STATUS OF RURAL DRINKING WATER AND SANITATION STATUS IN DISTRICTS OF HARYANA: A CASE STUDY

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CANDIDATE'S DECLARATION

I **SHWETA SINGH**, Roll No. **2K16/ENE/17** student of M. Tech, Environmental Engineering, hereby declare that the project Dissertation title "**Status of Rural Drinking Water and Sanitation Status in Districts of Haryana: A Case Study**" which is submitted by me to the Department of Environmental Engineering, Delhi Technological University, Delhi in partial fulfilment of the requirement for the award of the degree of Master of Technology, is original and not copied from any source without proper citation. This work has not previously formed the basis for the award of any Degree, Diploma Associateship, Fellowship or other similar title or recognition.

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CERTIFICATE

I hereby certify that the Project Dissertation titled "**Status of Rural Drinking Water and Sanitation Status in Districts of Haryana: A Case Study**" which is submitted by [Shweta Singh], Roll No. 2K16/ENE/17, [Environmental Engineering Department], Delhi Technological University, Delhi in partial fulfillment of the requirement for the award of the degree of Master of Technology, is a record of the project work carried out by the students under my supervision. To the best of my knowledge this work has not been submitted in part or full for any Degree or Diploma to this University or elsewhere.

Place: Delhi **(PROF. S K SINGH)**

Date: **SUPERVISOR**

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ABSTRACT

Water is essential for living and is used for drinking, irrigation and other purposes. Water is a compound of two chemicals and may occur in a liquid form or in a solid form or in a gaseous form. The presence of various contaminants found at the drinking water source in rural area of India is of major concern due to toxicity present in many life forms. Groundwater is the major water source for drinking purpose in India and this source is only 0.61% of the total available water on the Earth. It is found by report that only 4% of world's freshwater resources are available in India while India consists 14% of total world's population. This data shows scarcity for water in India. Article 47 of Indian Constitution includes the presence of providing the potable drinking water to the residents with the State Governments.

The technology used for the water supply for rural sector and sanitation is always affected by the economical, geological characteristics of the concerned area. The first application of technology fpr water supply and sanitation will be to reduce the infectious diseases which is very harmful. Mostly the pathogens presence in water would be associated with the suspended particles. The sanitation system can be combined with the system of water supply. After the progressive development of services in supply of water and sanitation, the important issue is the sustainability of sanitation services and water supply services in order to encourage the interest to pay of communities.

The rural water supply in India is generally based on the easily available water sources like wells and ponds. These sources of water have different water characteristics with respect to the contamination in the water. The surface sources of water may have high contamination as compare to the water sources from deep well. In general, there are no arrangements for the treatment of water in most of the village in Haryana state. Some villages situated near the Rajasthan border having more critical situation of availability of pure drinking water. It is also very difficult for the villagers to have the potable drinking water purifier to treat their water. ponds in the villages are being polluted continuously by the villager's activity of washing clothes, bathing of animals and self etc. The same sources of water considered as to recharge of adjacent deep wells.

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CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

Water is a compound of two chemicals and may occur in a liquid form or in a solid form or in a gaseous form. WHO refers to “control of water Supplies to ensure that they are pure and wholesome as one of the primary objectives of rural water supply and sanitation.”

The presence of various contaminants found at the drinking water source in rural area of India is of major concern due to toxicity present in many life forms. Groundwater is the major water source for drinking purpose in India and this source is only 0.61% of the total available water on the Earth. It is found by report that only 4% of world’s freshwater resources are available in India while India consists 14% of total world’s population. This data shows scarcity for water in India. Article 47 of Indian Constitution includes the presence of providing the potable drinking water to the residents with the State Governments. The water availability in India is almost fixed due to limited resources available. Accordingly, the estimate of 65% of rural population and 86% of urban population permitted to safe potable drinking water.

The technology used for the water supply for rural sector and sanitation is always affected by the economical, geological characteristics of the concerned area. The first application of technology fpr water supply and sanitation will be to reduce the infectious diseases which is very harmful. Mostly the pathogens presence in water would be associated with the suspended particles. The sanitation system can be combined with the system of water supply. After the progressive development of services in supply of water and sanitation, the important issue is the sustainability of sanitation services and water supply services in order to encourage the interest to pay of communities.

The elaborative plan with the cooperation of hospitals, public health centers and schools are very necessary in order to let residents understand the importance of water. Such system, invites residents to encourage in many stages of designing, planning and constructing.

1.2 FINANCING OF SCHEMES OF WATER SUPPLY AND THEIR DEVELOPMENT IN INDIA

The aim of any water supply undertaking should be to provide safe and adequate supplies of potable water at the lowest possible cost. This demands the knowledge of the works of water planning, design, construction and administration, a sound undertaking of the elements of financial policy, viz.,

I. The equitable spreading of the cost of the water supply by means of appropriate scales of charges and a potable water rate; and
II. The economic aspects of development and execution of the schemes, the method of providing the capital needed to finance such schemes and the manner of providing for the repayment of such capital.

Apart from the above, financing in the water supply sector requires consideration of expanding requirements of this natural resource due to increase in population, changes in living habits and also increasing requirements due to technological advancements in agriculture, industry, etc.

1.2.1 Scope

The salient features of water supply financing are:

- Methods of raising capital for the installation of the system and provision for repayment of loans where needed;
- Methods of raising revenue to meet the annual expenses of water supply including the determinations of tariffs as well as the collection or recovery of charges;\
- The application of revenue derived from water charges;
- The formation and use of reverse and contingency funds;
- Accounting in connections with income and expenditure;
- Wages, store and cost accounting;
- Financial organization and control such as ordering of goods, authorization of payments, internal audit, budgeting, insurance etc.

1.2.2. Capital and Revenue

The transactions of any water undertaking fall into two broad classes as under*:*

(a) Capital

Capital from an economical and engineering point of view means the amount invested by an agency from the beginning to the time the works are placed in operation. It includes:

(i) The purchase of property and rights of way;

(ii) Payments for the structures equipment and the engineering services.

(b) Revenue

Revenue denotes income sources such as from water charges and government grants. The revenue account is the summary of the expenditure and income of the undertaking during a financial year. Revenue expenditure includes the cost of operating and maintaining the undertaking.

1.3 PLANNING AND PREPARING OF WATER SUPPLY PROJECTS

The major objective of any protected system of water supply is to supply clean and safe water in adequate quantity, as economically as possible. The planning may be required at national level for the country as a whole, or for the state or region or community. Though the responsibility of the various organizations incharge of planning of water supply systems in each of these cases is different, they still have to function within the priorities fixed by the national and state governments, taking into consideration, the areas to be provided with water supply and the most economical way of doing it, keeping in view the overall requirements of the region.

Due to over and continuous exploration of groundwater in rural sector for agriculture as well as drinking purpose, the concentrations of different contaminants are increasing by regular basis. Most of the rural community of the country is being supplied with the untreated ground as well as surface water for drinking. This water is not safe being having physical, biological and chemical contaminations.

1.4 OBJECTIVE OF THE STUDY

This report has to be prepared of outcome of the study of rural water status and sanitation condition of Haryana. The Ministry of Drinking Water and Sanitation (MDWS), Government of India planned the task to conduct a evaluation for different blocks.

The objectives of the study for evaluation are given as below:

- To study the status of the systems of water supply and problems in rural water supply in different villages in Haryana (including the schools and Anganwadis in the GPs).
- To determine the functionality of systems of water supply in selected villages, Anganwadi and schools of Haryana.
- To study water supply status and sanitation condition of different villages as a case study.
- To provide the recommendations for improving the rural water supply status in the study area mentioned in the report.

1.5 ORGANIZATION OF THE DISSERTATION

The dissertation has been organized in 5 chapters. A outline in brief of the chapters presented hereafter:

The chapter 1 presents the introductory part of the dissertation which may be subdivided into introduction, financing of schemes of water supply and their development in India, and planning and preparing of water supply projects. Chapter 2 deals with the literature review, in which the pertinent literature from various sources has been reviewed so as to enable the study to be taken up in right perspective and planned manner. The materials and methods have been described in Chapter 3, which incorporates the actual methodology of the work and data collection. Next to this chapter is Chapter 4 which covers the analysis of data, results and discussion. In this chapter the data analysis has been carried out and the resulta have been discussed critically. The recommendations and conclusions based upon the outcome of the study have been incorporated in Chapter 5.

CHAPTER-2

LITERATURE REVIEW

2.1 GENERAL

The rural water supply in India is generally based on the easily available water sources like wells and ponds. These sources of water have different water characteristics with respect to the contamination in the water. The surface sources of water may have high contamination as compare to the water sources from deep well. In general, there are no arrangements for the treatment of water in most of the village in Haryana state. Some villages situated near the Rajasthan border having more critical situation of availability of pure drinking water. It is also very difficult for the villagers to have the potable drinking water purifier to treat their water. ponds in the villages are being polluted continuously by the villager's activity of washing clothes, bathing of animals and self etc. The same sources of water considered as to recharge of adjacent deep wells.

Rural water coverage as per the Department of Drinking Water Supply (DDWS) stands at 94% of rural habitations in early 2004. This means that India is more than on course to meet the MDG target of 70.5% of habitations 'fully covered' by 2015. Smaller studies have highlighted a large number of non-functional or unusable water sources, primarily a result of falling ground water levels leading to insufficient yield, increasing problems of water quality or poor maintenance leading to defunct infrastructure. There is a difference between the number of habitations considered 'fully covered' and the number with coverage plus use plus sustainability. Huge financial resources have been earmarked for the rural drinking water sector in the Tenth Five-Year Plan even with 94% of habitations considered fully covered. It is hard to understand that if officially 95% of the rural population is fully covered with drinking water, what is the need to allocate massive outlays for the rest of the target population? Effectiveness of government spending in rural drinking water is emerging as a major concern. Despite huge financial allocations committed under the Tenth Plan, it looks unlikely that India will reach the MDG targets for rural water and sanitation. There is still a lack of clarity about whether public monies are being spent in a pro poor and sustainable manner. The increasing financial outlays for the rural water sector in India do not reflect the

true status on the ground. Rural drinking water sector financing in India is already a major political issue and will continue to be so in the years to come.

2.2 DIFFERENT SOURCES OF WATER FOR RURAL AREA

Streams: The districts of Haryana covered under the Sub-regional plan, have no perennial river. The Yamuna flows along eastern boundary. The Markanda stream (ancient name was Aruna) is a seasonal stream like the Ghaggar, it originates from the lower Shivalik hills and enters Haryana near Ambala, hence cannot be used. All the seasonal streams are selectively used for irrigation. However Markanda, swells up during the monsoons. A new canal from Yamuna has been proposed. A Rs.5-crore canal drinking water scheme for Sonipat is among the development projects to begin work soon. Once constructed, this canal will supplement the demands of both drinking and irrigation water. Therefore, at present the water supply has to depend primarily on ground water and canal water. The canal-based water supply schemes are mainly implemented in Rewari district.

Canal water: Over the years, several canals and diversion works (barrages) have been constructed in Yamuna and Ganga basin, to utilize the potential of the region. The earliest canal, dates to 1356 A.D and is still in use. These canal systems have been upgraded and expanded over a period of time and now form a network in NCR. There are a few inter-basin water transfer canals that transfer water from Indus basin to Yamuna basin. These are shown in Figure 8.1. These canals primarily supply water to Haryana, NCT Delhi and some parts of Rajasthan. Estimation of water supplied through the canals flowing through Haryana Sub-Region is given below:

- Major canals and diversion works: The major irrigation works, diversion works and canal systems data has been collected from state irrigation departments of Uttar Pradesh & Haryana.

- Major diversion works and head works in the Haryana Sub-Region

- Major Canal Systems in Haryana

Ground water source: The groundwater is saline throughout the Bhakra canal system in Punjab & Haryana and the lift canal system in south-western Haryana. Water extraction

without proper recharge and leaching of pollutants from pesticides and fertilizers into the aquifers has polluted the groundwater supply. The leachates from agriculture, industrial waste, and the municipal solid waste have also polluted surface as well as groundwater. It is essential to understand that groundwater is not a resource to be utilized without thought. Problems and issues such as water logging, salinity, agricultural toxins, and industrial effluents, all need to be addressed. Water use has to be integrated effectively with water regeneration. Similarly, in some urban cities of Haryana, there is a need to regenerate groundwater aquifers because of the high degree of dependence on them for drinking water. Urban wetlands need to be protected. The effective answer to the freshwater crisis is the integration of conservation and development activities – from water extraction to water management – at the local level; making communities aware and involving them is critical. (**MDWS**).

2.3 THE TECHNOLOGICAL DEVELOPMENT IN THE WATER SUPPLY SECTOR IN RURAL AREA

According to study done in the village of Maharashtra, the rural water supply status was done in follows:

The status of water supply in Maharashtra can be considered as satisfactory in terms of coverage at the habitations and in terms of service at the households. Maharashtra adopted the reform processes ahead of many other states in the country and it has been steadily implementing various steps to improve water and sanitation services in rural areas. However, it can be argued that there is tremendous scope for improvement. According to the guidelines of NRDWP, the role of VWSCs is critical for ensuring effective O&M of water supply schemes. However, the active engagement of only 50% VWSCs in the study area highlights the need for ensuring greater community led processes. Issues with respect to the functioning of VWSCs such as inadequate representation of women members, irregular meetings, lack of capacities to manage water supply schemes efficiently, poor water tariff collection and the direct involvement of GPs role in O&M, calls for proactive steps to increase their effectiveness. Piped water supply schemes are being managed by the GPs to a greater extent. However, out of the 42 PWSS schemes surveyed, 28 PWSS schemes were functioning, 14 were in partial functioning condition and 6 were not-functioning. The reasons for

semifunctional status of PWSS quoted are; no water in the source in summer in five schemes of PWSS, technical defect in four of the scheme, and no supply from joint schemes in another five schemes.

