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Assessment of Severity of Water Pollution Near Kureepuzha Dump Yard

AJMAL M SAJEEV

CHAPTER.1 INTRODUCTION

1.1 GENERAL

Pollution is the process of making land, water, air or other parts of the environment dirty and unsafe or unsuitable to use. This can be done through the introduction of contaminants into a natural environment, but the contaminant doesn't need to be tangible. Things as simple as light, sound and temperature can be considered pollutants when introduced artificially into an environment. Thus, pollution can take the form of chemical substances or energy, such as noise, heat or light. Pollutants, the components of pollution, can be either foreign substances/energies or naturally occurring contaminants. Pollution is often classed as point source or nonpoint source pollution. Pollution started from prehistoric times when man created the first fires. According to a 1983 article in the journal Science, "soot" found on ceilings of prehistoric caves provides ample evidence of the high levels of pollution that was associated with inadequate ventilation of open fires. It was the industrial revolution that gave birth to environmental pollution as we know it today. London also recorded one of the earlier extreme cases of water quality problems with the Great Stink on the Thames of 1858, which led to construction of the London sewerage system soon afterward. Pollution issues escalated as population growth far exceeded view ability of neighborhoods to handle their waste problem. The major forms of pollution are:

- Air pollution: Air pollution is the release of chemicals and particulates into the atmosphere. Common gaseous pollutants include carbon monoxide, sulfur dioxide, chlorofluorocarbons (CFCs) and nitrogen oxides produced by industry and motor vehicles.
- Water pollution: Water pollution is caused by the discharge of wastewater from commercial and industrial waste (intentionally or through spills) into surface waters; discharges of untreated domestic sewage, and chemical contaminants, such as chlorine, from treated sewage; release of waste and contaminants into surface runoff flowing to surface waters (including urban runoff and agricultural runoff, which may contain

chemical fertilizers and pesticides); waste disposal and leaching into groundwater; eutrophication and littering.

 Soil contamination occurs when chemicals are released by spill or underground leakage. Among the most significant soil contaminants are hydrocarbons, heavy metals, herbicides, pesticides and chlorinated hydrocarbons.

 Noise pollution: Noise pollution is one which encompasses roadway noise, aircraft noise, industrial noise as well as high-intensity sonar.

1.2 WATER POLLUTION

Water pollution is the contamination of water bodies (e.g. lakes, rivers, oceans, aquifers and groundwater). This form of environmental degradation occurs when pollutants are directly or indirectly discharged into water bodies without adequate treatment to remove harmful compounds. Water pollution affects the entire biosphere – plants and organisms living in these bodies of water. In almost all cases the effect is damaging not only to individual species and population, but also to the natural biological communities. Water pollution is a major global problem which requires ongoing evaluation and revision of water resource policy at all levels (international down to individual aquifers and wells). It has been suggested that water pollution is the leading worldwide cause of deaths and diseases, and that it accounts for the deaths of more than 14,000 people daily. An estimated 580 people in India die of water pollution related illness every day. About 90 percent of the water in the cities of China is polluted. As of 2007, half a billion Chinese had no access to safe drinking water. In addition to the acute problems of water pollution in developing countries, developed countries also continue to struggle with pollution problems. For example, in the most recent national report on water quality in the United States, 44 percent of assessed stream miles, 64 percent of assessed lake acres, and 30 percent of assessed bays and estuarine square miles were classified as polluted. The head of China's national development agency said in 2007 that one quarter the length of China's seven main rivers were so poisoned the water harmed the skin. Water is typically referred to as polluted when it is impaired by anthropogenic contaminants and either does not support a human use, such as drinking water, or undergoes a marked shift in its ability to support its constituent biotic communities, such as fish. Although interrelated, surface water and groundwater have often been studied and managed as separate resources. Surface water seeps through the soil and becomes groundwater. Conversely, groundwater can also feed surface water sources. Sources of surface water pollution are generally grouped into two categories based on their origin.

1.2.1 POINT SOURCES

Point source water pollution refers to contaminants that enter a waterway from a single, identifiable source, such as a pipe or ditch. Examples of sources in this category include discharges from a sewage treatment plant, a factory, or a city storm drain. The U.S. Clean Water Act (CWA) defines point source for regulatory enforcement purposes. The CWA definition of point source was amended in 1987 to include municipal storm sewer systems, as well as industrial storm water, such as from construction sites.

1.2.2 NON-POINT SOURCES

Nonpoint source pollution refers to diffuse contamination that does not originate from a single discrete source. NPS pollution is often the cumulative effect of small amounts of contaminants gathered from a large area. A common example is the leaching out of nitrogen compounds from fertilized agricultural lands.[11] Nutrient runoff in storm water from "sheet flow" over an agricultural field or a forest are also cited as examples of NPS pollution.

1.2.3 GROUNDWATER POLLUTION

Interactions between groundwater and surface water are complex. Consequently, groundwater pollution, also referred to as groundwater contamination, is not as easily classified as surface water pollution.[8] By its very nature, groundwater aquifers are susceptible to contamination from sources that may not directly affect surface water bodies, and the distinction of point vs. non-point source may be irrelevant. A spill or ongoing release of chemical or radionuclide contaminants into soil (located away from a surface water body) may not create point or non-point source pollution but can contaminate the aquifer below, creating a toxic plume. The movement of the plume, called a plume front, may be analyzed through a hydrological transport model or groundwater model. Analysis of groundwater contamination may focus on soil characteristics and site geology, hydrogeology, hydrology, and the nature of the contaminants.

