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Physicochemical Characterization Of Leachate From Multan Landfill Site

Nazuk Sarfraz

Dr. Kiran Farhan

Kinnaird College Women, LHR, Lahore

Abstract:

***Introduction and Aim of the Study:** This study focuses on the solid waste management system in Multan, the variations in leachate's physical and chemical parameters from the Multan Landfill Site. It also explains the quality of soil, drinking water, and health wellness of the people living around the landfill site. Multan has built up the first sanitary landfill site in Pakistan.*

***Material and Method:** This landfill is developed by the Fukuoka method, specially designed for catering to the affordability and sustainability considerations of the developing countries. The site, located at Mouza Habiba Sayal Vehari Road, can collect 35 % of solid waste generated in the area. Sampling was done for six consecutive months to help monitor the variations in physical and chemical parameters of leachate.*

***Results and Discussion:** The results of the leachate quality explain that COD, BOD, Chloride, Nitrate, Calcium, and Magnesium are under the standard values with no harm to the environment. In heavy metals, the copper content is high in the summer and low in the winter season. The cadmium, lead, and chromium content is high in all the leachate samples, and zinc content remains below the standard value. The concentration of TOC is also deficient compared to the standard value. The drinking water quality analysis explains the absence of copper, nickel, and chromium in drinking water while zinc, arsenic, and iron content is below the standard value. Only the lead concentration is high. Similarly, for the soil analysis, the two soil samples from a distance of 2 km and 5 km were taken. The results indicated that the heavy metal concentration is zero or in trace amount. The heavy metal content is very low in the soil sample of 2 km. A questionnaire survey was also conducted to examine the health issues amongst the people living around the landfill site. The results reveal no severe concerns regarding the vector conditions or harmful odor.*

***Keywords:** Solid Waste Management; Leachate; Chemical Oxygen Demand (COD); Biochemical Oxygen Demand (BOD); Landfill; Physical and Chemical Parameters*

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I. INTRODUCTION

There is an escalating consciousness to lessen contaminants and toxins discharged into the environment in the developing nations. In the last quarter of the twentieth century, the focus is on the issues related to solid waste and its proper management of the environment and ecology. Over several decades, landfilling has been preferential as a process of waste dumping for several reasons, frequently because it is perhaps the cheapest accessible technique. Landfills or open dumps that cause a severe hazard to groundwater and surface water resources have been demonstrated and verified by some workers [1, 2].

Solid waste undergoes a combination of physical, chemical, and microbial processes when it is disposed of and processed at the landfill site. These procedures convert waste into various water-soluble complexes and transport the contaminants from the discarded material to the soluble liquid substances. The polluted water or the toxic wastewater is known as “leachate.” Landfill leachate is generated when surplus water seeps into the path of the waste layer or the rainwater penetrates the solid waste. The sources for water penetration include precipitation, irrigation, surface runoff, groundwater interference, and the waste's original moisture content [3].

Leachate is regarded mainly as the fluid generated from the disintegration of waste. It is highly toxic wastewater that includes a high concentration of ammonium, nitrogen, and organic matter [4]. There is a variation in the composition of heavy metal, organic, and inorganic components with time in the leachate creating it more complicated to be dealt with appropriately. The composition is dependent on the landfill age, amount and quality of solid waste mean, the quantity and quality of the solid waste, organic and elemental processes, and the quantity of percolation and precipitation.

The putrefaction of waste in landfills can be improved by moisture from precipitation, physical, chemical, and biological procedures. Landfill comprises three phases; the solid phase, liquid phase, and gaseous phase. The gaseous phase contains carbon dioxide (CO2) and methane (CH4). The liquid phase is extremely complicated chemically as its composition is exemplified due to diverse types of dissolved organic compounds, inorganic compounds, and heavy metals. This fluid is called leachate, which gathers at the base of the landfill and afterward penetrated gradually into the soil to pollute aquifer below it and adjoining surface water bodies [5].

Generally, the leachate can be characterized into three major groups: organic matter, inorganic matters, and xenobiotic organic compounds. Other compounds, such as arsenate, barium, borate, cobalt, lithium, mercury, selenate, and sulfide, are also likely to be present in the leachate. The listed compounds present in small amounts and of the less critical level. Leachate quantity and quality are considerably manipulated by the waste age or length of time after waste fills [6].

Leachate by leakages and penetration not only depreciate soil capacity but also cause damage to the connected aquifer and make it unfit for drinking purposes [7]. The leachate level is also affected by the original humidity content of the waste, solid waste composition, biochemical and physical alteration taking place in them and causing modification in their humidity and the inflow of water from outside a landfill [8, 9].