However, none of the schools and Anganwadis surveyed had dedicated hand washing facilities available. In the absence of hand washing facilities, children wash their hands with water kept in bucket/mug, hand pumps or taps of drinking water storage tanks. Also, issues such as lack of round the year water supply, absence of design features for differently-abled students/baby friendly, defunct toilets and poor maintenance require attention. However, there is scope for improvements in the facilities provided in schools and Anganwadis. (**Sakthivel *et al*, 2015**)

Further studies shows that none of the schools and Anganwadis surveyed had dedicated hand washing facilities available. In the absence of hand washing facilities, children wash their hands with water kept in bucket/mug, hand pumps or taps of drinking water storage tanks. Also, issues such as lack of round the year water supply, absence of design features for differently-abled students/baby friendly, defunct toilets and poor maintenance require attention. However, there is scope for improvements in the facilities provided in schools and Anganwadis. It is important to note that even if there is a large financial outlay for urban areas and all of this outlay is matched by actual spending it does not guarantee that those with the worst WATSAN provision will enjoy substantially improved coverage by 2015. Inequity in public spending in towns and cities – and the resultant difference in coverage levels between poor and wealthy areas – will remain a major issue. A break-up of resource outlays for maintenance and new physical infrastructure in different socio-economic parts of urban areas is required for an informed public debate about the equity of public spending. It is also important to look at equity between urban and rural areas, as there is a temptation for large towns and state capitals to corner large spending outlays and public subsidies and transport surface water and/or mine ground water from afar to satisfy their needs, which can be at the expense of the water needs of rural areas and smaller towns. 61 Whether or not India will reach the MDG and the GOI targets for water and sanitation again depends on the criteria by which coverage is measured. For instance: can basic sanitation be ensured in urban areas (especially high density slums) without the basic sewerage infrastructure in place? Can

safe, sustainable water be provided to urban areas that do not have adequate sanitation facilities? If we conclude that the answer to such questions is essentially 'yes' then it may look like India is broadly on target to meet the water and sanitation MDGs. If the answer to such questions is negative, significant infrastructure enhancements would be needed in many parts of the country (plus the sector capacity to implement them), massively increasing the investments needed to reach the MDG/GOI targets as well as creating a less optimistic assessment of the present coverage situation **(Saxena, 2009)**.

Recurring droughts and emergence of water quality problems are the major issues of concern in provision of drinking water in the State. Over 85% of drinking water supply schemes in the State are dependent on ground water (**GSDA & CGWB, 2014**). The availability of water on a sustainable basis for meeting future demand will be critical given the over exploitation of ground water occurring in the State. The 12th plan, proposed to increase the coverage of piped water supply to households in place of the traditional hand pump based water supply, enhancement of service levels for rural water supply from the norm of 40 lpcd to 55 lpcd, priority for coverage of water quality affected habitations (NRDWP, 2010).

It is viewed as the study done in the village of Kharakkalan, District Bhiwani, Haryana by using jal tara water testing kit. The sample was taken twice in a month and this study was done for the water sample from January, 2014 to June 2014, for six months. From the study, major conclusions were drawn i.e. the DO level in the pond water was found very low due to presence of algae and due to no DO level, there was no aquatic life surviving in the pond. Phosphate level was fluctuating with time. Due to high phosphate level, eutrophication problem occurred in some areas. TDS concentration was also fluctuating with time.it was seen that Artificial aeration was determined as an excellent option for maintaining the healthy quality of water sourced as pond water by regaining purification by supporting aquatic life. (**Kumar, 2014**)

According to the study done, the enhancement in water supply schemes is tabulated below for different years:

Table 2.1: Chronology of drinking water schemes

Description	Period	Highlight
Dug well era	1960-70	• Providing dugwells • Mainly manual drawing
Bore well era	1971-85	• Bore well digging technology introduced. • Provided hand pumps and power pumps on bore wells.
Rural piped water supply	1985-97	• Increase in PWSS in rural areas based on surface water source. • First world Bank project with 17 single village, 47 multi village schemes
Master Plan Era	1997-2000	• First state in India to adopt state wide new reform policy • Use of participatory processes • Adoption of 10% capital cost and 100% O&M sharing by beneficiaries • Human resource development at village level • Independent monitoring and evaluation by third parties • Well designed IEC campaigns
Department of Drinking Water and Sanitation	2010-17	• Nirmal Bharat Abhiyan

(Source: WSSD, 2017)

However, to tackle the issues plaguing rural water supply coverage, such as slippages of covered habitations and increasing number of water quality affected habitation; the National Rural Drinking Water Programme (NRDWP) was launched in 2009. The NRDWP guideline aims to bring community driven decentralized approach to tackle these issues (**NRDWP, 2010**). The programme aims to increase the service levels of rural water supply with households as the primary unit to determine coverage, which is a major shift from the earlier

policy of habitation as the coverage unit. In addition, water safety has been accorded importance in the guideline to ensure sustainability of drinking water sources.

As a developing nation, although India has a long way to go in order to achieve International standards of health and sanitation and with the advent of new government schemes and initiatives for improving sanitation in public places, rural household etc. it gives a new hope to the citizens for a cleaner and better tomorrow as long as they are doing their bit. According to the previous census of 2011, percentage households having water closets, pit latrines and other latrines had a significant increase in both urban and rural areas of all the states in the country. Government implemented schemes such as Swachh Bharat Abhiyaan have proved to be revolutionary schemes as 31 lakh household toilets and 11 lakh public toilets have been built in a span of 3 years. The primal objective of Nirmal Bharat Abhiyaan which was to make the country open defecation by 2017 have been given a steadfast uplift by making 531 cities open defecation free. Thus quality health and sanitation depends on our attitude and values towards way of living which we inculcate and pass on to the next generations that ultimately reflects the nations development (**Pandey et al, 2017)**.

CHAPTER-3

METHODOLOGY

3.1 STUDY AREA

3.1.1 Overview

On 1 November 1966, Haryana discovered as the state which is East Punjab according to the language. It is situated in North India and with availability of land is less than 1.4%. The area covered is 44,212 km^2 of India's Land area.

3.1.2 Climate and rainfall

It is noticed that, In summers, Haryana is very hot around 45 ^{0}and in winter it is mild. May and June found the month as hottest and December and June found coldest. The climate semi-arid to arid with 354.5 mm average rainfall. Haryana received around 29% of rainfall from July to September.

3.1.3 Geographical Features

In Northern India, Haryana is a state as landlocked. It is situated in between $27^0$39' to $30^0$35' N latitude and between $74^0$27' and $77^0$36' E longitude. The geographical are covered in the state is 4.42 m ha, and result as the 1.4% of area of overall country.

The four major features of geographical area are:

- The plain of Yamuna-Ghaggar is the largest part of state and it is also known as Delhi doab which includes Sutlej-Ghaggar doab in Northern Haryana, Ghaggar-Hakra doab and Hakra-Yamuna doab
- The Shivalik Hills at the Northest
- The semi-desert dry sandy plain Bager tract to the south-west.
- At the northest, the Aravali Range's.

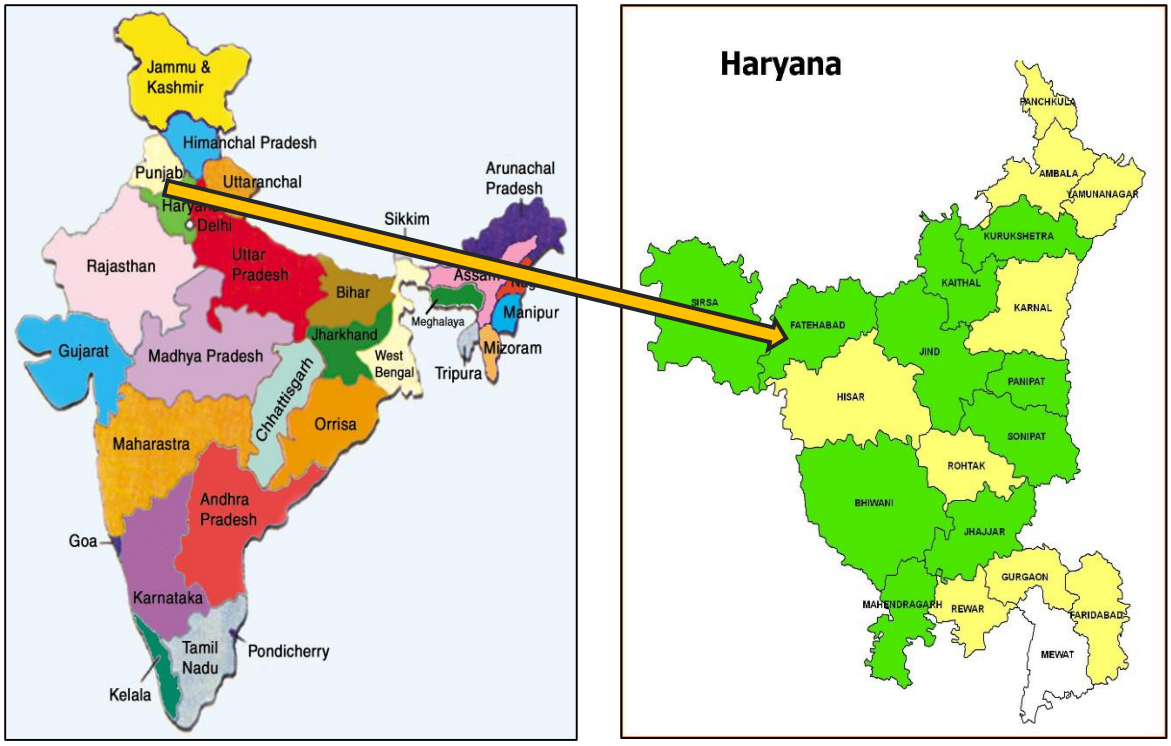

Figure 3.1 : Study Area : Districts of Haryana

3.2 LOCATION

The area where the data is taken includes five districts and their villages which are explained below:

3.2.1 Ambala

- **Overview**

  Ambala is the district in Haryana, India. It is located near the border of Punjab and to the states of capital Chandigarh. It is covered by two rivers: Ghaggar and Tangri which distribute the Ganges river from the Indus river.

  It includes 456 villages with the total 474 numbers of schools and 977 number of Anganwadis.

Total area of geographical region includes 1574 sq. km. Mainly, it is divided into three tehsils which names are Ambala, Naraingarh and Barara and further divided into six blocks which names are Ambala I, Ambala II , Saha, Barara, Shahzadpur an Naraingarh.

- **Rainfall and Climate**

The subtropical monsoon found in the district of Ambala, hot summer, sub-humid and mild and dry winter expected during the season of monsoon.

Rainfall : From the IMD data, Ambala receives 1076 mm of normal annual rainfall and also distributed evenly over the area. On an average, 44 days are noticed as rainy days. Total 81% of rainfall receives in the month from June to September to annually from south-west monsoon. Rest 19% came at period of non-monsoon from western disturbances.

- **Ground Water Condition**

Total 21 exploratory borehole, 13 piezometers and 4 slim holes drilled by Ground Water Board to determine the aquifer evaluation characteristics data and also zones of potential aquifers. Seismic surveys were also conducted in that area and it reveals that a large alluvial thickness of 3000 m depth below MSL.

The exploration of ground water data revealed that the presence of 4 aquifer group at 450 m down. It comprises of clay, kankar and silt. At 167 m depth the first zone of granular material forms the water table aquifer. The aquifer mainly constitutes less coarse material than the layer of first material and shows the presence of Kankar. Third one constitutes fine sandy beds in alternate with thick beds of clay from 197 to 385 m depth exist between the depth of 180 and 205 m depth. The last fourth aquifer found below 212 m onwards. Shallow tubewells are mainly found upto a depth of 45 m. The discharge from shallow tubewells varies 100 to 500 litres per hours for a medium drawdown.

- **Ground Water Quality**

Water found at ground level in the district is nature of alkaline. The range of pH values varies from 7.07 to 10.10. Thus it represents that the ground water is neutral to alkaline. The table shows above represents the tabular form of ground water condition for the district of ambala.

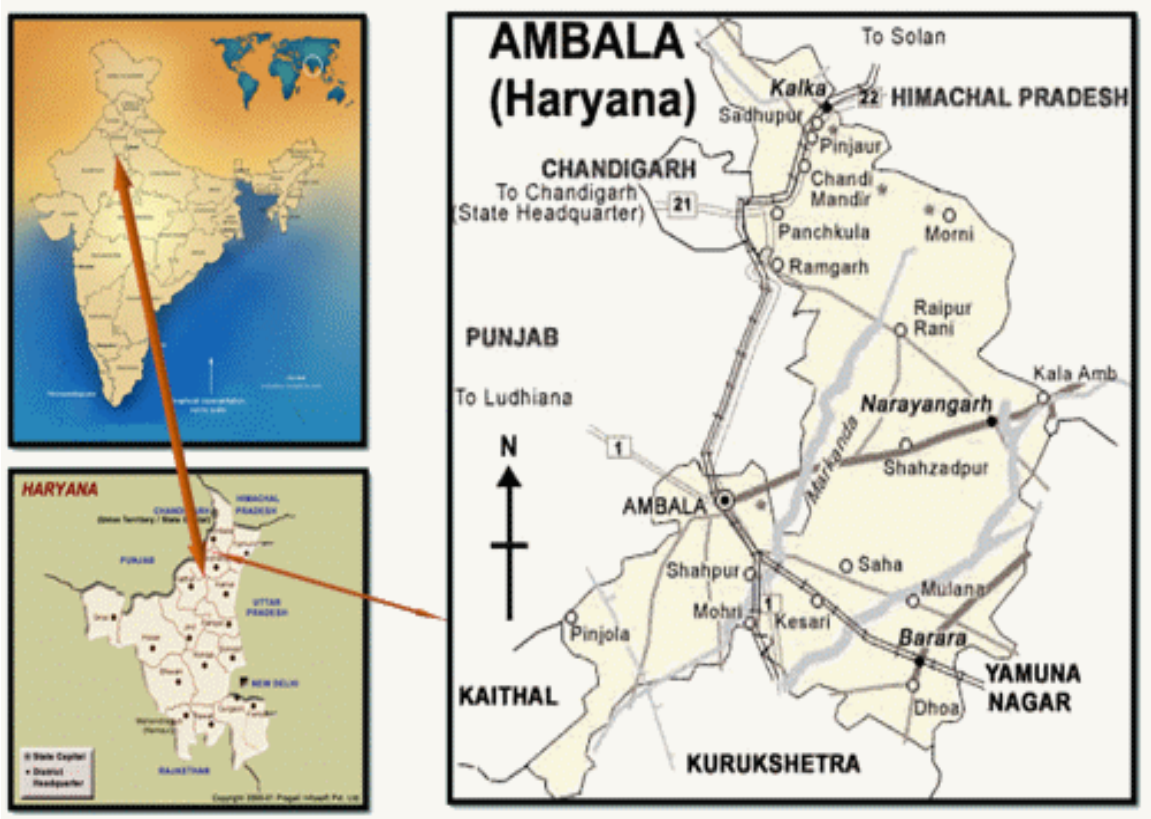

Figure 3.2 : Geographical map of Ambala district in Haryana

3.2.2 Jhajjar

- **Overview**

The city of jhajjar exist in the state of Haryana in India. It get divided off from the district of Rohtak on 15 July 1997. This City is exist between connecting road Rewari to Rohtak(NH-71), Gurgaon to Bhiwani Charkhi and Dadri to Delhi.

