1. **INTRODUCTION:**

This chapter included the background of research area, current status of problems and objectives of the research. Groundwater is an important source of drinking water in many countries, providing approximate 50% of global drinking water supply, as well as significant part of water required for industrial and agriculture purposes. The availability of freshwater is one of the greatest issues facing mankind nowadays, because problems associated with water and are affecting the lives of many millions of people. Water scarcity is a critical issue because 1.1 billion of the world’s 6 billion people lack access to safe drinking water (World Health Organization, 2003). The rapid growth of population together with the steady increase in water requirements for agricultural and industrial development has imposed severe stress on the available water resources. According to Scanlon et al. (2007), water requirements for food production will increase to meet demands of the projected 50% increase in global population from 6 billion in 2000 to 9 billion in 2050. Meeting the United Nations Millennium Development Goal of reducing the proportion of people that suffer from hunger by 50% by 2015 is putting additional stress on limited water resources. Therefore, freshwater resources in terms of both the quantity and quality, requires consistent and careful assessment and management for its sustainable development.

The chemical, physical and bacteriological characteristics of groundwater determine its usefulness for municipal, commercial, industrial, agricultural, and domestic water supplies (Walton, 1970). Water pollution is a serious problem in India as almost 70 per cent of its surface water resources and a growing percentage of its groundwater reserves are contaminated by biological, toxic, organic, and inorganic pollutants. About 95% of rural population living in India depends on groundwater for domestic use (Moharir et al., 2002). According to some estimates, it accounts for nearly 80 percent of the rural domestic water needs, and 50 percent of the urban water needs.
in India (Dinesh and Tushaar, IWMI). Groundwater is generally less susceptible to contamination and pollution when compared to surface water bodies. In many cases, these sources have been rendered unsafe for human consumption as well as for other activities, such as irrigation, industrial needs and domestic purpose. This shows that degraded water quality can contribute to water scarcity as it limits its availability for both human use and for the ecosystem. In 1995, the Central Pollution Control Board (CPCB) identified severely polluted stretches on 18 major rivers in India. Not surprisingly, a majority of these stretches were found in and around large urban areas. The high incidence of severe contamination near urban areas indicates that the industrial and domestic sectors’ contribution to water pollution is much higher than their relative importance implied in the Indian economy.

National Capital Territory (NCT) of Delhi occupies an area of 1483 sq.km. with the population density of 9344 persons/sq.km. The projected population for year 2009 works out to be 176 lakhs and total water requirement for drinking and domestic purposes, 927 million gallons per day (MGD). The Delhi Jal Board (DJB) supplies 815 MGD (including around 100 MGD from groundwater). The deficit in drinking water supply works out to be 112 MGD. This deficit in drinking water supply of Delhi can be partially augmented through exploitation of groundwater resources. The groundwater availability in Delhi area is controlled by the hydrogeological conditions characterized by different geological formations. The major aquifers contributing to the groundwater are fine to medium sand of older alluvium, medium to coarse sand of small newer alluvium along the Yamuna Flood Plain (YFP) and the hard rock formations occupied by quartzite, inter-bedded with mica schist belonging to Delhi Super Group (DSG). The depth of water in the Delhi state varies greatly from 1.2 meter (in the Yamuna flood plain) to more than 64 meters (in the southern part of the Delhi Ridge) below ground level (Shashank et al., 2015). The groundwater
is declining in majority of the areas of Delhi on account of overexploitation of the resources. The rate of decline is as high as 1.7 to 2 meters/year in some areas (South & South west Dist.). Thus seven out of nine districts of Delhi are categorized as overexploited with respect to dynamic groundwater resources. The groundwater quality shows horizontal and vertical variation in space. The deeper aquifers are mostly underlain by saline water in alluvial areas (Hemanti, 2014). The extent of fluoride contamination in groundwater is also high in western part of Delhi in areas like Northwest, Southwest & West districts. The groundwater management aspects of Delhi emphasizes on augmentation of groundwater resources and improvement in groundwater quality through measures like rainwater harvesting and artificial recharge, conservation of groundwater by limiting withdrawal in overexploited areas and limited development of potential aquifers of Delhi to augment drinking water supply (CPCB, 2007).