Major causes of water pollution include;

- Human dumping: Due to human dumping of waste and other harmful substances in to river water directly.
- Industrial waste release: Most industries release their processing waste into the water bodies. This is an easy method for them to get rid of waste. But by release of industrial sewage into river water there is severe pollution to the water.
- Land water flow: Contamination during rains due to flow of rain water from contaminated land into rivers. In-case of floods where water from river flows over surrounding lands. This flow collects all the possible waste and dump into river.
- Air pollution: The air pollution is formed by disposal of harmful gases into air. This pollution from air in-turn returns to ground through rains and contaminate ground water and river waters. This indicates that the pollution we create finally reaches us in one or other way.
- Farm pollution: Farming is the industry which relies largely on river water. The river water is used for irrigation. But pesticides and other toxic chemicals are used by farmers to control diseases. These toxins reach the river canals which supply water the cities and towns ahead.
- Improper Drainage system: Drainage system pollution, this is the form of water pollution where sewage and normal public water supply mix up. This is seen especially in cities where water is pumped from distant out places. This occurs when there is leakage of sewage water and mixing with that of pure water supplied by municipal water pipes. This happens when both sewage draining pipes and pure water supply pipes are passing close to each other and there are some leaks in the pipes. In course of travel in pipe lines, there are chances of any drainage system flowing nearby. This provides chances of mixing of both waters leading to sewage water pollution. This is one of the prime reasons for infectious diseases caused due to water.
- Groundwater contamination: Water on the land is absorbed by the soil. Along with water any chemicals or toxin on the land are also absorbed. This happens at places of open dumping of solid waste. These harmful substances on the land percolate into deep ground layers (leachate) causing pollution. Thus there are many cases where ground water from bore-well was found to be causes of water pollution.
- Plastic waste: Plastic is another threat adding to marine water pollution. Plastic pollution occurs due to accumulation of plastic waste for long in the seas beds as it is not decomposed fast. It is thought to be responsible for destruction of aquatic environment.
- Due to fisheries: Fisheries is a part of agriculture but mainly depend on rivers. Many chemicals

and drugs are used to enhance fish growth.

- Due to leakage of petroleum and other oils from vehicles etc. on to the local roads. Even from mechanic sheds this is released. These petroleum wastes are mixed with ground andother water sources.

1.3 DISPOSAL OF SOLID WASTE

In India, in most of the cities solid waste is disposed of by open dumping. The accumulated dumps produced nuisances such as smoke foul smell, air borne litter, presence of pathogens and rodents and mosquito breeding. Rapid increase in population and change in life style have resulted in a dramatic increase in the generation of municipal solid waste (MSW). It includes domestic as well as commercial waste that accounts for a relatively small part of the total solid waste stream in developed countries. Accumulation of a large amount of waste may create several problems to inhabiting populations. Population growth has been contributing to increase the quality and variety of waste. Collection, transportation and handling of the waste must also be properly dealt with, if not, the waste creates a number of problems, many of which are related to human health and environment. It is unfortunately observed that developing countries where the waste is dumped directly in unscientific and uncontrolled manners can be detrimental to the urban environment. MSW leachate contains variety of chemicals like detergents, inorganic chemicals and complex organic chemicals and metals. These components are themselves very much toxic for the environment and additionally uncontrolled microbial action may result in release of more toxic elements which were not present in a free or reactive form in the waste. During infiltration of water by rainfall, water already present in the waste, or water generated by biodegradation cause the leachate to leave the dumping ground laterally or vertically and find its way into the ground water thereby causing contamination. Open dumps are well known to release large amounts of hazardous and otherwise deleterious chemicals to nearby ground water and to the air, via leachate ("garbage juice") and landfill gas. It is known that such releases contain a wide variety of potential carcinogens and potentially toxic chemicals that represent a threat to public health. However, little quantitative information exists on the total hazard that open dumping site caused to those who lived near the landfill. The leachate from MSW landfills is a highly concentrated "chemical soup" so concentrated that small amount of leachate can pollute large amounts of ground of water rendering it unsuitable for use for domestic water supply. Both gas and leachate from MSW landfills contain many organic chemicals that have not been characterized with respect to specific chemical content or their associated public health or other hazards. Solid wastes openly dumped or landfilled undergo various biochemical degradation processes. Aerobic and anaerobic reactions produce a wide variety of leachable bye products. Many of them get transformed into pollutants affecting both land and water resources. The leachate containing numerous inorganic and organic compounds accumulated at the bottom of the landfill and slowly percolated through the soil. Infiltration of leachate into the ground water directly or indirectly by rain has turned into a major threat to ground water resources (USEPA, 1984; Fatta et al, 1999). Areas near the landfills have greater chances of contamination, producing substantial risks to the natural environment and to the local resources. The changes that are produced by the leachates on the quality of potable water have received much attention in recent times.

1.4 OBJECTIVES OF THE WORK

- To determine the bacteriological and physiochemical characteristics of water samples.
- To suggest suitable remedy to the problems arising by the MSW dump yard kureepuzha.

CHAPTER.2 LITERATURE REVIEW

- Raman *et.al.* (2008): Soil and groundwater samples were collected nearer to Pallavaram Solid waste landfill-site in Chennai to study the possible impact of solid waste effect on soil and ground water quality. The physical and chemical parameters such as temperature, pH, hardness, electrical conductivity, total dissolved solids, total suspended solids, alkalinity, calcium, magnesium, chloride, nitrate, sulphate, phosphate and the metals like sodium, potassium, copper, manganese, lead, cadmium, chromium, nickel, palladium, antimony were studied using various analytical techniques. It has been found that most of the parameters of water are not in the acceptable limit in accordance with the IS 10500 Drinking Water Quality Standards. It is concluded that the contamination is due to the solid waste materials that are dumped in the area.