- **Climate and Rainfall**

The district climate can be categorized as tropical steppe, hot and semi-arid which is generally introduced by the huge dryness in the air except during the months of monsoon, hot intensely summers and also cold winters. The monsoon of south west during three months from June to September, the air which contains moisture of origin from oceanic penetrates into the district and causes extreme humidity and rainfall. From the period of October to December it contains post monsoon season. The cold weather season exists from January at the beginning of March and then by the hot weather or season of summer.

Rainfall : In district of Jhajjar, there is about 532 mm of annual rainfall and over 23 days rainy days exists. The monsoon from south-west occurs in the June and ends in September and it includes about 85% of the normal annual rainfall. The wettest months are July and August in which total 14% of the normal annual rainfall sets during the months of non-monsoon at the wake of western disturbances. The maximum temperature reached up to 45^0C while in the season of winter minimum temperate falls to 4^0C in January.

- **Ground Water Condition**

In Quaternary age, the ground water exist in the alluvium of that area. The zones of permeable stratum cosists of fine to medium sand and also gravel and coarse grained sand. Their vertical as well as lateral extent found limited. The study of data of borehole given by the CGWB represents that group of clay formations dominate over group of sand in the district. The correlation of lithology clearly shows the existence of layer of clay at the of surface. In general, ground water source in the area was rainfall, seepage from canal, sub- surface inflow, and seepage return from irrigation. The discharge from natural source have sub-surface flow and also evapo-transpiration. The discharge from artificial sources must include utilization of groundwater for the purpose of irrigation, industrial and domestic purposes. The zones of granular layer that occur at inter bedded with the formation of clays in alluvial formations, form the water for ground sources. The surface of upper layer in zone of saturation is shown by levels of water in dug wells. Groundwater for area exist under water table and semiconfined or confined conditions. At a depth of 315.50 m the basement is found near Jhajjar. Two to four permeable zones of granular layer with an aggregate thickness varying between 23 m and 50 m have been encountered down to the depth of bed rock.

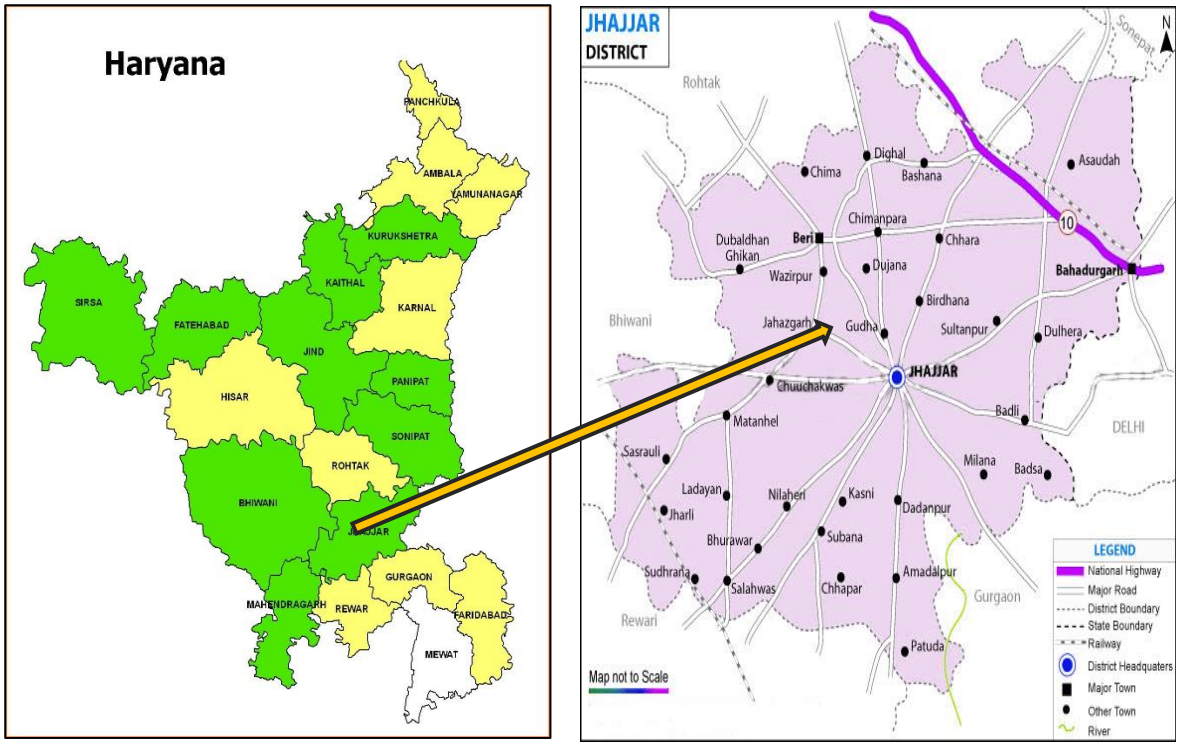

Figure 3.3 : Geographical map of Jhajjar district in Haryana

- **Ground Water Quality**

The Ground Water exist in the district is slightly Alkaline in nature. The value of pH varies from 7.44 - 8.60, shows that the quality of ground water is neutral to alkaline (weak base type in nature). Today, development of highly productive agricultural practices, industries and changing life style of people has taken place which has deteriorated the surface quality and groundwater. The impassive behavior of 'pH' and Electrical Conductivity(EC) confirms that there is no remarkable change in the water quality in the district arena .

3.2.3 Mewat

- **Overview**

In 21 districts of the 'Haryana' State, Mewat is one of them in North India. The district was found as the 20th known district of Haryana from former 'Gurgram' and Hathin Block of the 'Faridabad' District on 4 April of 2005. The Sub Division of Hathin was moved to New District, 'Palwal' in 2008 and It is now bounded by the 'Gurugram' district at the north, the

district of “Rewari” at the west end and ‘Palwal’ and “Faridabad” districts at the east. ‘Nuh’ town is the headquarter of this district. This district exist on a geographicsl Area of 1859.61 km². The district have a total population of around 10,89,263 (According to 2011 census). Mewat is populated by the ‘Meos’, who are basically agriculturalists.

- **Climate and Rainfall**

The climate of the district may be classified as the Tropical Steppe, Semi-Arid and Hot. During the 3 months of Monsoon of South West from the months ‘July’ to ‘September’, the Moist Air of the Oceans enter into the district, thus causing high humidity, clouds and heavy Monsoon Rainfall. The duration from October to December comprises the post monsoon season. The extremely Cold Season starts from January till the starting of March and then is followed by the very hot weather in the Season of Summer which continues till the last week of ‘June’. The normal annual rainfall happens in the district is about 596 mm spread over a span of 31 days. The monsoon from South West sets in the week of June and ends at the last week of the month of September and the contribution is about 74% of the total normal annual rainfall. The July month and August month are the wettest. Around 25% of the total normal Annual Rainfall happens during the time of period of non-monsoon in the beginning of thunder storm and Western Disturbances.

- **Ground Water Quality**

The Area of district is mainly underlain by ‘Alluvium’ of Quaternary age which in turn forms the fundamental Ground Water Reservoir. Some ground water gets collected in the joints, fractures and crevices of rocks which are found as strike ridge in the district. The ground water present in the upper zone, is known to be present down to 70 m deep, and it holds the water under a phreatic condition. The aquifers that occur at the deeper levels are collected to the semi-confined. The ‘Central Ground Water Board’ has done exploratory drilling in the Mewat District with the depth ranging between 39 to 290 m. The data shown by the exploratory boreholes projects that in the deeper zone, alluvial formation contains sand, clay and kankars (small stones) in different proportions.

The Ground Water Exploration data also projects that the alluvial sediments contains fine to medium sand, clay and kankars. Clay and Sand beds are mainly mixed up with the kankars. In

the Nuh block, the Sand layers are few and the complete Lithology is made up of clay and kankar. In the Punhana block, Sand Ratio predominates at 30 m deep zone. Otherwise the Clay Ratio dominates at all the other deep ranges in the entire district.

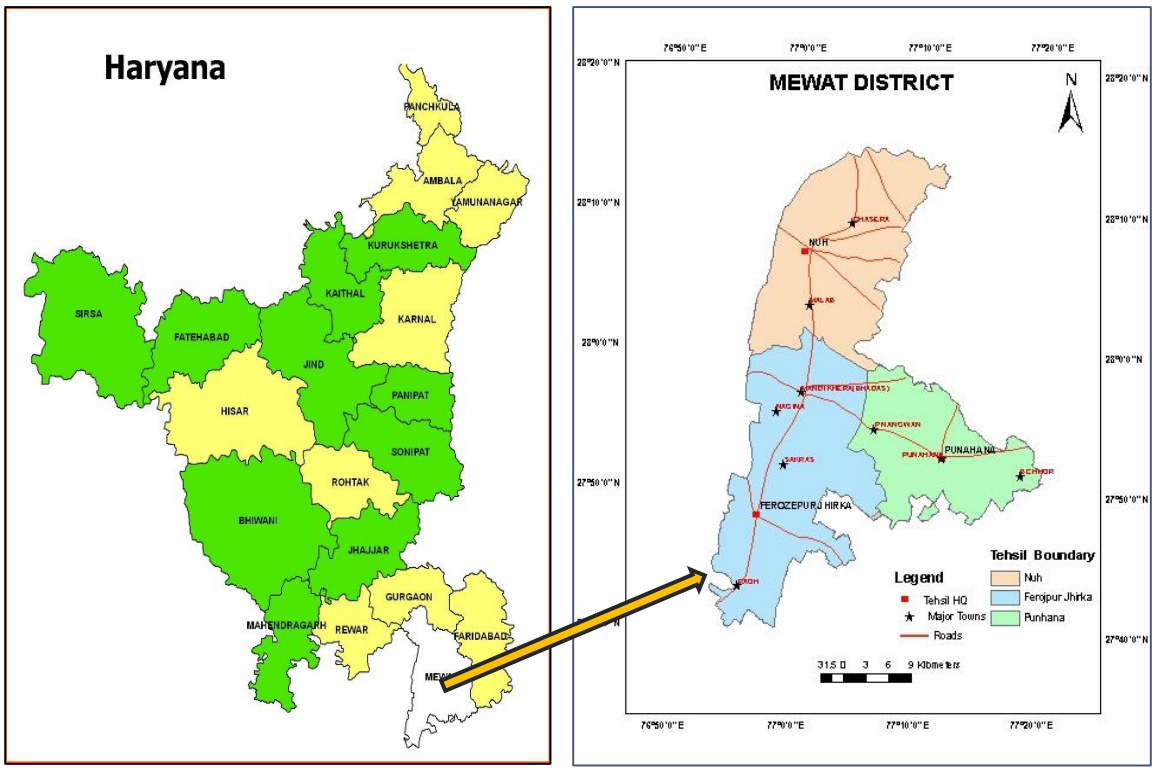

Figure 3.4 : Geographical map of Mewat district in Haryana

3.2.4 Palwal

- **Overview**

The Palwal district of Haryana is located between (27º50': 28º 15'40") North Latitudes and (77º 05' : 77º33') East Longitudes. The total area of the district is (1364.55) sq.km. Administratively, 'Palwal' is a District Headquarter, It is further divided into 4 Development blocks: Palwal, Hathin, Hodal and Hassanpur . The district area is surrounded on the western side with Mewet district, on the Eastern part of Uttar Pradesh state and on the Northern Side by the Faridabad district. There are specially two main canals in the district: The Agra Canal and the Gurgaon Canal, which goes through the Western and the Central part of District from the North to the South. The 'Budia Nala' flows from East to West in northern part and it finally discharges its rainy water in river Yamuna.

- **Climate and Rainfall**

The climate of the district may be characterized as a Tropical steppe, Semi-Arid and Hot which is mainly described by the extreme dry part of the Air apart from the monsoon months. During the three months of South-West monsoon from the month of June to month of September, the moist air of oceans enter into the district and lead to high humidity, cloudiness and monsoon rainfall. The period of October to December comprises season of post monsoon. The weather of cold season lasts from the month of January to the start of March and in turn is followed by the summer season which goes up to the month of June.

The total normal annual rainfall in Palwal district is noticed about 542 mm and is remain over 27 days. The South - West monsoon comes in about the month of June and leaves towards the month of September and thus, contributes to about 84% of the total annual rainfall. It should be noted that July and August are the most humid months as a total of 20% of the normal annual rainfall noticed during the period of non-monsoon months in the start of the storms with thiunder and the Western Disturbances.

- **Ground Water Condition:**

The district is completely occupied by the Indo-Gangetic alluvial plain, and falls in the sub-basin of Yamuna of the Ganga basin. The Central Ground Water Board (CGWB) has till now drilled 21 exploratory boreholes and find the aquifer zones of potential nature, determination of the aquifer characteristics. Out of the all exploratory boreholes, 13 of them were rejected due to very poor characteristics of the ground water. The zones of permeable granular contains fine to medium grained sand and occasionally gravel and coarse sand. The lateral and as well as vertical height is limited. The borehole data says that the clay group formations dominate against the sand group in the district. Ground water found in alluvium and the underlying fractured Quartz. Alluvium contains sands silt, kankars and gravel, which form the main ground water bearing horizon. The discharge of the wells range from 750 lpm to 900 lpm at a drawdown of 5.5 to 7.00m.