Contaminants in MSW landfill leachate can be separated into four groups: Dissolved Organic Matter quantified as Chemical Oxygen Demand (COD) or Total Organic Carbon (TOC), volatile fatty acids (that gathered during the acid phase of the waste stabilization,) and further intractable compounds such as fulvic-like and humic-like compounds. Inorganic Macro Components: Calcium (Ca2+), Magnesium (Mg2+), Sodium (Na+), Potassium (K+), Ammonium (NH4+), Iron (Fe2+), Manganese (Mn2+), Chloride (Cl–), Sulfate (SO42–) and Hydrogen Carbonate (HCO3–).Heavy metals: Cadmium (Cd2+), Chromium (Cr3+), Copper (Cu2+), Lead (Pb2+), Nickel (Ni2+) and Zinc (Zn2+). Xenobiotic Organic Compounds (XOCs) are generated from household or industrial chemicals and present in moderately low concentrations (usually less than 1 mg/l of individual compounds). These compounds comprise, amongst others, a diversity of aromatic hydrocarbons, phenols, chlorinated aliphatics, pesticides, and plasticizers [10, 11].

Landfill leachate comprises organic matter (recyclable and non-recyclable), inorganic contaminants, and dangerous materials. Harmful substances in MSW are paints, mercury-containing wastes, pharmaceuticals, vehicle maintenance products, batteries, and many other disseminated products. Thus, removing landfill leachate and its treatment is a cause of the risk of receiving water bodies. Landfill leachate categorization is essential to have an appropriate treatment capability because landfill leachate composition is different from site to site. The move helps introduce site-specific techniques such as in-situ permeable reactive obstruction for the management of landfill leachate [9, 12].

The objectives of this research study include the following;

- ✓ Evaluate the seasonal variations in the physicochemical characteristics of leachate from the Multan landfill site.
- ✓ To determine the level of soil pollution around the landfill site.
- ✓ To determine the impacts of leachate on groundwater quality.
- ✓ Assess the health issues of the people living around the landfill site.
- ✓ Assess the solid waste management system of Multan.

The most common and frequently used method of eventual disposal of solid waste is Landfilling. It is an engineered and proper method of finally disposing of solid wastes on land in a certain way that reduces the environmental dangers and annoyance. Landfilling process engages compaction of solid wastes in films and layers at landfill sites. It means permitting waste to crush and decompose under restricted circumstances until it ultimately changes into a very fine material. The disintegration, stabilization, and removal of contaminants from a landfill depend upon these factors: composition of the refused material, quantity of compaction, quantity of moisture content, presence of reducing materials, rate of water movement, and temperature [14].

Different societies are producing much diverse type of solid wastes that causes various threats to the environment and the health of the community and neighborhood. For other types of wastes, different types of disposal sites are available. The kind of liner system mandatory for every type of landfill is decided by the possible threat posed by the waste. Liners can be single (also known as simple), composite, or double liners [15].

Leachate is composed of liquid that can penetrate the landfill from outside sources, for example, surface drainage, rainfall, groundwater, and fluid formed from the putrefaction of solid waste within the landfill. The liquor transferring through the trash dissolves saline liquid, organic components, and heavy metals. They are causing a severe hazard to the receiving water bodies. This leachate contains many substances which depend upon the type of waste disposed into the landfill and may be toxic to life. It may alter the ecology of the stream or watercourse if not removed by treatment. The leachate also penetrates the soil and move into groundwater [16].

The major environmental troubles at landfill sites are the penetration of leachate and its contamination of the neighboring land and aquifers. Enhancement in landfill engineering is expected to decrease the leachate production,

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collection, management, and treatment earlier to discharge and expulsion. Therefore, it must develop consistent and sustainable alternatives to manage leachate production and handling successfully [17].

Leachate manufacturing starts at the early stages of the landfill and is prolonged numerous decades after closing the landfill. It is mainly produced in filtered water, which surpasses the solid waste load and transmits contaminants from solid to liquid. Because of the inhomogeneous type of waste and the contradictory compaction densities, water penetrates through and comes into view as leachate at the site's base. Depending on a landfill site's physical and geological nature, leachate may percolate into the ground and possibly enter groundwater sources. Thus it can be the most important source of groundwater pollution [17].

The leachate includes a lot of severe threats, including destruction to the environment. The consequences pointed out that the surface and groundwater pollution around the landfill has an affinity to enhance. During the last five years, the number of chlorides, nitrogen amalgam, and heavy metal ions in the leachate has improved. The study also verifies that the leachate varies in its composition on the diverse sides of the landfill. The leachate of the northern and eastern sides is contaminated more than that of the western side [18].