- Kanmani *et.al.* (2012): The concentration of heavy metals was studied in the soil samples collected around the municipal solid waste (MSW) open dumpsite, Ariyamangalam, Tiruchirappalli, Tamilnadu to understand the heavy metal contamination due to leachate migration from an open dumping site. The dump site receives approximately 400–470 tonnes of municipal solid waste. Solid waste characterization was carried out for the fresh and old municipal solid waste to know the basic composition of solid waste which is dumped in the dumping site. The heavy metal concentration in the municipal solid waste fine fraction and soil samples were analyzed. The heavy metal concentration in the collected soil sample was found in the following order: Mn≥ Pb≥Cu≥Cd. The presence of heavy metals in soil sample indicates that there is appreciable contamination of the soil by leachate migration from an open dumping site. However, these pollutants species will continuously migrated and attenuated through the soil strata and after certain period of time they might contaminate the groundwater system if there is no action to be taken to prevent this phenomenon.

- Gautam *et.al.* (2011): The study was done at Sewapura MSW dumpsite near Jaipur to assess the ground water quality in and around the study area. The results reveal that high amount of Fluoride (2.4 - 3.2 mg/l). Chlorides (288.4 – 1038.2 mg/l) and TDS (610.4 – 1828.4 mg/l) are present in the studied samples which are of higher range of acceptable limits. The ground water in the study area is being polluted by percolation of toxic substances into it. MSW dumping in the open area should be prohibited by the authoritiesto control the further pollution of water.

- Adeolu *et.al.* (2011): Physio-chemical and microbiological parameters were analyzed in leachate and groundwater samples obtained at different locations adjacent to a municipal solid waste landfill in order to assess the impact of leachate percolation on groundwater quality. Total dissolved solids (TDS), electrical conductivity (EC), and Na+ exceeded the World Health Organization (WHO) tolerance levels for drinking water in 62.5, 100, and 37.5% of the groundwater samples, respectively with pH and Fe exceeding WHO limits in 75% of the samples. Significant negative correlations of -0.839, -0.590, and -0.590 were shown by Na+ , TDS, and EC respectively to distance from landfill. A high population of Enterobacteriaceae ranging from 4.0 × 103 ± 0 to 1.0575 × 106 ± 162,705 CFU/ml was also detected in the groundwater samples, indicating contamination. The results show that the leachate from the landfill has a minimal impact on the groundwater resource and this can be attributed to the existing soil stratigraphy at the site consisting of clay which is deduced to have a significant influence on the natural attenuation of leachate into groundwater.

- VenkataRamaiah *et.al.* (2014): In this study an effort has been made to study the extent of ground water contamination due to percolation of leachate on the surrounding soil and ground water in around the dump site. Six sampling points were selected within 0.5 km radius of the dump site from where the ground water samples were taken and leachate samples were collected from the existing leachate pond.

- SohailAyub *et.al.* (2015): This review paper basically throws light on the ground water contamination due to leachate which is basically caused by non-engineered landfills or open landfills in India and abroad as found by various researchers.

- NitinKamboj *et.al.* (2013): In this study the impact of domestic wastes disposal on ground water quality at Delhi, India was analysed. The samples of ground water were collected and analyzed for various physio-chemical parameters viz. conductivity, total dissolved solids (TDS), alkalinity, total hardness, calcium, magnesium, chloride, sulphate, nitrate, phosphate, fluoride, sodium and potassium. The present study concluded that the chloride and TDS in water samples were above to the desirable limit and below to the permissible limit of BIS and rest all other parameters were within desirable limit.

CHAPTER.3 METHODOLOGY

3.1 STUDY AREA

The study area selected was about 0.5 km radius around Kureepuzha solid waste dump yard. It was started as solid waste dumping depot before independence. By 1985, problems began to arise due to open dumping of wastes including plastics. It was found that the life for the residents of the area have become miserable as heaps of waste and garbage are always kept open in the premises, flies collect in large numbers to which a very powerful chemical is used which is extremely harmful to the people particularly to the old age and children. The site is located 6 km away from the city and where the density of population is high and large number of residences is also situated. Close to the Plant is situated the beautiful Ashtamudi lake. It was the only dump yard under Kollam Municipal Corporation with 260 collection points. Current situation is non- functioning of plant.

Fig: 3.1- KUREEPUZHA DUMP YARD

3.2 QUESTIONNAIRE SURVEY

A questionnaire survey was conducted in the houses around the study area. The followingtable shows the data obtained from the survey.

Table: 3.1– QUESTIONNAIRE SURVEY

SL NO:	HOUSE NO:	DISTANCE FROM PLANT	NO:OF OCCUPANTS	SOURCE OF WATER	PRESENCEOF COLOUR, ODOUR AND TASTE		ANY HEALTH EFFECTS	
					YES	NO	YES	NO
1	268	120m	4	Well	*		*	
2	440	100m	2	Well	*		*	
3	446	165m	4	Well	*		*	
4	449	200m	5	Well	*		*	
5	472	250m	3	Well	*		*	
6	483	300m	4	Well		*		*
7	489	370m	5	Well		*		*

8	TEMPLE	100m	-	Well	*		*	
9	SCHOOL	50m	-	Well	*		*	

3.3 SAMPLING POINTS

Based on table 3.1, sampling points were selected as shown in table 3.2. The points fromlake were selected based on previous studies.

Table: 3.2– SAMPLING POINTS

SAMPLE NUMBER		TYPE	DISTANCE FROM PLANT
1		HOUSE NO: 268	120m
2		HOUSE NO: 440	100m
3		HOUSE NO: 446	165m
4	4.1	LAKE (surface)	5m
	4.2	LAKE (0.5m from surface)	5m
5	5.1	LAKE(surface)	10m
	5.2	LAKE(0.5m from surface)	10m
6		SCHOOL	50m
7		TEMPLE	100m

3.4 SAMPLING

Polythene bottles sterilized in hot water was used for sampling. The water samples were collected carefully so that it has minimum air contact. Bottles were then labelled with necessary details like sample no: , date and time of sampling. These samples were tested within 24 hours of sampling. Extra care was taken while collecting samples from the lake. Two points were selected and from each points two samples were collected at different depths ie, one sample from surface and other at a depth of 0.5 m.