- **Ground water quality**

The ground water nature of the district is slightly alkaline (pH 7.75 to 8.62) and is highly saline (EC 692 to 3600 µg/cm). Among the anions, Bicarbonate dominates at some places, whereas

at the other places either none of the anion dominates or the Chloride is dominant. Among the cations, Sodium is most dominant cation. At some places mixed ionic character has been noted.

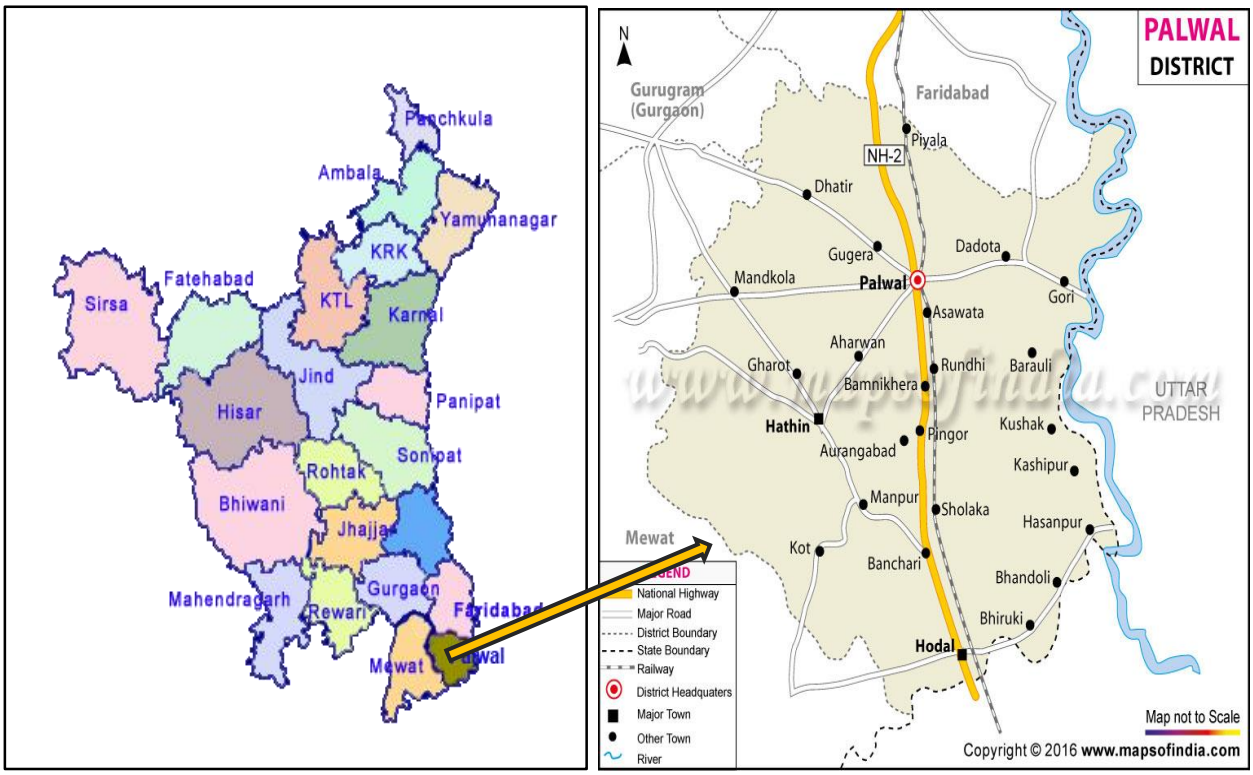

Figure 3.5: Geographical map of Palwal district in Haryana

3.2.5 Panchkula

- **Overview**

In the Northern part of Haryana State, the Panchkula district is situated and it is located between (30º 26': 30º 55') latitude of North and (76º 46': 77º 10') longitude of East. Himachal Pradesh exist in the North, on the East side by Uttar Pradesh, on the West side by Ambala district and on the south side by the Kurukshetra and Karnal districts. The area of the district is 898 sq. kms of geographical nature.

- **Climate and Rainfall**

The climate of Panchkula can be characterized as a subtropical monsoon, mild and dry winters, summer and sub-humid to humid which is mostly dry with high temperature of

summers and winters of very cold except during monsoon when the humid air of oceanic origin starts entering into the district. There are mainly 4 seasons in a year. The summer season starts from the mid of March and continues till the last week of the June followed by the South-West Monsoon, which continues up to the month of September. The transition period from September to November comprises the post monsoon season. The Winter season begins late in the month of November and continues up to first week of March.

The normal annual rainfall of the district is around 1057 mm, which is unevenly distributed over the area for 49 days. The South-West monsoon starts from the last week of June and continues till the end of September, contributes about 86% of the annual rainfall. July and August are the wettest months of the year. Rest of the 14% rainfall is received during non-monsoon time in the start of western disturbances and thunderstorms.

- **Ground water conditions**

The Ground Water Exploration in the district shows that clay group formation dominates over the sand group in the district area. The ground water in the district occurs in the alluvium under the water table and is semi-confined to the confined conditions. These aquifers consist of sand, silt, gravels and kankars associated with the clay and form a very high potential aquifer. In alluvium, the permeable granular zones contains fine to medium grain sand and occasionally coarse sand and gravel are the rest. Their lateral as well as their vertical extent is extensive. In the Kandi belt, which has not yet been explored, full boulders cobbles and pebbles constitute the major aquifer horizon. Siwalik Hills occupy the marginal areas in the northeastern areas of the district constitute a very low potential zone.

The ground water is found in the pore-spaces of the alluvial formation including the Kandi Belt stretching in the range of Siwalik Foothills. In alluvium, sands, silts, kankars and gravels form the potential aquifer zones in the area. The Kandi Belt, yet to be explored, contains boulders, pebbles and cobbles forming main aquifer horizon.

- **Ground Water Quality**

The ground water in the district is mainly alkaline in nature with a low to medium salinity. The Chemical Quality Data from the shallow and deep aquifers indicate that all the major Cations (Ca, Mg, Na, K) and Anions (CO_3, HCO_3, Cl, SO_4) are inside the permissible limits as set by

BIS, 1991.The electrical conductivity is less than 650 µs/cm in almost the entire area of the district. Ground water around the village 'Kakar Majra', in the Southern part of the district, has slightly higher Electrical Conductivity of 1030 µs/cm. The ground water in the district has no particular cation as dominant, while HCO_3 is the most found anion in 56% of the samples. Hence, ground water can be described as of mixed character.

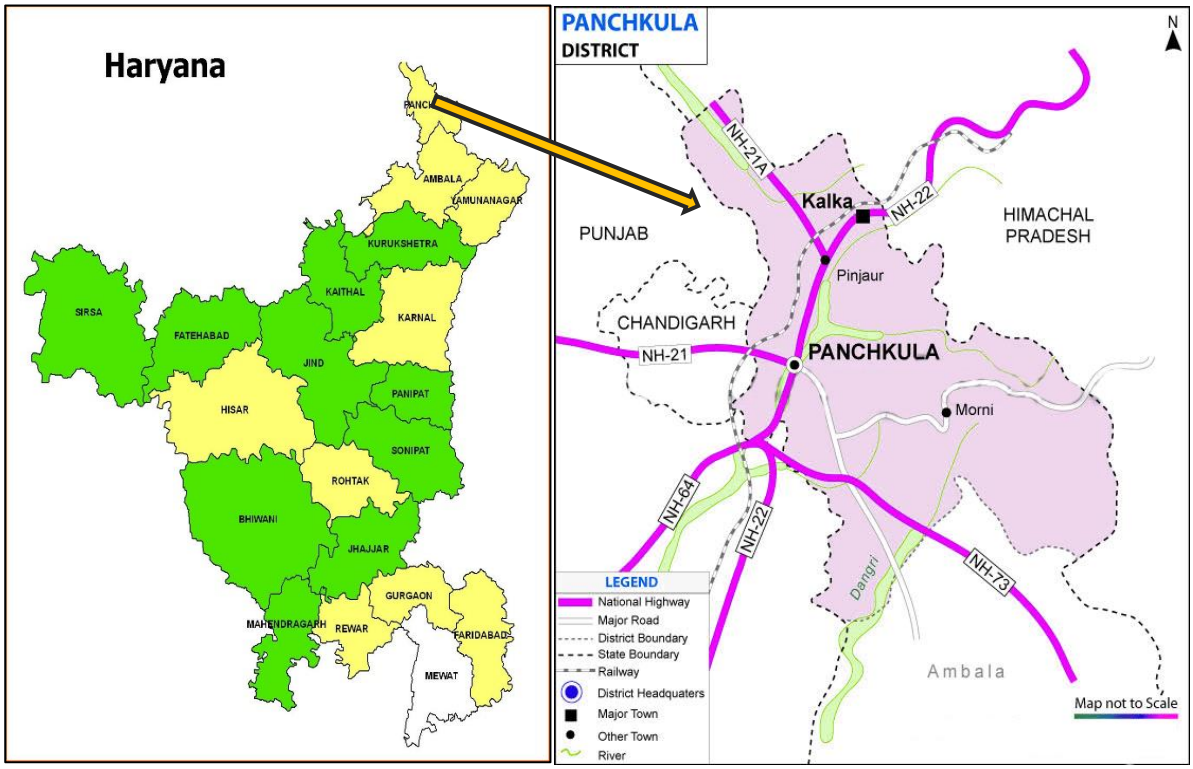

Figure 3.6: Geographical map of Panchkula district in Haryana

3.3 METHODOLOGY

3.3.1 Sampling for rural water supply

In order to conduct the study based on mentioned objectives, we take the 5 divisions of Haryana for the purpose of analysis viz Ambala, Jhajjar, Mewat, Palwal, Panchkula were covered. From each division, to get the representative sample we take some villages of mentioned districts which is shown in tables below.

The sampling criteria for different districts are given below:

- **Ambala**

The assessment has been done blockwise according to the ground water resource potential in the district. After assessing the data, it has been noticed that the ground water development in the area varies between 65% to 116% mentioned in Table 3.1. thus, the overall stage of groundwater development for the district of Ambala is 86%.

Table 3.1 : Ground water resource and potential for development of Ambala district

Assesment unit/block	**Net ground water availability (ham)**	**Stage of ground Water Development (%)**	**CATEGORY OF BLOCK**
AMBALA I	13996	65	Semi Critical
AMBALA II	7275	77	Critical
BARARA	6692	116	Over-exploited
NARAINGARH	9622	104	Over-exploited
SAHA	7027	111	Over-exploited
SHEHZADPUR	8640	66	Critical
TOTAL	**53252**	**86**	

The data of hydrogeological generated by test drilling of exploratory type provided major information regarding the occurrence of aquifer systems, assessment of its vertical and lateral extent, depiction of aquifer characteristics. These studies represents information on design of well and techniques of drilling. A 305/203mm dia of well assembly is installed. Using, a combination of 60m to 80m length having size of slot of 1.19 mm would be perfect for the area of district. Direct Rotary rig may also carry out the drilling in area of the district except in a area of small boundary where Percussion rig may required for this purpose.

- **Jhajjar**

The ground water resource for block wise analysis in the district assessed potentially. The ground water development stage varies between 77% (Beri) to 113% (hajjar). The total resource of ground water in the district has been analysed as 427. The overall stage of ground water development for the district of Jhajjar is 96%.

Table 3.2 : Ground water resource and potential for development of Jhajjar district

Assesment of block	**Net ground water availability (ham)**	**Stage of ground Water Development (%)**	**CATEGORY OF BLOCK**
BAHADURGARH	12231	99	Critical
BERI	8261	77	Semi-Critical
JHAJJAR	10635	113	Over-exploited
MATANHAIL	6272	78	Semi-Critical
SALHAWAS	5319	105	Over-exploited
TOTAL	**42718**	**96**	

The data of hydrogeological generated by test drilling of exploratory type provided major information regarding the occurrence of aquifer systems, assessment of its vertical and lateral extent, depiction of aquifer characteristics. These studies represents information on design of well and techniques of drilling. A 305/203 mm diameter of well assembly is installed. Using, a combination of 12m to 20m length having size of slot of 1.0 mm would be perfect for the area of district. Direct Rotary rig may also carry out the drilling in area of the district except in a area of small boundary where Percussion rig may required for this purpose. The total discharge expected of the tubewell constructed in this area is 350 to 460 lpm.

- **Mewat**

The ground water potentials in blockwise estimated based on technique offered by Ground Water Estimation Committee (1997). In Mewat district, the net annual ground water found was 21623 Ham in which1830 Ham kept reserved for industrial and domestic purposes for next 25 years. The ground water development at average level in the district is 67% and found in critical category. Therefore care must be required for future development of ground water.

Table 3.3 : Ground water resource and potential for development of Mewat district

Assesment of block	**Net ground water availability (ham)**	**Stage of ground Water Development (%)**	**CATEGORY OF BLOCK**
FEROZPUR JHIRKA	4727	64	Over-exploited
NAGINA	4185	48	Safe
NUH	4526	44	Safe
PUNHANA	5420	72	Critical
TAURU	21623	126	Over-exploited
TOTAL	**21623**	**67**	

The data of hydrogeological generated by test drilling of exploratory type provided major information regarding the occurrence of aquifer systems, assessment of its vertical and lateral extent, depiction of aquifer characteristics. These studies represents information on design of well and techniques of drilling. A 200/107 mm diameter of well assembly is installed. Using, a combination of 60m to 80m length having size of slot of 1.13 mm would be perfect for the area of district. Direct Rotary rig may also carry out the drilling in area of the district except in a area of small boundary where Percussion rig may be required for this purpose.

- **Palwal**

The ground water resource potential at block wise level for the district has been analyzed. The ground water development stages varies between 89% (block-Hathin) to 113% (block-Palwal). The total availableground water resource is 44769 Ham in the district in which the total available ground water demand by all means has been 46891 Ham. So, the net available ground water draft for future development will be 2074 Ham.

