area of the state is underlined by unclassified crystalline rocks of Archaen age. The sedimentary belt forms 27% of the total area, which occurs all along the coast flanking the main crystalline mass on the West. The sedimentary formations are suitable for large scale development of ground water. But its proximity to seacoast creates problems like sea water intrusion. The occurrences of ground water in the crystalline formations which occupy major part of the area are sporadic and limited. The ground water movement in hard rocks is restricted to the top weathered and jointed zones, the thickness of which may vary, both in space and depth due to heterogeneity in characteristics.

UDNP/CMWSSB Studies (1965-69, 1975-78, 1982-91) This series of studies was the first to identify the Araniar-Kosathalaiyar (A-K) basin as a source of groundwater supply. The initial study of the groundwater resources of the area was carried out and reported between 1965 and 1973. There then followed a second round studying water supply and sewage disposal and included the artificial recharge potential of the area. The third part looked at water resource development and management. Phase I of this project started in June 1982 and was completed in August 1985. During this period Satellite Image Analysis, Hydrology, Hydrogeology, Recharge studies, Sea Water Intrusion, Artificial Recharge, Socio Economic studies and Water Quality studies were undertaken. The important findings of this study are:

1. In the A-K basin the alluvial deposits cover an area of 1000
km². The thickest part of the aquifer (35m) occurs along the course of a buried channel. The approximate area of the buried channel is 290 km².

2. The aquifer is generally unconfined in the West and confined by overlying clays in the East, towards the coast.

3. The general direction of groundwater movement is eastward towards the coast. However, due to the over exploitation near the coast, the gradient is reversed. The seasonal water level fluctuation of the whole basin during the study duration of (1982 to 1985) is about 2 to 4.5m

4. Transmissivities derived from pumping tests in the study area range from 140m²/day to 6536m²/day and from 1400m²/day to 5980m²/day in the production wells in all six well field areas

5. The average annual groundwater recharge during a normal monsoon period in the A-K basin is about 450Mm³. The average pumping from this basin for domestic and irrigation purposes is about 350Mm³. During below average rainfall periods, due to the poor storage of surface water runoff and reduced natural recharge, the additional extraction was met from groundwater storage is done.

Phase II of the study was carried out between 1986 and 1991. Mathematical modelling was repeated using the data available during this period. This time a Finite Difference model based on the TALISMAN program was used. This model covers the Kosasthalaiyar basin, with an area of 1130km². On this basis it was calculated that the average abstraction by farmers in the period 1978 – 1989 was 400 Mm³/year and the reliable yield of all six of the Chennai Metropolitan Water Supply and Sewerage Board
(CMWSSB) well fields is likely to be between 10.95 Mm³/year (30Mld) and 25.5 Mm³/year (70Mld).

Chennai district is part of a coastal plain with a gentle slope towards the east and the elevation of the ground varies from mean sea level to 10m above mean sea level. Adyar, Coovum and Otteri Nullah drain this district. The average annual flow in the Adyar is 89.43 Mm³ and in the Coovum is 40.2 Mm³. River Coovum is highly polluted with sewerage disposal from Chennai city. The annual rainfall is 1285mm and the North East contributes about 60% of the total rainfall.

The occurrence of groundwater is limited to thin granular zones in the alluvium and in the weathered and jointed/fractured crystalline rocks. The Gondwana sandstones and shields are compact and fractured and in places contain an appreciable quantity of water.

The dynamic groundwater resources of the district, 170km² area, is of the order of 55.34Mm³/year and almost 82% of the dynamic resources are developed by a number of abstraction structures such as domestic wells. The decline in water table is reported in some areas, which could be an indication of landuse change, the fluctuation is increasing with time and the static water level recovers more or less after rain.

A combined surface and groundwater model was developed to simulate the conjunctive use of the city’s reservoirs and well fields.

Surface water supply for Chennai is obtained from the Kosathalaiyar river and its upstream tributaries. Recently, water has also been diverted to the Kosathalaiyar river from a temporary weir on the Arani river, which flows to the north of the Kosathalaiyar. In most years the rivers flow only during the period of the North-East monsoon. During the rest of the year water is drawn
from storage and/or groundwater.

Flow from the upstream tributaries of the Kosathalaiyar river is collected in Poondi reservoir. Below Poondi, flow in the, main Kosathalaiyar river is diverted at Thamaraipakkam into a canal leading to Cholavaram and Red Hills reservoirs. These reservoirs also have their own direct catchments. Due to the flat terrain, all three reservoirs are shallow and are, in fact, large tanks formed by long earth embankments.

The Arani-Kosathalaiyar aquifer comprises an old buried river channel of the river Palar, which now flows along the south of the city of Chennai. The aquifer extends from the vicinity of Poondi reservoir to the coast to the north of Chennai, and covers an area of about 750km², which includes the course of the Kosathalaiyar river and the lower reaches of the Arani river. Water is pumped from the aquifer both by farmers and the municipality. In its lower part, roughly down stream of Thamaraipakkam, the aquifer comprises two layers, the lower layer being confined. The alluvium is underlain by an impervious basement of hard Gondwana rocks.

The high rate of pumping from the aquifer has resulted in piezometric levels at the seaward end falling below sea level, resulting in sea water intrusion in the aquifer.

Average recharge is estimated to be roughly equal to abstraction, but varying between 170Mm³ per year in a dry year to 450 Mm³ per year in a year of high rainfall. Recharge appears to take place mainly from the bed of the rivers during the period of river flow.