Fig: 3.2 – SAMPLING BOTTLE

3.5 SAMPLE ANALYSIS

3.5.1 BACTERIOLOGICAL ANALYSIS

3.5.1.1 E COLI NUMBER

The MPN procedure involves a multiple tube fermentation technique where three or more decimal dilutions of the sample are inoculated into tubes of broth medium and incubated at a specific temperature and for a specific time. The method is progressive; i.e., first determining the presence of coliforms in the tubes, then determining if these tubes also contain fecal coliforms, and then confirming whether E. coli is present. Based on the number of tubes indicating the presence /absence of the three groups of organisms, the most probable number present can be estimated from a standard statistical MPN table.

3.5.2 PHYSIOCHEMICAL ANALYSIS

3.5.2.1 ACIDITY

Acidity of water is its capacity to neutralize a strong base to designated pH. Acidity contributes corrosiveness to water and influence certain chemical and biological processes. Acidity is determined by titrimetric method using 0.02N NaOH as titrant and methyl orange and phenolphthalein as indicator. The acidity of a water sample is its capacity to neutralize hydroxide ions. Acidity may be caused by mineral acids such as sulfuric acid or hydrochloric acid or by dissolved carbon dioxide. Most commonly in drinking water, carbon dioxide is the principal cause of acidity. Acidity increases the corrosive behavior of water. Drinking water with a high acidity is likely to be corrosive to copper water pipes and to the solder which joins those pipes. High levels of copper and lead in drinking water often occur when acidic water stands in pipes for extended periods of time (such as overnight). In addition to creating a possible health hazard due to dissolved metal ions, acidity in water can cause copper plumbing to develop pin holeleaks after a few years.

Acidity was measured by titration with sodium hydroxide to an accepted pH value. Phenolphthalein is an acid-base indicator which changes from colorless to a pink (magenta) at a pH of about 8.3. It was measured by titration of water sample to pH 8.3 with NaOH titrant. Metacresol purple also changes color at pH 8.3, but gives a sharper color change than phenolphthalein. If available, its use is recommended over phenolphthalein. If a water sample is at the alkaline color of the indicator before any titrant is added, then the acidity is zero and the alkalinity of the water should be tested.

3.5.2.2 ALKALINITY

Alkalinity of water is its quantitative capacity to neutralize strong acids to designated pH. It is primarily due to the salts of weak acids or weak or strong bases. Alkalinity influences chemical and biological processes in water. Alkalinity is the measure of a water sample's ability to neutralize hydrogen ions (its acid-neutralizing ability). Alkalinity may be caused by dissolved strong bases such as sodium hydroxide or potassium hydroxide (and other hydroxide-containing compounds), and it may also be caused by dissolved carbonates, bicarbonates, borates, and phosphates. The measured alkalinity is the total of all of these species found in a water sample. For the sake of simplicity, it is expressed in terms of mg CaCO3/L although many species other than dissolved calcium carbonate may actually contribute to the alkalinity. One important environmental consequence of alkalinity is the ability of a body of water to withstand acidification due to acidic precipitation or atmospheric deposition. A body of water may have a fairly neutral pH, but if its alkalinity is low, it will be readily acidified. A body of water with the same pH but with higher alkalinity will have a greater buffer capacity and, consequently, a greater resistance to acidification.

3.5.2.3 HARDNESS

Hardness is caused by divalent metallic cations capable of reacting with soap to form precipitates and with certain anions present in the water to form scale in hot water pipes, heaters, boilers etc. The principal hardness causing cations are calcium, magnesium, strontium, ferrous iron and manganese ions. Hardness of water sample was determined by titrating sample mixed with EBT indicator against EDTA.

3.5.2.4 DISSOLVED OXYGEN

Oxygen is poorly soluble in water. The solubility of atmospheric oxygen in fresh water ranges from 14.6 mg/l to 7mg/l. Determination of DO serves as the basis of BOD test. The amount of oxygen found dissolved in given water at a given temperature and pressure is known as the dissolved oxygen.DO is determined using Winkler method. In this method, the titrant used is sodium thiosulphate and reagents used are azide alkali iodide reagent, manganese sulphate, starch solution and concentrated sulphuric acid. Reduced DO levels in stream water may be because the water is too warm. The increased molecular activity of the warm water pushes the oxygen molecules out of the spaces between the moving water molecules. Decreased DO levels may also be indicative of too many bacteria and an excess amount of biological oxygen demand - BOD (untreated sewage, partially treated sewage, organic discharges, anoxic discharges) which use up DO. A third reason for decreased DO may be fertilizer runoff from farm fields and lawns. The same fertilizer which was meant to make land plants grow better now makes the aquatic plants do the same. If the weather becomes cloudy for several days, respiring plants will use much of the DO while failing to photosynthesize. When the increased numbers of aquatic plants eventually die, they support increasing amounts of bacteria which use large amounts of DO.

3.5.2.5 BOD (Biochemical oxygen demand)

BOD is the amount of oxygen required for decomposition of organic matter by bacteria. BOD test procedure is based on the activities of bacteria and other aerobic microorganisms (microbes), which feed on organic matter in presence of oxygen. The result of a BOD test indicates the amount of water-dissolved oxygen (expressed as parts per million or milligrams per liter of water) consumed by microbes incubated for five days at an ambient temperature of 20°C.