Table 3.4 : Ground water resource and potential for development of Palwal district

Assesment of block	**Net ground water availability (ham)**	**Stage of ground Water Development (%)**	**CATEGORY OF BLOCK**
PALWAL	19552	113	Over-exploited
HATHIN	7263	89	Safe
HODAL	9569	103	Safe
HASSANPUR	7284	103	Safe
TOTAL	**44769**	**102**	

The data of hydrogeological generated by test drilling of exploratory type provided major information regarding the occurrence of aquifer systems, assessment of its vertical and lateral extent, depiction of aquifer characteristics. These studies represents information on design of well and techniques of drilling. A 119/203mm diameter of well assembly is installed. Using, a combination of 50m to 70m length having size of slot of 1.19 mm would be perfect for the area of district. Direct Rotary rig may also carry out the drilling in area of the district except in a area of small boundary where Percussion rig may required for this purpose.

- **Panchkula**

The ground water resource potential at block level in the district assessed. The ground water stage development varies between 85% (Raipur Rani) to 103% (Barwala). The total resource

of ground water in the district is 138.76 mcm. Net data for ground water draft is 118.62 mcm. The ground water development stage in the district found was 85%.

Table 3.5 : Ground water resource and potential for development of Panchkula district

Assesment of block	**Net ground water availability (ham)**	**Stage of ground Water Development (%)**	**CATEGORY OF BLOCK**
BARWALA	5823	103	Over-exploited
PINJORE	3950	59	Safe
RAIPUR RANI	4103	85	Semi-Critical
TOTAL	**13876**	**85**	

3.4 SANITATION STATUS FOR RURAL COMMUNITY

The village level survey has been done for the mentioned districts i.e. Ambala, Jhajjar, Mewat, Palwal and panchkula, which include taking detail information by doing questionnaire consisting questions related to facilities of sanitation, also the practices related to santation facilities and by observing in general hygiene behaviors. Mainly, 876 households were covered in 5 districts of the study area which gives the status of sanitation out to 10% of the population in the districts.

The domestic waste generated in rural households of India is increasingly becoming an issue of serious concern. Though, solid waste generated in rural areas is predominantly organic and biodegradable, it is becoming a major problem as the waste generated is not segregated in-situ and is of the order of 0.3 to 0.4 million metric tons per day, as reported the Ministry of Drinking Water and Sanitation (MDWS), Government of India. Inconsiderate littering causes poor environmental sanitation resulting in unhealthy quality of living. Therefore, domestic-refuse should be handled responsibly. In order to manage waste in a desirable way, there should be a functional waste management system in place. Without a functional waste collection and disposal system at the

Panchayat level it is arbitrary to hold individual households responsible, or blame them of irresponsibility.

3.4.1 Solid waste generated in the study area

In rural areas, examples of solid waste include wastes from kitchens, gardens, cattle sheds, agriculture, and materials such as metal, paper, plastic, cloth, and so on. They are organic and inorganic materials with no remaining economic value to the owner produced by homes, commercial and industrial establishments.

Most household waste in rural areas is organic, with little inorganic material, and is non-toxic. Because of its environment-friendliness, composting is a highly suitable method of waste management in rural areas.

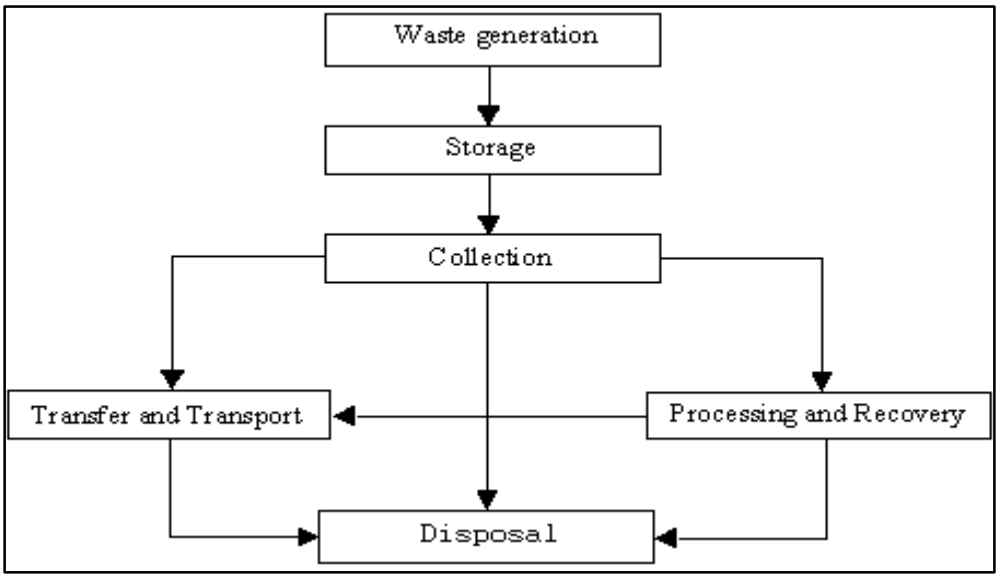

Figure 3.7 : Flow Chart of Components of Solid Waste Management in Rural area

3.4.2 Implementation of solid waste disposal for rural sector

- **Segregation at Source** : The households must have sufficient knowledge of segregating bio-degradable from non-bio-degradable wastes. Since we have covered about preparing the community at Step – 1 itself, at this stage we assume that the community members know how they should participate and contribute. First of all, primary segregation takes place at the source, namely at the household itself. If this is done properly, it will

considerably reduce the work in secondary segregation. Otherwise, it is an unpleasant task to lay hand in wet waste that is more than 8 to 12 hours old, which has already started decomposing / decaying. The households keep kitchen refuses in a Green Bin.

- **Collection:** The sanitation workers indicate their arrival by blowing a whistle. The Green Bin is emptied into the cabin meant for it in the tri-cycle. Wet wastes are collected every day morning from 7 – 11 am; or in the evening from 4.30 – 6.30 pm. During the collection, the sanitation workers progressively perfect the community on what should be kept in the Green Bin, and what should go into the Blue bin, and what are hazardous items, and how they should be disposed safely.
- **Facility for Treatment & Treatment of Waste:** Construct two composting yards of 3 x 5 metres of one metre height in single brick masonry. It can be above the ground level. It does not require any plastering. There needs to be a roof (tin sheet) over them considering the rainy days. That means both the composting yards are under one roof. One composting yard can be used for 60 – 75 days. When it is nearly full in two months time, cover it with sand, and start using the second one. By the time the second one gets filled, the garbage dumped in the first yard has become compost and is ready to go to field. These two pits can be used alternately like in a twin pit toilet. We do not impose vermi-composting considering the work and additional workers required to maintain it.

3.5 ANALYSIS OF SAMPLES

The whole analysis process was carried for some villages of selected districts of Haryana. All the samples were analyzed to assess the groundwater quality for different places mentioned above.

Household survey conducted in all mentioned places for the study purpose. The data from households were collected from the study area. The caste composition of the villages has been analyzed which belongs to SC, ST, OBC and general.

According to the study, it was found that 58.9% were identified as APL households, 35.1% households were BPL households on an average level. The average primary occupation found in 47 % households were farming. The no. of schools and anganwadis were analysed with the status of water supply.

In the study, status of rural water supply and sanitation by doing the different survey techniques has been determined and then we can conclude the comparison between the status of different

districts according to the data has been done and finally, the perception has been made accordingly by doing pictorial representation.

CHAPTER-4

RESULTS AND DISCUSSIONS

4.1 DISTRICT SURVEY

The district survey has been done for the analysis of details about no. of villages, no. of schools, no. of anganwadi's, with also the details of schemes mostly used after study the area of villages from chosen districts. The district survey data gives the rough idea about the development status of villages in terms of rural water supply sector or in terms of sanitation status in mentioned area. The data for the above mentioned presentation is discussed below in tabular form:

Table 4.1 : Status of rural water supply in Schools and Anganwadi's

Division Covered	No. of Villages	No. of Schools		No. of Anganwadi's		Schemes details	
		With drinki -ing water	With no dri -nking water	With drinking water	With no drinking water	PWS	Hand Pump
AMBALA	456	474	0	855	122	110	0
JHAJJAR	250	301	0	485	130	141	0
MEWAT	416	488	103	211	189	110	0
PALWAL	282	459	0	472	109	74	0
PANCHKULA	212	344	3	77	187	69	0
TOTAL	**1616**	**2066**	**106**	**2100**	**737**	**504**	**0**

The pictorial representation of data mentioned above by bar charts and pie charts are given below for the no. of Schools and Anganwadi's in different districts:

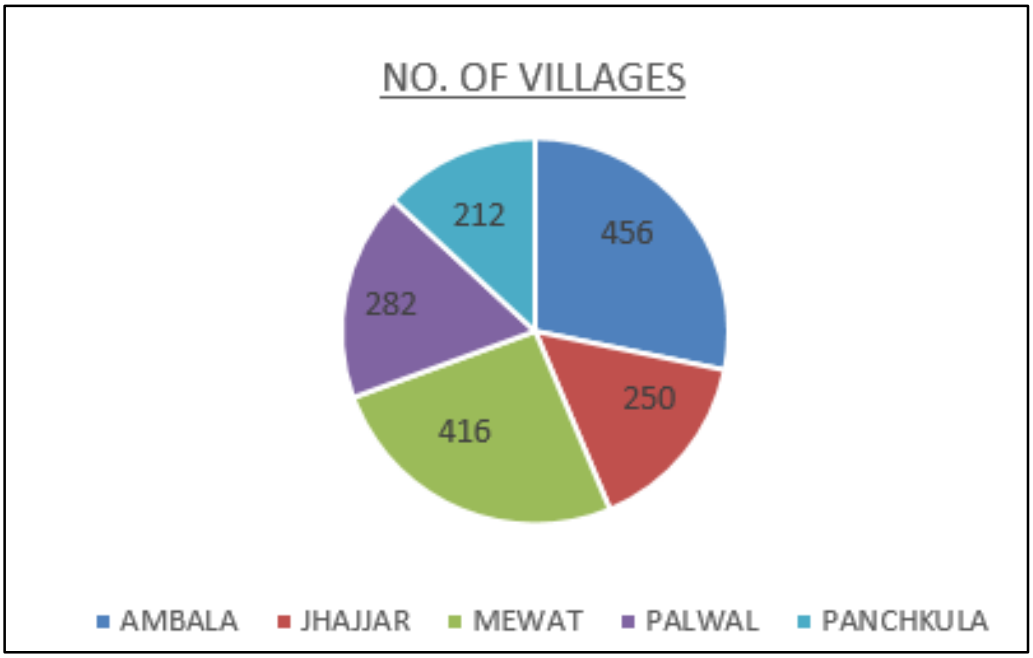

Figure 4.1 : No. of villages in the study area

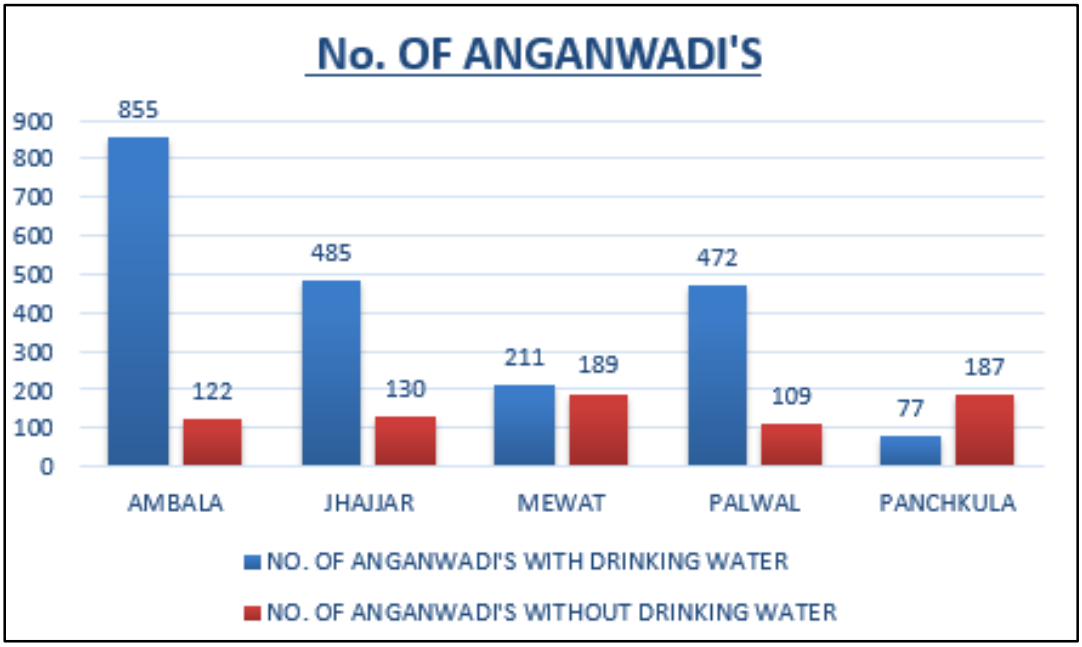

Figure 4.2 : No. of Anganwadi's with and without drinking water in the study area