The World Development Report says: Delhi’s water supply is among the worst in many big cities of the developing world. The Central Pollution Control Board (CPCP) has found that the tap water in Delhi contains carcinogenic substances and the toxic quotient is five times higher than the WHO standards. It is reported that of the 1.42 million villages in India, 1, 96,813 villages are affected by chemical contamination of water.

The water supply from rivers is invariably contaminated to a greater extent by bacteria, viruses and parasites. These are found in large numbers in domestic sewage, effluent from slaughter houses and animal processing plants, all of which contaminate water catchment areas (Gupta YP, 2015).

Over 18,000 million litres of untreated sewage water enters the Yamuna river daily, passing through Delhi, and thereby polluting it with toxic chemicals and high level of coliform and other bacteria. The high level of coliform bacteria increases the incidence of water-borne diseases. These
microbes grow in the intestines of humans and animals, where they multiply and thereby cause disease.

According to the recently released 'Ground Water Year Book 2011-12' by the Central Ground Water Board has found that Nitrate concentrations in some parts of the city are as high as 1500 mg/l. This can have grave health impacts as the concentrations are several times higher than the prescribed safe limit. The permissible limit for Nitrate as per Bureau of Indian Standards (BIS) is only 100 mg/l and the Maximum Contaminant Level (MCL) according to the US Environment Protection Agency (EPA) is just 10 mg/l (TOI, 2014). Data indicates that higher concentrations of nitrates are found at the places where domestic effluent is discharged into open unlined drains and usually these places are thickly populated.

It is evident that many parts of the industrial area in India are colonized and in very close vicinity of the industries using groundwater for drinking, cleaning, bathing, domestic and other agricultural practices. In the close vicinity of this industrial area, there is a dense population of residents who generally use underground water for most of their domestic purposes (Wequar et al., 2009).

Historically, groundwater supplies were thought to be free of pathogenic microbes due to the natural filtering ability of the subsurface environment and the distance a microbe would have to travel in order to reach the groundwater source. Contaminants that find their way into groundwater may originate due to lack of treatment, improper management of wastewater disposal, septic tank contamination, underground storage tank or landfill leaks, mismanagement of animal waste disposal or many other reasons like saturation of soil profile with the sewage waste (Reynolds, 2004).

The natural impurities in rainwater, which replenishes groundwater systems, get removed while infiltrating through soil strata. But, In India, where groundwater is used intensively for irrigation
and industrial purposes, a variety of land and water-based human activities are causing pollution of this precious resource. Its over-exploitation is causing aquifer contamination in certain instances, while in certain others its unscientific development with insufficient knowledge of groundwater flow dynamic and geo-hydrochemical processes has led to its mineralization (Dinesh and Tushaar, 2004).

Non-point pollution caused by fertilizers and pesticides used in agriculture, often dispersed over large areas, is a great threat to fresh groundwater ecosystems. Intensive use of chemical fertilizers in farms and indiscriminate disposal of human and animal waste on land results in leaching of the residual nitrate causing high nitrate concentrations in groundwater. Nitrate concentration is above the permissible level of 45 ppm in 11 states, covering 95 districts and some blocks of Delhi. Pollution of groundwater due to industrial effluents and municipal waste in water bodies is another major concern in many cities and industrial clusters in India. A 1995 survey undertaken by Central Pollution Control Board (CPCB) identified 22 sites in 16 states of India as critical for groundwater pollution, the primary cause being industrial effluents. No estimates of the public health consequences of groundwater pollution as it involve methodological complexities and logistical problems (Machender et al., 2012).