3.5.2.6 pH

pH is a numeric scale used to specify the acidity or basicity of an aqueous solution. It is approximately the negative of the base 10 logarithm of the molar concentration, measured in units of moles per liter, of hydrogen ions. More precisely it is the negative of the logarithm to base 10 of the activity of the hydrogen ion. Solutions with a pH less than 7 are acidic and solutions with a pH greater than 7 are basic. Pure water is neutral, at pH 7, being neither an acid nor a base. pH of a water sample is determined using pH meter.

Fig: 3.3- pH METER

3.5.2.7 ELECRICAL CONDUCTIVITY

It is the measure of a material's ability to conduct an electric current. It is commonly represented by the Greek letter σ (sigma). Its SI unit is Siemens per meter (S/m) and CGSE unit is reciprocal second (s^{-1}).An electrical conductivity meter (EC meter) measures the electrical conductivity in a solution. It is commonly used in hydroponics, aquaculture and freshwater systems to monitor the amount of nutrients, salts or impurities in the water.

Fig: 3.4- ELECTRICAL CONDUCTIVITY METER

3.5.2.8 TOTAL SOLIDS

It is the total content of suspended and dissolved solids in water. Suspended solids are those that can be retained on a water filter and are capable of settling out of the water column onto the stream bottom when stream velocities are low. Dissolved solids are those that pass through a water filter. Levels of total solids that are too high or too low can also reduce the efficiency of wastewater treatment plants and industrial processes that use raw water.

3.5.2.9 CHLORIDE

Chloride in water is mainly due to leaching of marine sedimentary deposits, pollution from industries and domestic waste. The presence of high quantity of chloride indicates pollution of water due to sewage and other human and industrial waste.

- TESTING OF SAMPLE: 100 ml or a suitable portion of the sample was diluted to 100 ml with double distilled water (volume of sample in ml =V). 1 ml K2CrO4 indicator was added and was titrated with standard silver nitrate. End point was pinkish yellow. The titer volume was noted. 20 ml of control standard was taken and diluted to 100 ml with double distilled water. 1 ml K2SO4 indicator was added and again titrated with standard silver nitrate. End point was pinkish yellow and the titer volume was noted.

3.5.2.10 FLUORIDE

Fluoride is one of the very few chemicals that has been shown to cause significant effects in people through drinking-water. Fluoride has beneficial effects on teeth at low concentrations in drinking-water, but excessive exposure to fluoride in drinking-water, or in combination with exposure to fluoride from other sources, can give rise to a number of adverse effects. These range from mild dental fluorosis to crippling skeletal fluorosis as the level and period of exposure increases. Water fluoridation is the controlled addition of fluoride to a public water supply to reduce tooth decay. Fluoridated water has fluoride at a level that is effective for preventing cavities; this can occur naturally or by adding fluoride.

Fluoridated water operates on tooth surfaces: in the mouth, it creates low levels of fluoride in saliva, which reduces the rate at which tooth enamel dematerializes and increases the rate at which it rematerializes in the early stages of cavities. Typically a fluoridated compound is added to drinking water, a process that in the U.S. costs an average of about $1.04 per person-year. De fluoridation is needed when the naturally occurring fluoride level exceeds recommended limits. In 2011 the World Health Organization suggested a level of fluoride from 0.5 to 1.5 mg/L (milligrams per liter), depending on climate, local environment, and other sources of fluoride. Bottled water typically has unknown fluoride levels.

Dental caries remains a major public health concern in most industrialized countries, affecting 60–90% of schoolchildren and the vast majority of adults Water fluoridation reduces cavities in children, while efficacy in adults is less clear. A Cochrane review estimates a reduction in cavities when water fluoridation was used by children who had no access to other sources of fluoride to be 35% in baby teeth and 26% in permanent teeth. The evidence quality was poor. Most European countries have experienced substantial declines in tooth decay without its use. Recent studies suggest that water fluoridation, particularly in industrialized nations, may be unnecessary because topical fluorides (such as in toothpaste) are widely used, and caries rates have become low. Although fluoridation can cause dental fluorosis, which can alter the appearance of developing teeth or enamel fluorosis, the differences are mild and usually not considered to be of aesthetic or public health concern.

CHAPTER.4 RESULTS AND DISCUSSIONS

4.1 WATER SAMPLE ANALYSIS

4.1.1 E COLI

The result of MPN test conducted is given in table 4.1 below.

Table: 4.1- RESULT OF E COLI TEST

SAMPLE NO:	RESULT (MPN/100ml)	ACCEPTABLE LIMIT (IS10500 : 2012)
1	200	0
2	200	0
3	100	0
4.1	300	0
4.2	300	0
5.1	300	0
5.2	300	0
6	300	0
7	200	0

The results show the presence of E coli in the collected sample. This indicates that the water has been contaminated with the fecal material of man or other animals. At the time this occurred, the water may have been contaminated by pathogens or disease producing bacteria or viruses which can also exist in fecal material. Some waterborne pathogenic diseases include typhoid fever, viral and bacterial gastroenteritis and hepatitis A. The presence of fecal contamination is an indicator that a potential health risk exists for individuals exposed to this water.

4.1.2 ACIDITY

The result of test conducted is given in table 4.2.

Table: 4.2- RESULT OF ANALYSIS OF ACIDITY IN SAMPLES

SAMPLE NO:	ACIDITY (mg/l of CaCO3)	ACCEPTABLE LIMIT (IS10500:2012)
1	30	50
2	30	50
3	10	50
4.1	25	50
4.2	25	50
5.1	20	50
5.2	20	50
6	35	50
7	30	50

From the results obtained, we can conclude that the acidity of water samples tested are within limits.

4.1.3 ALKALINITY

The result of test conducted is given in table 4.3. Alkalinity of samples collected from the lake and school is higher than the limit. Alkalinity in water produces incrustation, sediment deposition and difficulty in chlorination.