The greatest average annual draw-off is about 250 Mld. In contrast to this, the estimated unrestricted demand for water in the city is about 1100Mld. In view of the magnitude of the deficit, it would not be practical to restrict
draw-off to the reliable yield, if a greater quantity could apparently be taken. The combined model was thus used to estimate the frequency and severity of restrictions that could be expected when the “normal” draw-off exceeds the reliable yield.

Apart from the yield and water management studies described in the paper, other aspects covered by the program including the development of a finite difference groundwater model to provide data for the combined surface/groundwater simulation model and to study measures proposed for reducing saline intrusion, the planning of a series of check-dams on the Kosathalaiyar river to increase groundwater recharge, proposals for re-use of sewage effluents to provide non-potable supplies to industries and advice on pump maintenance procedures.

2.6 CHENNAI GROUNDWATER BASIN

The ground water component of the project aims to provide a general hydrogeological characterization of the region and to examine the relationship between surface and ground water, particularly with respect to Madras City and Metropolitan Area. Groundwater protection will also be considered so that supplies to the City and its environs may be maintained and improved. It is worthy of mention that there is no groundwater related engineering measures proposed for reducing the volume and concentration of storm runoff. However, a wholesome understanding of the hydrology/hydrogeology of the system may allow development of better conservation and protection measures of the available groundwater resource, which is currently under stress in much of the region.

The area of interest from the point of view of the groundwater component, includes Madras city itself, with the surrounding Metropolitan Area, the catchment of the rivers converging on the city namely the Adayar, the Coovum and the Korattalayar, and the adjacent groundwater basins, one
major (the Arani Korattalayar or the AK Basin) and some minor such as those along the coastal sand ridge south of Madras. In total these cover about 6500 km$^2$.

The hydrological and consequently the hydrogeological conditions in the area (particularly its urban parts) are expected to undergo some changes in the near future. Planned improvements in domestic and industrial water supplies include the import of a large quantity of surface water from Srisailam Reservoir on the Krishna River system (some 500 km away) in Andhra Pradesh. This is discussed by Engineering Science and Technical Consultants 1978 and by Tata Consulting Engineers and Binnie Partners 1991. This will affect the operation of the surface water sources currently used for Madras water supply and may reduce groundwater abstractions in the city and the surrounding Metropolitan area.

Recharge conditions in the whole area are generally advantageous. The rainfall is relatively high and strongly seasonal, normally exceeding potential evaporation over several months. The land is mainly flat with poorly developed surface drainage; soils are often light with a high potential infiltration intake and the rivers and the reservoirs can be expected to have high losses, though the farmers carry flow only for limited periods at best. Relatively high recharge confirmed by large seasonal water table fluctuations, is often in the range of 2 to 5m. From experience elsewhere, natural recharge to the alluvial aquifers would be expected to be about 25 to 30% of average rainfall. This compares well with the UN project computation of annual recharge to the AK basin of 170 Mm$^3$ during a wet year.

Groundwater quality is variable. In the inland basins it is mainly good, with overall mineralization of less than 1000 mg/l (in the deeper, high permeability layers often less than 500 mg/l). Nevertheless there are potential quality problems in several areas:
- Sea water intrusion of the coastal aquifers and part of the Arani Kosathalayar Basin;
- Increasing salinity of some aquifers through groundwater recirculation by irrigation;
- Severe pollution of the aquifers underlying urban and industrial areas, particularly Madras City itself;
- Long term pollution of potable supply well fields by agricultural chemicals; with relatively thin phreatic aquifers and extensive use of chemical fertilizers and insecticides, some index compounds, such as nitrate and lindane, should be monitored in wells used to provide drinking water.

2.7 PRESENT DEVELOPMENT

Mott Macdonald (1994) states that groundwater is extensively used in the Chennai Metropolitan region for irrigation, domestic supplies and industrial purpose. Both the private and public sectors are involved. Much of the region is underlain by strata of limited transmissivity, either because the nature of the rock or because of limited saturated thickness of beds of relatively high permeability. However, as mentioned before recharge conditions in much of the region are advantageous with relatively high rainfall, flat ground slopes, and many soils with high infiltration intakes and rivers with sandy beds, underlain and bordered by shallow phreatic aquifers. Thus groundwater is available for domestic, irrigation and industrial supplies, except where affected by sea water invasion and/or urban and industrial pollution.

The ground water resource of the area is extracted by development of small discharge wells or a network of small discharge wells for higher abstraction rates. The first approach has been adopted by private sector and
second approach by the public sector.

The largest user of groundwater in the region is agriculture. There are thousands of private irrigation wells in practically all the geological formations. Farmers have been very adept at developing technologies appropriate to particular condition.

2.8 SUMMARY

From the review of literature, it was observed that application of SCS-CN method in HEC-HMS based on land use pattern and for estimating the flood discharges is a suitable model for river flows. Further, the hydrologic model HEC-HMS in GIS environment, in combination with the GIS extension HEC-GEOHMS was selected for estimation of peak flow from the hydrograph that will be derived as an output. For determining the recharge and the optimal location for the recharge sites to improve the groundwater storage, the aquifer characteristics were obtained using the MODFLOW groundwater model. To evaluate the interconnections between groundwater and river systems in the catchment area, a range of hydrometric data was used to infer the conjunctive mechanism.