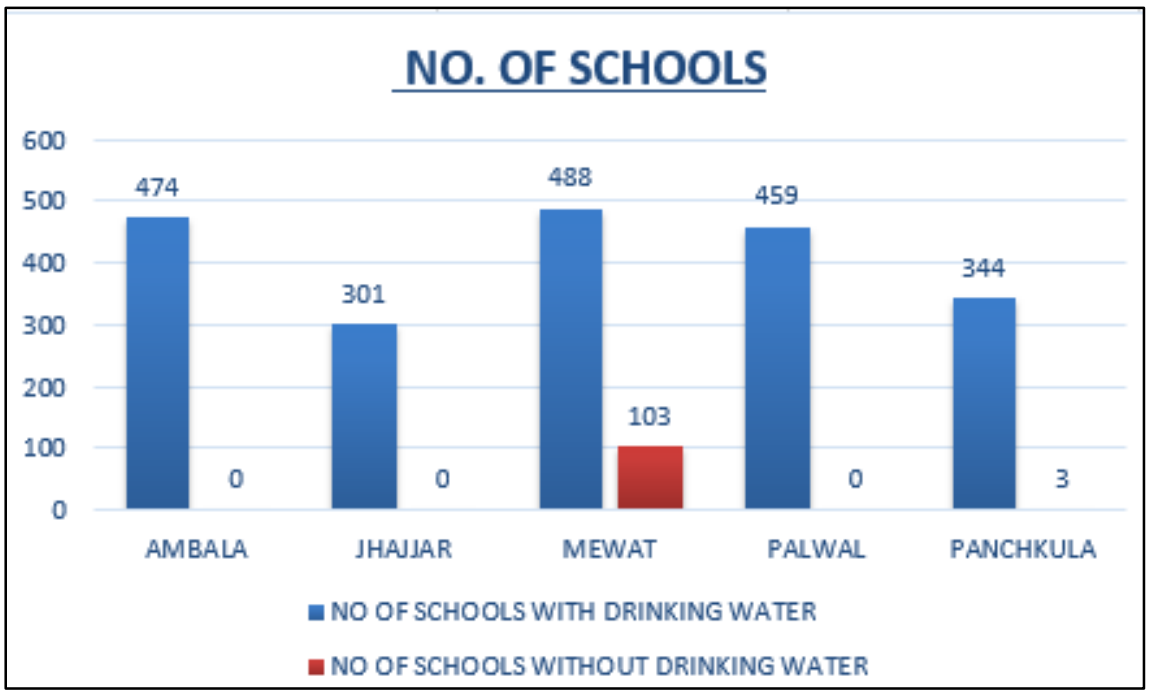

Figure 4.3 : No. of Schools with and without drinking water in the study area

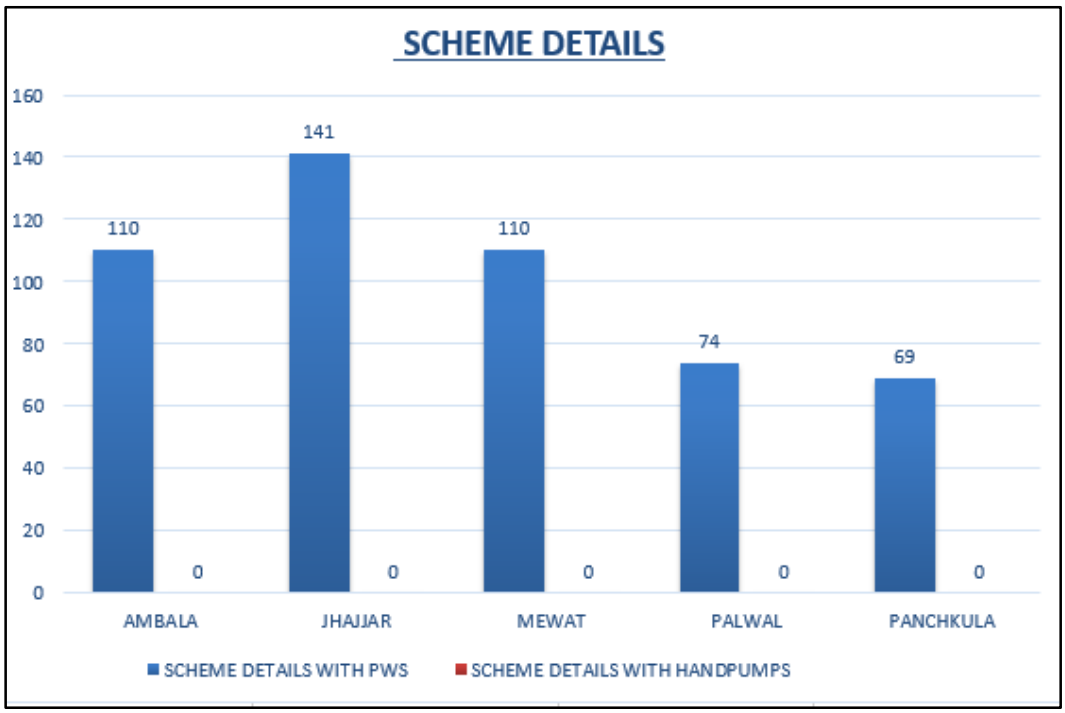

Figure 4.4 : Overall scheme details in schools and anganwadis with PWS and Handpumps

4.2 SOCIO-ECONOMIC STATUS OF DISTRICTS COVERED UNDER THE STUDY

The study was conducted in 5 districts covered some villages across different divisions in Haryana. In each districts total households are counted their analysis was done on the basis of caste and economic status. According to the study done in different villages and also from household survey data total 1817 households were collected, which is nearest to the 10% of the study area. The total 37.8 % belongs to BC, belongs to ST, 21.7% belongs to SC, 13.3% and rest of 27.2% belonging to others.

Table 4.2 : Socio-Economic category of the study area

Districts Covered	No. of Households	Social Category (%)				Economic Category	
		SC	ST	OBC	GENERAL	APL	BPL
AMBALA	475	20.7	24.1	51.2	4.7	57	43
JHAJJAR	265	4.9	18.8	25.3	52.3	75.3	24.7
MEWAT	483	24.6	14.4	60.1	47.9	53.5	46.5
PALWAL	315	19.6	37.0	22.7	23.3	62.8	59.2
PANCHKULA	279	2.0	18.6	46.5	57.7	78.4	21.6
TOTAL	1817	21.7	29.9	47.8	59.9	64.9	34.1

Data on the pattern of households survey were collected to understand the education level and sources of income. From the data obtained we can determine the education profiles of households and it shows that 38.9 % were illiterates, 36.9 % goes to the primary schools and rests were graduates or gone to high/higher secondary schools.

Also the comparison is done by using line diagram for above data is shown in figure below:

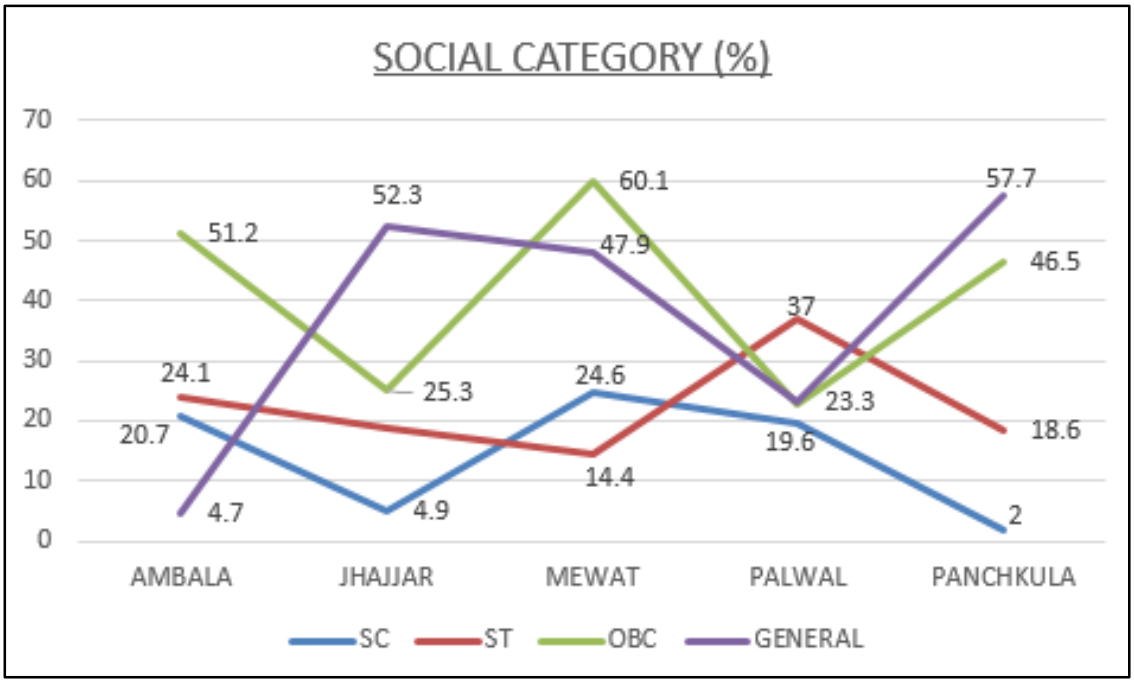

Figure 4.5 : Comparison of Social Category Division for different districts

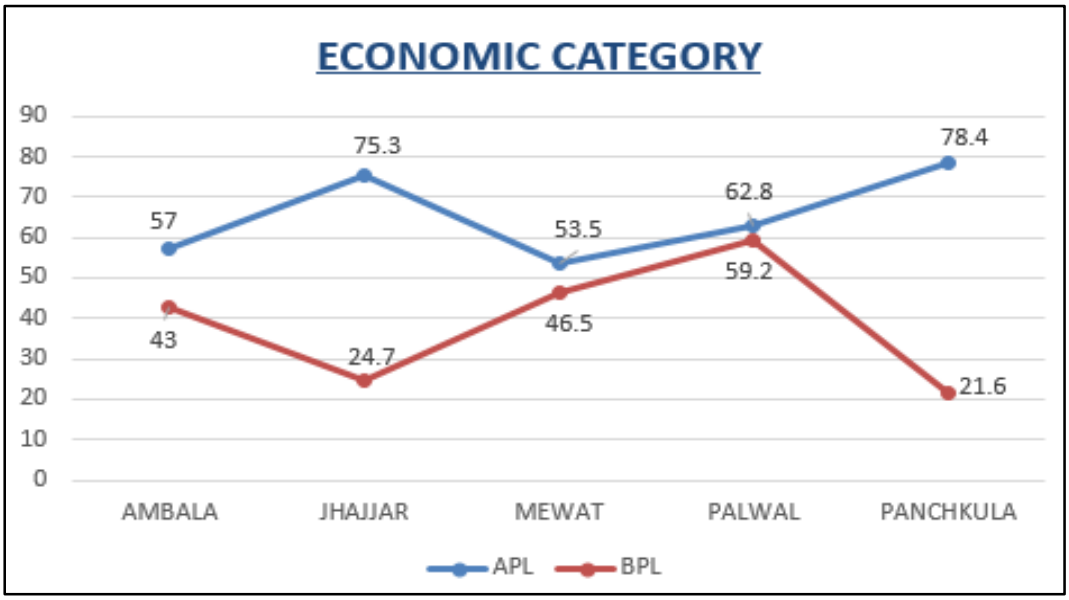

Figure 4.6 : Economic Category for Different Districts

4.3 STATUS OF PWSS SCHEMES IN THE STUDY AREA

From the study the status of PWSS (Piped Water Supply Schemes) were analyzed and it shows that PWSS schemes develop in the area serves one or more habitations in the GP's and Regional ural Water Supply Schemes (RRWSS). Mini-water supply sources also includes in the PWSS category for the study purpose. As the study mainly focuses on the status of PWSS /RRWSS schemes and therefore overall status of GP'S were analyzed in such a way that other water sources such as handpumps and dug wells were based on the study of mentioned area.

Status of other sources data also were collected and it can seen from the following table in the study area.

Table 4.3 : Status of dug wells and hand pumps in the study area

Division covered	**Dug wells**			**Hand Pumps**		
	Total no. of Dug wells	**Functioning (%)**	**Not-Functioning (%)**	**Total no. of Hand Pumps**	**Functioning (%)**	**Not-Functioning (%)**
AMBALA	23	91.3	8.7	78	76.7	23.3
JHAJJAR	11	90.9	9.1	56	71.4	28.6
MEWAT	19	89.5	10.5	22	81.8	18.2
PALWAL	39	92.3	7.7	95	87.4	12.6
PANCHKULA	10	100	0.0	149	70.5	29.5
TOTAL	**102**	**91.2**	**8.8**	**400**	**75.3**	**24.8**

When we study the area for PWSS schemes, I studied the data for 5 districts which includes the villages i.e. mentioned in the Table3.1 to Table 3.5 then the quality and problems related to different sources are mentioned and it is found that the major sources of water in the study area was tubewells and the maximum development of ground water occurs in Palwal district. The data shows that the sources of water in PWSS schemes were bore wells, dug wells and also the surface water bodies.

The hours of pumping of PWSS schemes for water supply in the study area were observed as less than 4 hours in given schemes. This show that most of the schemes were operate for lower number of hours for a significantly period. Also, the availability of standby pumps were considered to be the efficient design of the scheme.

The following table shows the different ground water schemes and different data for ground water quality in the study area and consequently problems and remarks of ground water quality is discussed below.

Table 4.4 Status of PWSS schemes in the GP's of study area

STATUS OF PWSS SCHEMES IN THE GP's						
S. NO.	SOURCE AND FUNCTIONALITY	AMBALA	JHAJJAR	MEWAT	PALWAL	PANCHKULA
1	DUG WELLS (GROUND WATER)	8	15	13	12	11
2	PIEZOMETERS	-	4	2	5	-
3	TUBEWELLS/BOREWELLS	27042	29008	31669	770	4502
4	GROUND WATER DEVELOPMENT	86%	96%	67%	102%	85%
5	MAJOR GROUND WATER PROBLEMS AND ISSUES	LOCAL PONDAGE,TW, INCRUSTATION	TWIN PROBLEM OF WATER LOGGING,SALINITY, HIGH FLORIDE.	WATER LOGGING,SALINITY, HIGH FLORIDE	WATER LOGGING,SALINITY, HIGH FLORIDE	DECLINE OF WATER LEVEL DUE TO FAILURE OF TUBEWELL
6	AVERAGE ANNUAL RAINFALL (mm)	1076	532	594	542	911
7	**GROUND WATER QUALITY:**					
7.1	EC (µho) at 26°C	3770	621-15,500	1890-9970	4850	675
7.2	F (Mg/l)	2.6	0.12-2.89	3.12	-	-
7.3	As (Mg/l)	0.051	-	-	-	-
7.4	Fe (Mg/l)	2.41	0-0.29	-	-	10.84

The pictorial representation of the ground water quality data is given below in the form of pie charts are given below:

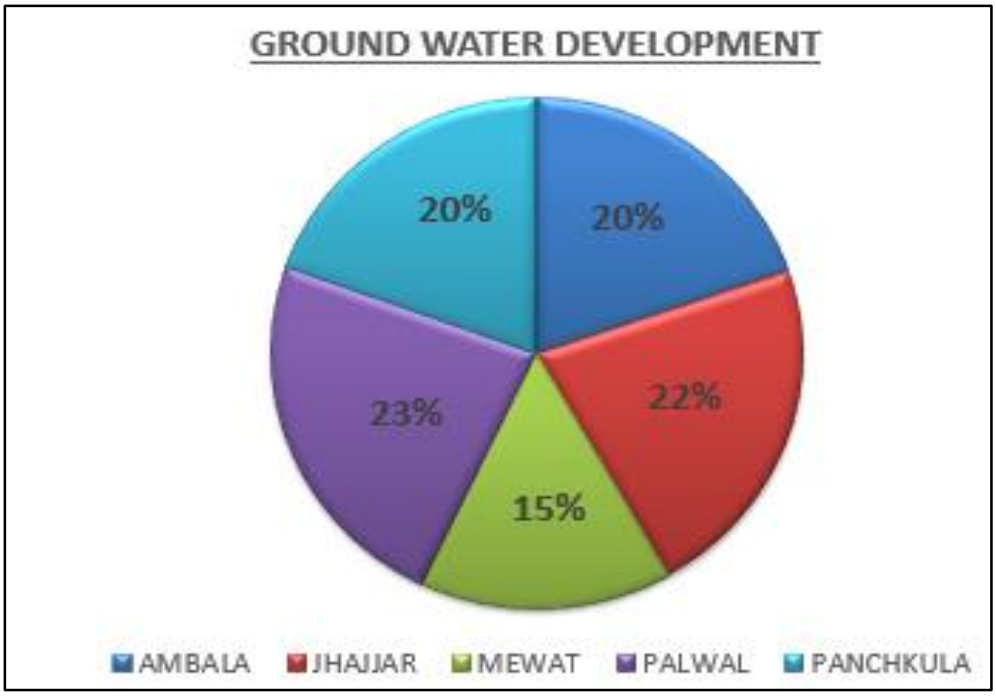

Figure 4.7 : Ground water development in different districts in percentage form

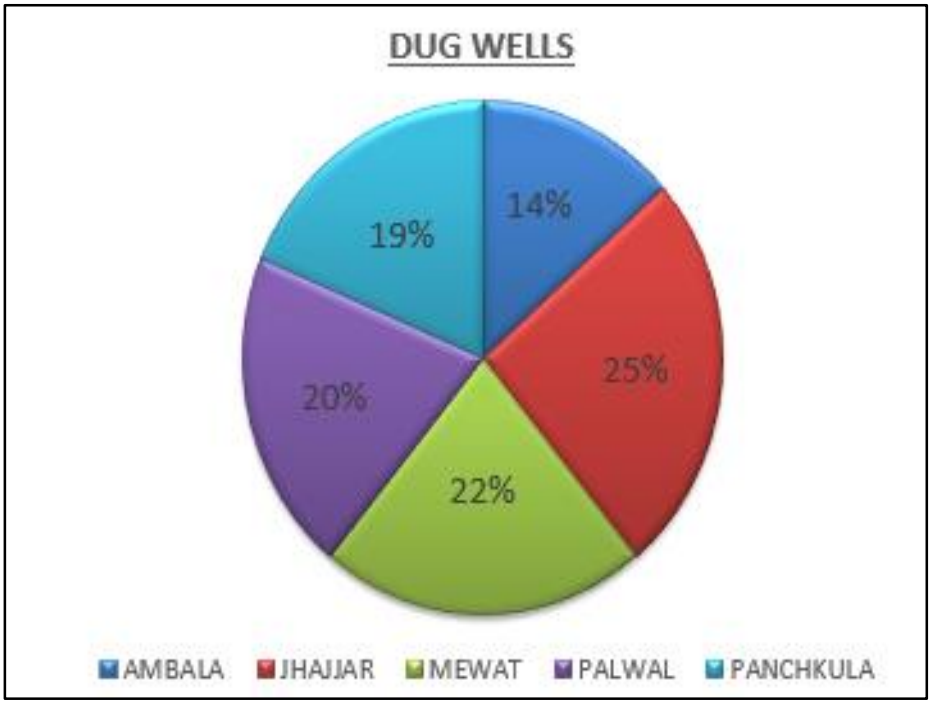

Figure 4.8 : Percentage of Dug Wells constructed in the study area

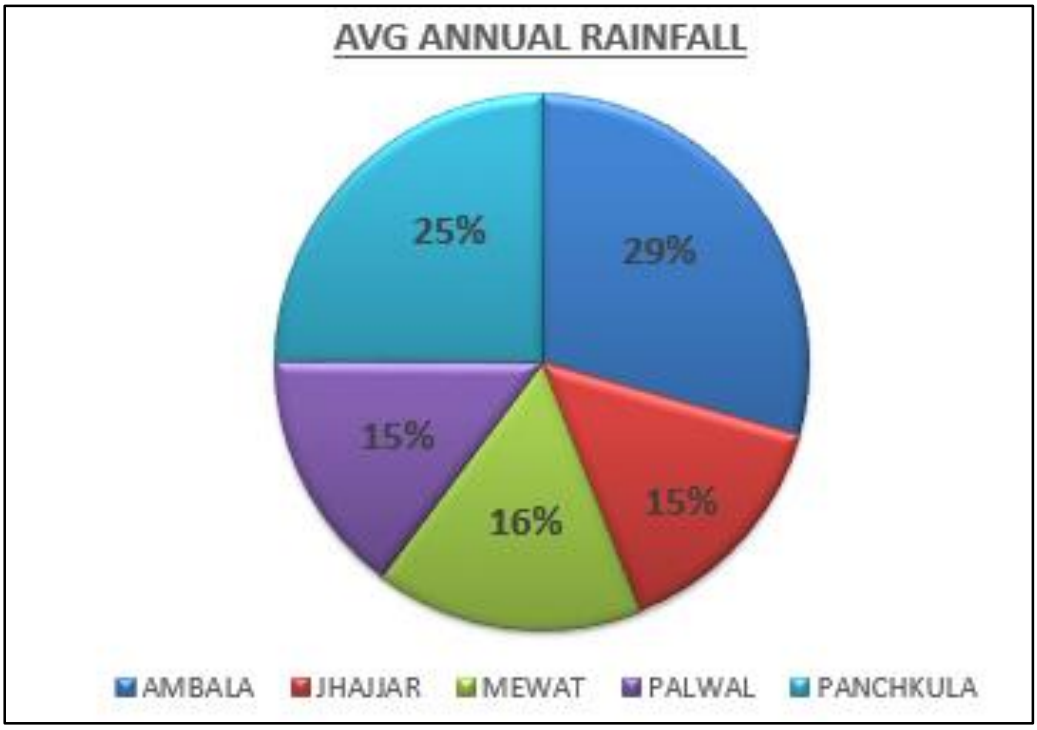

Figure 4.9 : Average annual rainfall received in the study area

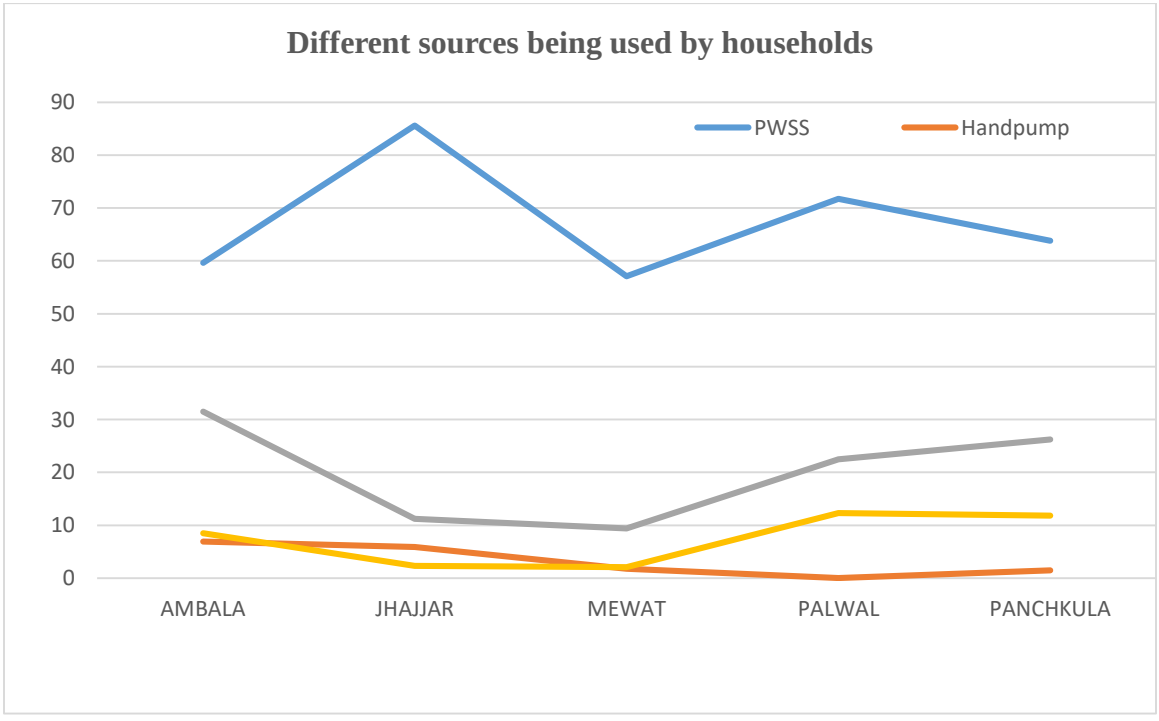

Figure 4.10 : Different type of water sources being used by households

4.4 WATER QUALITY FOUND IN THE STUDY AREA

The ground water of the studied area is utilized for washing, cleaning and other domestic purposes including drinking. All the water samples are collected from the hand pumps near the mentioned districts. The samples collected were analyzed for its physio-chemical characteristics. The following table shows the result of groundwater samples by bore testing of samples.

4.4.1 Water Quality found in Deep Wells

The quality parameters details are also discussed in brief below:

- **pH**

  The pH of water obtained form groundwater sources ranges from 6.5-8 with the mean pH of 7.02. The values obtained from the test are determined for deep wells and pond water sources.

- **Temperature**

  The temperature of water obtained from pond and deep wells ources ranges from 21^0C to 23^0C. The temperature of water controls the biological activity of water.

- **Coliforms**

  Coliforms in water represents the biological activity of water by counting pathogens in water.

- **Fluoride**

  Fluoride in water prevents the teeth from cavity but if exceeds the limit, it will cause bone fluorosis.

- **Dissolve Oxygen**

  The dissolved oxygen in water controls the self purification process of water

- **Phosphorus**

  The phosphorus quantity assessed from the test is quite less than other parameters. There is no standards laid by indian government to measure the standard quantity for drinking purpose.

- **Nitrate**

The major sources of nitrate in the groundwater are domestic sewage, runoff from agricultural fields. Its standard value is 45 mg/l.

- **Hardness**

Multivalent cations mainly Ca and Mg are generally present at considerable concentration in natural water. it will cause hardness to the water.

- **Chloride**

According to GOI manual, the chloride concentration for water supply is ranges from 200 mg/l to 1000 mg/l.

- **TDS**

TDS accounts for inorganic salts as well as organic matter that get dissolved in the water. EC and TDS values are comparatively proportional to each other.

- **Iron**

The ground water sample were alo analyzed for one of the most undesirable heavy metals viz. Fe. Its presence is highly disagreeable for drinking water consumption.

- **Turbidity**

Turbidity in water represents the suspended solids present in water which increases the color and odor to the water and makes it undesirable to use for drinking purposes. The turbidity of ground water is less than the turbidity of surface water.

Table 4.5 Quality Parameters found in deep wells in different districts

Parameters	AMBALA	JHAJJAR	MEWAT	PALWAL	PANCHKULA	STANDARD VALUE
Ph	8	8.5	8.3	8.2	8.5	6.5-8
Temperature (^{0}C)	21	21.5	21	22	22	-
Coliform	A	A	A	A	A	A
Fluoride (mg/l)	1.9	1.2	1.4	1.1	1.5	1-1.5
Dissolve Oxygen	10	9	8	7	9	>3 mg/l
Residual chlorine	0.1	0.1	0.1	0.1	0.1	0.2 mg/l
Phosphorus (µg/l)	105	110	113	225	116	10-30 µg/l
Nitrate	nil	nil	nil	Nil	Nil	45 mg/l
Iron	0.3	0.3	0.3	0.3	0.3	0.3 mg/l
Hardness	1100	850	1350	1220	1850	300-600 ppm
Chloride	1136	1150	1147	1350	1345	250-1000 mg/l
Turbidity	5	4	6	8	3	5-10 NTU
TDS	260	230	250	240	270	<400

In the study area, efforts were made to understand the water quality related aspect. Routine water quality testing of sources is done on the basis of bacteriological and chemical parameters. The different quality parameters are obtained is discussed in above table.

4.4.2 Water quality found in pond in the study area

In the study area, efforts were made to understand the water quality related aspect. Routine water quality testing of sources is done on the basis of bacteriological and chemical parameters.

Table 4.6 Quality parameters found in pond in different districts

Parameters	AMBALA	JHAJJAR	MEWAT	PALWAL	PANCHKULA	STANDARD VALUE
pH	10	9	11.5	9.3	9.7	6.5-8
Temperature (^{0}C)	22	23	22	23	26	-
Coliform	P	P	P	P	P	A
Fluoride (mg/l)	1.7	1.3	1.2	1.9	2.1	1-1.5
Dissolve Oxygen	0.3	0.6	0.9	0.7	0.8	>3 mg/l
Residual chlorine	0.1	0.1	0.1	0.1	0.1	0.2 mg/l
Phosphorus (µg/l)	100	104	97	189	108	10-30 µg/l
Nitrate	nil	nil	nil	nil	nil	45 mg/l
Iron	0.3	0.3	0.3	0.3	0.3	0.3 mg/l
Hardness	1170	1500	1750	1100	1840	300-600 ppm
Chloride	1136	1150	1147	1350	1345	250-1000 mg/l
Turbidity	5	4	6	8	3	5-10 NTU
TDS	260	230	250	240	270	<400

4.5 SANITATION STATUS IN THE STUDY AREA

In the study, toilet availability data, its usage, construction year were collected. The toilet availability and supply of water in the chosen area of households were also compared to know the relation between the sanitation status in different districts.

4.5.1 Household Toilets

In the study area, the coverage of household toilets were 54.6% was observed among the 1817 households surveyed. The percentage of toilets reported in the districts of study area can be seen from Table 4.7. The Mewat division covered the maximum no. of toilets construction with the minimum reported in Panchkula district.