Table: 4.3- RESULT OF ANALYSIS OF ALKALINITY IN SAMPLES

SAMPLE NO:	ALKALINITY (mg/l of CaCO3)	ACCEPTABLE LIMITS (IS10500:2012)
1	120	200
2	140	200
3	80	200
4.1	280	200
4.2	280	200
5.1	250	200
5.2	250	200
6	220	200
7	140	200

4.1.4 HARDNESS

The result of test conducted is given in table 4.4.

Table: 4.4- RESULT OF ANALYSIS OF TOTAL HARDNESS IN SAMPLES

SAMPLE NO:	HARDNESS (mg/l of CaCO3)	ACCEPTABLE LIMIT (IS10500:2012)
1	100	200
2	150	200
3	55	200
4.1	250	200
4.2	250	200
5.1	225	200
5.2	225	200
6	200	200
7	180	200

From the results obtained, we can conclude that the samples collected from lake have hardness higher than the limits. This may be due to the presence of calcium, magnesium, strontium, ferrous iron and manganese ions.. Presence of hardness in water has many undesirable effects like greater soap consumption, corrosion, encrustation of pipes and scaling of boilers.

4.1.5 DISSOLVED OXYGEN

. The result of test conducted is given in table 4.5.

Table: 4.5- RESULT OF DISSOLVED OXYGEN ANALYSIS IN SAMPLES

SAMPLE NO:	DO (mg/l)	REQUIRED DO(IS10500:2012)
1	3.6	4-8
2	3	4-8
3	4	4-8
4.1	2.2	4-8
4.2	2	4-8
5.1	2.4	4-8
5.2	2.2	4-8
6	2.6	4-8
7	3.4	4-8

From the results obtained, we can conclude that samples have DO less than that is required. DO determination is a principal measurement in pollution. Reduction in DO is often due to the addition of organic pollutants. This will affect the aquatic life.

4.1.6 BOD

. The result of test conducted is given in table 4.6.

Table: 4.6- RESULT OF BOD ANALYSIS OF SAMPLES

SAMPLE NO:	BOD (mg/l)	ACCEPTABLE LIMIT (IS10500 : 2012)
1	3.7	5
2	4	5
3	2.4	5
4.1	5.2	5
4.2	5.2	5
5.1	5	5
5.2	4.8	5
6	5	5
7	3.6	5

From the results obtained, we can conclude that, the samples from the lake have higher BOD content. Higher the BOD, higher the amount of pollution in the test sample. The high value of BOD in the lake is due to the presence of sewage outfall and higher activities of human beings.

4.1.7 pH

. The result of test conducted is given in table 4.7. pH of the water samples are within the limits.

Table: 4.7- RESULT OF pH MEASUREMENT OF SAMPLES

SAMPLE NO:	pH (pH scale)	ACCEPTABLE LIMIT
1	7.25	6.5-8.5
2	7.5	6.5-8.5
3	6.55	6.5-8.5
4.1	8.29	6.5-8.5
4.2	8.2	6.5-8.5
5.1	8	6.5-8.5
5.2	8	6.5-8.5
6	7.82	6.5-8.5
7	7.2	6.5-8.5

4.1.8 ELECTRICAL CONDUCTIVITY

The result of test conducted is given in table 4.8.

Table: 4.8- RESULT OF ELECRICAL CONDUCTIVITY MEASUREMENT OF SAMPLES

SAMPLE NO:	ELECRICAL CONDUCTIVITY (Milli Siemens/cm)	ACCEPTABLE LIMIT
1	0.356	0.05-0.5
2	0.345	0.05-0.5
3	0.691	0.05-0.5
4.1	9.8	0.05-0.5
4.2	10.5	0.05-0.5
5.1	17.5	0.05-0.5
5.2	17.536	0.05-0.5
6	0.634	0.05-0.5
7	1.094	0.05-0.5

The samples from lake, school and temple have high electrical conductivity. This is anindirect indication of the presence of dissolved solids in the samples.

4.1.9 TOTAL SOLIDS

The result of test conducted is given in table 4.9.

Table: 4.9- RESULT OF ANALYSIS OF TOTAL SOLIDS IN SAMPLES

SAMPLE NO:	TOTAL SOLIDS (mg/l)	ACCEPTABLE LIMIT
1	3590	3000
2	3800	3000
3	1850	3000
4.1	4860	3000
4.2	4840	3000
5.1	3960	3000
5.2	3900	3000
6	4000	3000
7	3500	3000

From the results obtained we can conclude that samples have total solids above the limit. A high concentration of total solids makes drinking water unpalatable and might have adverse effects on people who are not used to drinking such water.

4.1.10 CHLORIDE

The result of test conducted is given in table 4.10.

Table: 4.10- RESULT OF ANALYSIS OF CHLORIDE IN SAMPLES

SAMPLE NO:	CHLORIDE (mg/l)	ACCEPTABLE LIMIT
1	50	250
2	80	250
3	44	250
4.1	19838	250
4.2	19800	250
5.1	1500	250
5.2	1500	250
6	100	250
7	50	250

From the results obtained we can conclude that, the samples from lake have higher chloride content. This may be due to the infiltration of pollutant ions from leachate and dumping of waste into the lake. Higher chloride content causes corrosion of pipes and structures and damage growing plants.

4.1.11 FLUORIDE

The result of test conducted is given in table 4.11. From the results obtained we can conclude that, the samples from lake have slightly higher fluoride content than the limit. Pollution from various sources in the Ashtamudi Lake may be the reason for the presence of chlorides and fluorides in the water. Continuous intake of this water leads to minor healtheffects.