Because of their small size and ease transport in the subsurface, bacteria were traditionally thought to be the most likely pathogen to be found in groundwater. Fecal coliforms (sometimes faecal coliforms) are facultative-anaerobic, rod-shaped, gram-negative, non-sporulating bacteria. Fecal coliforms are capable of growth in the presence of bile salts or similar surface agents. They are oxidase negative, and produce acid and gas from lactose within 48 hours at 44 ± 0.5°C. Coliforms include genera that originate in feces (e.g. Escherichia) as well as genera not of fecal origin (e.g. Enterobacter, Klebsiella, Citrobacter) (Kumar et al, 2014). In general, increased levels of fecal
coliforms provide a warning of failure in water treatment, a break in the integrity of the distribution system, or possible contamination with pathogens. When levels are high, there may be an elevated risk of waterborne gastroenteritis, typhoid fever, diarrheal, dysentery, cholera etc. Nearly 90% of diarrheal-related deaths have been attributed to unsafe or inadequate water supplies and sanitation (WHO, 2004) conditions affecting a large part of the world’s population (Hughes and Koplan 2005). An estimated 1.1 billion people (one sixth of the world’s population) lack access to clean water and 2.6 billion to adequate sanitation (WHO, 2005).

A recent report by the United Nations says that more than three million people in the world die from water-related diseases due to contaminated water each year, including 1.2 million children. In India, over one lakh people die of water-borne diseases annually. It is reported that groundwater in one-third of India’s 600 districts is not fit for drinking as the concentration of fluoride, iron, salinity and arsenic exceeds the tolerance levels. About 65 million people have been suffering from fluorosis, a crippling disease due to high amount of fluoride and five million are suffering from arsenicosis in West Bengal due to high amount of arsenic. A World Resources Report says: about 70 per cent of India’s water supply is seriously polluted with sewage effluents. The UN reported that India’s water quality is poor - it ranks 120th among the 122 nations in terms of quality of water available to its citizens.

Viewed from the International standard that <1,700 m3/person/year’ qualifies as water stressed and ‘1,000 m3/person/year’ as water scarce, India is water-stressed today and is likely to face severe water scarcity by 2050. Delhi, as the rapidly growing capital city of Asia, is facing problems in terms of both the groundwater quality and quantity.
Water-borne diseases like cholera, gastroenteritis, diarrhoea erupt every year during summer and rainy seasons in India due to poor quality drinking water supply and sanitation. Here is a list of the 5 most dangerous water related diseases that occur in India, which are described as follows:

1) **Cholera**

   India has made significant strides in cholera over the past few decades. While cholera deaths are negligible and cholera cases decreased by 77% from 5004 in 2010 to 1127 in 2013, they surged by 137% in 2014, when last counted.

   **Figure 1. Case of cholera in India, 2008-14**

![Cases Of Cholera In India, 2008-14](image)

2) **Diarrhoea**

   Among 15 high-burden countries, India ranks third from the bottom for its use of life-saving intervention for children at risk of dying from diarrhoea and pneumonia, according to this 2014 study. Although diarrhoeal disease cases decreased 8% from 11.7 million in 2012
to 10.7 million in 2013, a lot needs to be done. In 2014, 7.6 million cases were registered, when last counted.

Figure 2. Case of acute diarrhoeal disease in India, 2008-14 (in million)

3) Viral Hepatitis: Viral Hepatitis cases reduced by 12% from 0.118 million in 2012 to 0.104 million in 2013. But the disease is a threat, capable of resurgence: In 2014, 0.09 million cases were registered at last count.
4) Typhoid

The number of typhoid cases have increased 65% from 0.93 million cases in 2008 to 1.53 million in 2013, although deaths due to typhoid hovered around the 350-to-450 range. In 2014, 1.09 million cases were registered.
5) **Filariasis**

Cases and deaths due to acute encephalitis syndrome (AES) is an increasing problem in India. AES cases increased 159% from 3,855 in 2008 to 9,996 in 2014, while deaths increased by 122% from 684 in 2008 to 1,518 deaths in 2014.
The objective of the present study was to estimate the hydro-chemical data of groundwater and nine major overloaded unlined drains of Delhi locations named Najafgarh drain, Okhla drain, Shahdara drain, Khyberpass drain, Mori gate drain, Delhi gate drain, Barapullah drain, Maharani Bagh drain and Kalkaji drain in order to explore the preliminary, chemical and microbial contamination of groundwater through setup lysimetric experiments to know the leaching properties of pollutants from surface to groundwater aquifer. All the recorded mean values of water quality parameters were compared with World Health Organization (WHO) standard.