Table 4.7 : Status of household toilet construction in study area

DIVISION COVERED	NO OF HOUSEHOLDS	HOUSEHOLDS WITH TOILET (%)	TOILET IN HOUSE HOLDS WITH OWN WATER SOURCE (%)	TOILET IN HOUSE HOLDS WITH COMMON WATER SOURCE (%)
AMBALA	475	52.7	69.2	31.8
JHAJJAR	265	34.1	51.7	48.3
MEWAT	483	64.1	67.3	33.7
PALWAL	315	41.4	92.7	8.3
PANCHKULA	279	36.6	66	34
TOTAL	1817	47.2	69.8	32.7

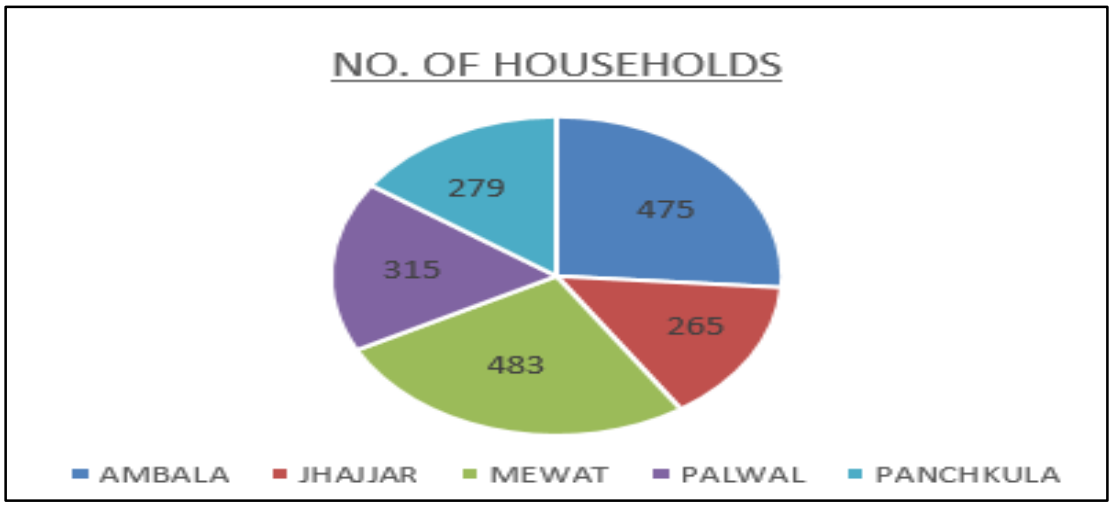

Figure 4.11: No. of Households in different divisions

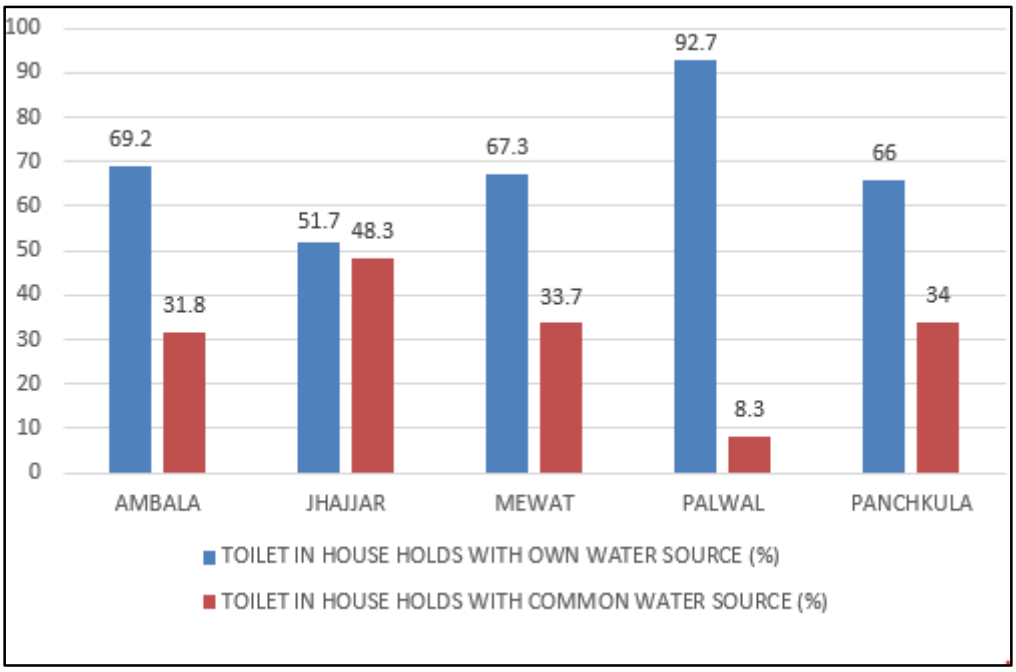

Figure 4.12 : Water sources used for sanitation purpose represented in bar chart

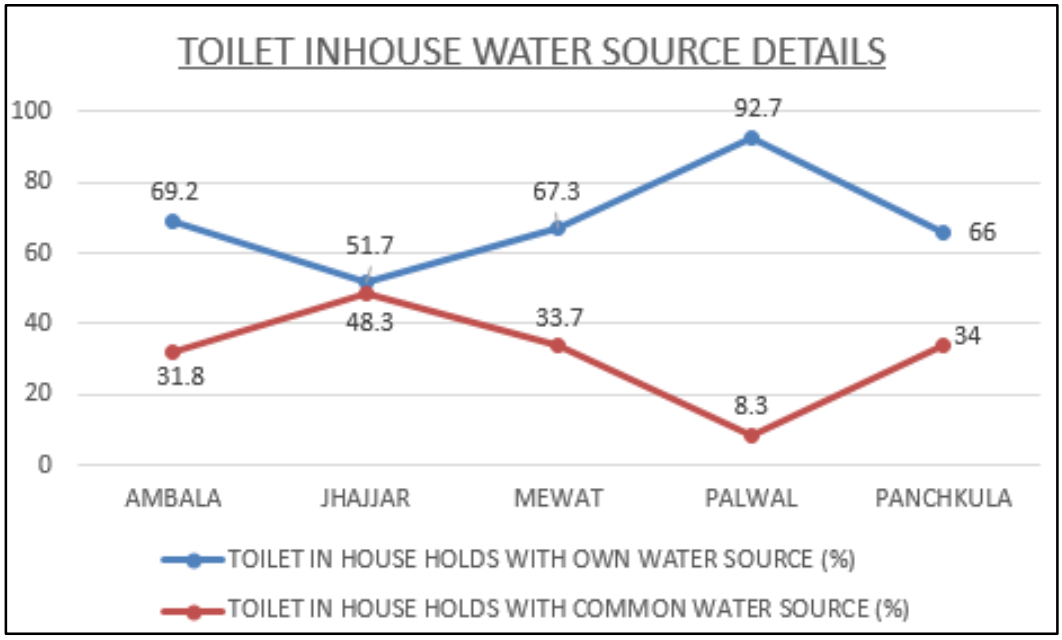

Figure 4.13 : Water sources used for sanitation purpose represented in line diagram

4.6 SOLID WASTE GENERATED IN STUDY AREA

Most household waste in rural areas is organic, with little inorganic material, and is non-toxic. Because of its environment-friendliness, composting is a highly suitable method of waste management in rural areas

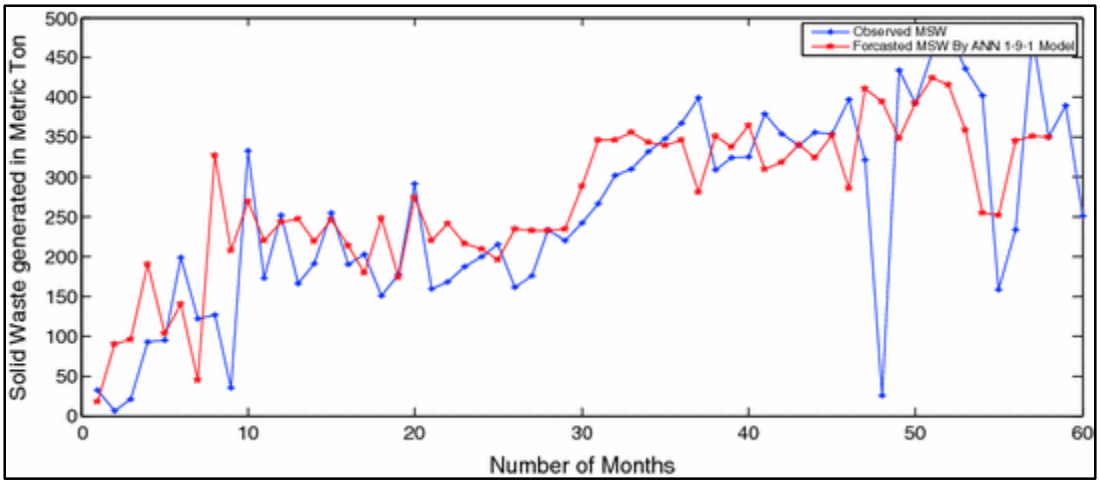

Figure 4.14: Solid Waste generated in the study area

CHAPTER 5

CONCLUSIONS AND RECOMMENDATIONS

5.1 CONCLUSIONS

The status of water supply in Haryana may be considered as satisfactory in terms of households data survey. The guidelines provided by the NRDWP, the ground water development by private and public agencies has been taken place for both Irrigation and Drinking purposes.

The pH values obtained in the district of Mewat is highest and also the increased amount of iron concentration created the incrustation problem on the pipe materials.

The household survey access for different sources of water show considerable improvements (67.8%) in the piped water supply status in the study area. According to the data obtained in Census 2011, the adequate quantity of water is the primary cause of satisfaction which is deriver for different divisions.

There is a scope to adopt improvements for overall management of schemes in substantial manner. In Anganwadis and Schools, the water availability seems to be better than in the availability for toilet facilities for villages. It has been observed that none of the anganwadis and schools had dedicated the facilities of hand washing. In the absence of these facilities, children use water placed in mug/bucket, handpumps or from drinking water storage tanks.

Theere are various conclusion which can be drawn from the study:

- Haryana adopted the technique of process of reform rather than many states in the country and it can be the rapidly implementing various steps to improve water and sanitation status in rural areas
- The schemes of piped water supply being managed by the GP's to higher extent. The issue related to regional water schemes fails to supply water to some of the habitations.
- According to the study done for ground water quality, it has been noticed that phosphate level was fluctuating with time with the variation of up and down
- The water collected from rain can also be diverted by constructing the drains of small sizes and also by small tributaries. Another best method can be of receiving water

includes the discharge of ground water. a very special attention has been given to recharge groundwater

- Artificial aeration process has come to be the best solution for keeping the healthy quality of pond by using purification and also supporting the aquatic life.

5.2 RECOMMENDATIONS

India; which is a developing country has still need to design more engineer water supply schemes to provide more potable water to every households in rural water supply sector. But, some measures can also be taken to avoid the problem of water supply in rural community.

The recommendations can be suggested in various manner described below in various points:

- By adopting suitable measures like lining of canals, village ponds, use of optimum water for irrigation purpose, and water courses, the problem of water logging can be avoided to increase the discharge from the aquifer below phreatic line by constructing of surface drains.
- The installation of shallow bore wells to be done so that the ground water can be withdrawn which may equals the annual recharge.
- The eucalyptus trees can be planted when the water table falls below 5m. It will play a dual purpose, first by providing the support to local farmers in economic way and secondly it lowers the water table by providing rapid transpiration.
- The fresh water can be used from canals for irrigation purpose should be arranged. Saline water should not be used for irrigation, if it will not stopped it will increase the salinity in the soil.
- The area of 140.29 sq. km. is underlain by rock in Delhi, the artificial recharge has been practiced Gabion and Bunding structures by streams flowing into the area.
- Rooftop rain water harvesting technology is adopted and the structures are constructed for recharge in depression areas where water can be collected in rainy days.

To meet the targets set by the Indian Governments “Swachh Bharat Mission” , there must be the technical support provided by the governments to demonstrate the sanitation status in rural area delivered with the scale of district and alo with the sustainable manner. Although we have already achieved to develop the hygiene condition in the rural area but there must be the future

scope to develop more in thin sector. There are a huge investments done by the government to focus more on this area. The proper utilization of money and also by increasing the awareness program, we can achieve the desired goal.

5.3 FUTURE SCOPE OF THE STUDY

Improving the health of women and children in India is paramount at this stage of India's development. Availability of safe drinking water supply and sanitation in rural areas and urban slums is critical to improved maternal and child health. USAID has highlighted the importance of water and sanitation interventions that include rural and urban water supply, water wells/water points, water harvesting, water transmission, latrines and toilets, point-of-use (POU) and other drinking water treatment, as well as water-related hygiene promotion. MCH-STAR plans to organize a technical consultation on water and sanitation interventions related to drinking water supply and sanitation for improved maternal, neonatal, child health and nutrition outcomes in India. MCH-STAR will bring together international and national experts and key stakeholders working in the field of Drinking Water and Sanitation to share evidence and deliberate on what is working. More specifically, the technical consultation will explore recent research and program evidence on water and sanitation interventions in India associated with improved MNCHN outcomes, and identify emerging research and evaluation, technical assistance, policy analysis and advocacy priorities in the area of water and sanitation relevant to the Indian context. Following the consultation, MCH-STAR will provide technical and financial support to its STAR-supported Institutions. Keeping these objectives in mind, MCH-STAR proposes to engage a consultant to develop a background paper to scan the Indian environment of what research and evidence-based interventions have been in recent years and are currently being done in India in the arena of Drinking Water Supply and Sanitation relevant to the health of mothers and children. The consultant will also generate a list of national and international experts, government ministries and departments, research institutions, private companies, technical assistant agencies, projects, non-governmental organizations and key stakeholders that are contributing significantly to the field of Drinking Water Supply and Sanitation within the country. This background paper will enable MCH-STAR to plan and design a Technical Consultation that is currently relevant, evidenced-based, and is able to produce a set of recommendations on critical technical directions and guidelines for action that will be useful to USAID/India and other key stakeholders.

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