Table: 4.11- RESULT OF ANALYSIS OF FLUORIDE IN SAMPLES

SAMPLE NO:	FLUORIDE (mg/l)	ACCEPTABLE LIMIT
1	-	1
2	-	1
3	-	1
4.1	1.3	1
4.2	1.3	1
5.1	1.2	1
5.2	1.1	1
6	0.1	1
7	-	1

4.2 DISCUSSION

The characteristics of leachate generated in a dumping site or landfill were depended on a number of intrinsic and extrinsic factors. Usually the leachate takes up organic and inorganic constituents by means of physical, hydrolytic, and fermentative processes and thus contains high concentration of organic matter and inorganic ions.

This old and unlined municipal solid waste landfill posed a long-term risk to ground water through the leaching of solutes. The present investigation showed that the alkalinity, hardness, dissolved oxygen, electrical conductivity, BOD, total solids, chlorides and fluorides of the water around the dump yard are above the allowable limits. Similarly fecal coliforms registered enormously high values, indicating the probable threats these constituents together would have on ground water of the locality. The high value of BOD in the lake is due to the presence of sewage outfall and higher activities of human beings. Pollution from various sources in the Ashtamudi Lake may be the reason for the presence of chlorides and fluorides in the water. It was thus derived from the ground water quality analysis that the ground water resources adjacent to the dumping site, especially wells near to it were highly contaminated with leachate from the dumping site and, therefore, adequate safety measures should be taken to decontaminatethe water before consumption by the locals.

Now new ideas and projects are been undertaken by KSUDP to reopen the yard with efficient waste treatment techniques. The objective of the larger waste management plan is to upgrade the MSW management system for collection of segregated waste from sources to the extent possible, transport the same directly or via a secondary storage, disposal of rejects / inerts and treatment of the biodegradable waste component through composting. There are several methodologies available for treating the organic waste. The options available are composting, biomethanation, pelletization, gasification, pyrolysis and incineration.

However this plan has not been accepted by the locality. They are not fully aware of the processes to be undertaken as part of the new plan. Therefore the locality should be made aware of the impact of accumulated solid wastes and the boons of the new project if implemented.

CHAPTER.5

CURRENT STATUS OF THE SITE AND REMEDIES TO BEUNDERTAKEN

5.1 IDEAS AND PROJECTS UNDERTAKEN TO REOPEN THE SITE

Though the yard was closed since 2012, there exist reasonable amount of impurities in water bodies around which make water unfit for use for human consumption and other activities. For water to be used for drinking it should be free from E Coli bacteria but the water has a considerable amount of E Coli in it. By our analysis on water quality most wells are still under polluted stage even after years of closing the yard.

Now new ideas and projects are been undertaken by KSUDP to reopen the yard with efficient waste treatment techniques.

The proposed project activity is designed to reduce Greenhouse Gas (GHG) emissions. The proposed project activity is also expected to provide a clean and healthy environment to the city of Kollam in state of Kerala, India. The purpose of proposed project activity is to reopen the Municipal Solid Waste (MSW) composting plant at the city of Kollam in state of Kerala, India.. The project activity would avoid the emissions of methane to the atmosphere from composting of organic matter that would have otherwise been left to decay anaerobically at municipal solid waste disposal site (MSWDS). The present solid waste treatment system for Kollam city involves open dumping of solid waste at the disposal site about 5 kilometers away from the city Centre at Kureepuzha. Large quantity of waste is accumulated at the site as a result of dumping during last two decades. The operations are not engineered or controlled, leading to leachate and windblown waste polluting surrounding areas. Occasionally, waste is pushed by the excavator loader to clear access and to make room for further dumping. Except for a small room for watchman no infrastructure is available at the site. Further expansion of current site is under active consideration of the municipal corporation along with alternate sites. Accordingly the corporation proposes to begin the process of acquisition of land. The objective of the larger waste management plan is to upgrade the MSW management system for collection of segregated waste from sources to the extent possible, transport the same directly or via a secondary storage, disposal of rejects / inerts and treatment of the biodegradable waste component through composting. The proposed project involving aerobic composting of organic waste is expected to avoid GHG (CH4) emission due to improved methods. It is estimated that the proposed project activity will treat 40 tons of bio degradable waste through composting per day (40 TPD). There are several methodologies available for treating the organic waste. The options available are composting, biomethanation, pelletization, gasification, pyrolysis and incineration. Few other processes like advanced in vessel composting process for accelerated decomposition of waste and plasma technologies are yet to be demonstrated for Indian conditions. The hot & humid climate of Kollam helps to faster decomposition of waste, necessitating daily removal and safe disposal. Further, heavy rainfall spread over six months results in high moisture content in Municipal Solid Waste and a resultant low calorific value MSW. Hence, aerobic composting is identified as the most feasible option for treatment of MSW at the project activity region. As per Municipal Solid Waste (Management & Handling) Rules 2000 (hereafter MSW Rules) promulgated by the Government of India, composting is one of the methods for treating the organic content of the MSW. In case any other technology not mentioned in the MSW Rules is to be implemented, clearance from Central Pollution Control Board (CPCB) is required. In view of these factors and considering simplicity of composting technology as well as experience in India, composting of the Solid waste is the method selected for disposal. The Kollam Municipal Corporation proposes to install composting machinery for treatment. The city of Kollam has planned a system for efficient management of municipal solid waste. The proposed project activity intends to have more scientific approach to dispose off collected MSW. The propose project activity involves the aerobic composting of municipal solid waste; the composting process involves placing the MSW into long heaps of trapezoidal shape / Wind Rows on a covered concrete platform. Cow dung culture or efficient microbial (EM) culture (combination of mesophilic and thermophilic bacteria) sprayed on windrows to control the odor and flies, temperature inside the windrow increases rapidly due to bacterial action, which eradicates Pathogens and weed seeds. In order to provide and maintain aerobic condition, the waste is turned from one windrow to the other. This process continues over four week period and the material after windrow process stored under shelter for a period of one week for stabilization. The stabilized material will be mechanically processed for extracting organic manure. The project activity will prevent anaerobic generation of methane. As a byproduct of this exercise, organic manure /compost will be produced and will be used as fertilizer. The compost will help in providing a source of carbon thereby reduction of reliance on chemical fertilizers in farm

Fig: 5.1- EQUIPMENTS INSTALLED AS A PART OF IDEAS TO REOPEN THE YARD

Fig: 5.2- PLASTIC LINERS PROVIDED ON DUMPING SITES WITH PIPES TO CARRYTHE LECHATE TO TRAETMENT EQUIPMENTS AND PLASTIC LINER IS COVEREDUSING STONE AGGREGATES

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5.2 REMEDIES

5.2.1 CONSRUCT PROPERLY OPERATED AND DESIGNED LANDFILL

There are three critical elements in a secure landfill: a bottom liner, a leachate collection system, and a cover. Bottom layer may be one or more layers of clay or a synthetic flexible membrane (or a combination of these). The liner effectively creates a bathtub in the ground. If the bottom liner fails, wastes will migrate directly into the environment. There are three types of liners: clay, plastic, and composite. Normally clay is used as bottom layer. But natural clay is often fractured and cracked. A mechanism called diffusion will move organic chemicals like benzene through a three-foot thick clay landfill liner in approximately five years very Best landfill liners today are made of a tough plastic film called high-density polyethylene (HDPE).

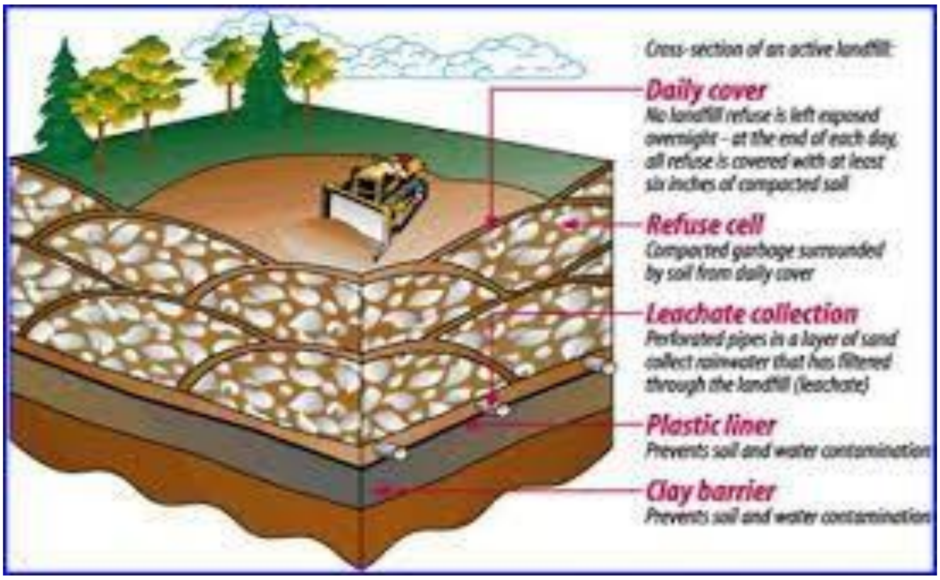

Fig: 5.3- PROPERLY DESIGNED LANDFILL

5.2.2 FILTRATION AND DISINFECTION OF ALREADY POLLUTED WATER

Filtration: Every household should be capable of developing its own water purification system. Different types of filters used are: UV water treatment, slow sand filters, ceramic filters, reverse osmosis filters, activated carbon filters etc. UV water treatment removes both bacteria and viruses so they are used with pre or post filtration techniques.RO water filters are used to improve drinking and cooking water quality. It is the finest method of filtration and reduce almost all organic and inorganic chemicals, bacteria, microorganisms, salts, metals, etc. that are found in contaminated water. A ceramic filter is one of the most economical methods of filtration and is being widely used in many third world countries. Ceramic filters blocks any molecule larger than water molecule allowing only water molecule to pass through the pores. Slow sand filters use biological methods under a non-pressurized system to purify water. It is constructed with a bed of sand as the filtering media, and gravel to support the sand. But it can filter water only up to certain turbidity level. Activated carbon filters are used due to higher rate of adsorption of activated carbon. Activated carbon can be used alone to improve taste and odour, and is most effective in removing organic compounds including VOC's.

Disinfection: Most common method of disinfection is chlorination. Water chlorination is a process adding chlorine or hypochlorite to tap water to kill certain bacteria and other microbes as chlorine is very toxic and cheaply and easily available. In particular chlorination is done to prevent spread of water borne disease such as cholera, dysentery, typhoid etc. Techniques for purification of water by compressed chlorine gas were also developed. So here the well waters already contaminated can be chlorinated to remove bacteria and microbes before the water is used for consumption.

CHAPTER.6 CONCLUSION

A healthy ecosystem makes no waste as the discards of one species become food for the next, in an endless cycle. The modern society interrupts these cycles which leads to harmful effects. The water quality data of the present investigation showed a negative trend in water quality parameters. This is mainly due to the dump yard which is located in the area. The Dissolved Oxygen (DO), which represents the health of the water system, was less than 4.0 mg/l. Other parameters are high for water sources (Ecoli-300/100ml, Fluoride-1.3mg/l, Chloride- 1500mg/l, Total solids-4860mg/l) .Ground water is the main source of water available in the locality and its quality is not satisfying the prevailing standards. It is highly recommended to implement the actions recommended by KSUDP in its newly proposed waste management plan. Regular awareness camp, training program for the general public to monitor the progress of the plan should be undertaken. Moreover the already contaminated well water in the houses around the dump yard can be used after carrying out suitable filtration and disinfection.

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