Landfilled waste is despoiled and degraded both biologically and chemically. The leachate's chemical composition depends on several parameters such as waste composition, pH, redox potential, and landfill age.

There are two main stages of biological decomposition, which include the aerobic degradation phase and anaerobic degradation phase. The layer involved in the aerobic metabolism is the upper layer, where oxygen is trapped in fresh waste and is supplied and completed by rainwater. The acetogenic fermentation is enhanced during the initial aerobic stage. The leachate produced is characterized by the high BOD, COD, and ammoniacal nitrogen contents. The main component of the organic matter released is volatile fatty acids (VFA), and lower pH solubilizes metals [19].

The quality of the leachate is severely dependent on physical, chemical, and biological processes which take place in landfills. Nevertheless, new research indicates that in younger landfills, leachate concentrations of COD, BOD, and TOC are lesser than in old landfills. This can be caused by expansions in the technology of waste landfilling, whereas in many younger landfills, the compaction of waste is slight and thin layers are formed. Also, in addition, the composition may have been changed (less biodegradable waste). They give an outcome in a limitation of the acid stage to increased methane production and carbon dioxide [19].

There are three methods of leachate treatment biological, physical, and chemical methods. To deal with the leachate, mainly two ways combine. Moreover, the natural treatment systems connect with the landfill design are cheap, and it also increases the efficiency of treatment. There are two processes of biological treatment, aerobic process and anaerobic process. The aerobic process removes the heavy metals by precipitation as carbonates from the leachate. The anaerobic treatment system produces surplus sludge that does not require so much management. The anaerobic process has low energy consumption than the aerobic process. Many substances are degraded at a higher rate in the aerobic process than in the anaerobic process [20].

The advantages of sanitary landfills include that it is one of the most economical methods of solid waste disposal. Its initial investment is meager as compared to the other disposal methods. A sanitary landfill is a complete or final disposal method compared to incineration and composting, requiring additional treatment or disposal operations for residue and unusable materials. It eliminates the need for a separate collection system by receiving all types of solid wastes. The submarginal land may be reclaimed for parking lots, playgrounds, golf courses, hospitals, and airports [21].

The commonly used methods for the landfilling of solid waste include excavated cell trench, area, and canyon. The trench method is suitable for the areas with sufficient cover material available at the site. The approach is applicable at the location where the water table is away from the surface. Excavated soil is used for the daily and final cover. The cells of trench methods are usually square [21, 22].

The area method is used when the terrain is unsuitable for the excavation of cells or trenches to place the solid waste. The high groundwater levels necessitate the use of area-type landfills. The wastes are uploaded and spread in long narrow strips on the land's surface in a series of layers that vary in depth from 40 to 75 cm. Each layer is compacted as the filling progresses until the thickness of the compacted wastes reaches the designated height ranging from 2 to 3 meters at the end of the day's work. A soil cover of 15 to 30 cm thickness is then placed over at the completed fill [21].

In the canyon or the depression method, dry borrow pits and quarries have been used for landfills. The techniques to place and compact solid wastes vary with the geometry of the location and the capping material's distinctiveness. They are also influenced by geology, hydrology, and access to the site [21].

The methane in the landfill site releases into the atmosphere. If methane remains uncontrolled, it can accumulate below buildings or in other enclosed spaces at or close to a sanitary landfill. With proper venting, methane should not pose a problem. On the other hand, carbon dioxide is troublesome because of its density. It tends to move towards the bottom of the landfill. Therefore, the concentration of carbon dioxide is high in the lower portions of the landfill site for many years. It is soluble in water and can react rapidly to form carbonic acid. The reaction lowers the pH value, which can increase the hardness and mineral content of the groundwater [21].

The movement of landfill gases is controlled to reduce atmospheric emissions. This minimizes the subsurface gas migration while allowing the recovery of energy from methane. Control systems are of two types; active and passive. In passive control, the pressure of the gas generated serves as the driving force for its movement. Inactive power, energy in the form of an induced vacuum, is used to control gas flow. Passive controls are achievable when the principle gases are being produced at a high rate by providing paths of higher permeability to guide the gas flow in the desired direction. A gravel-packed trench can serve to channelize the gas to a flared vent system [21].

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Topsoil and subsoil capping is necessary for the growth of plants and burrowing animals. Other sorts of covering materials are also being used. Few types of research indicate a rising interest in using geosynthetic clay liners (GCLs), which covers as a substitute for soil barriers because they are efficient as being hydraulic barriers and can rise quickly. The main problem with the covering of landfills is the cracking of clay. The primary cause of clay cracking is 'external loads' and settlement [23] [24].

The mixture of municipal, commercial and mixed industrial waste is included in most sanitary landfills. Dangerous, radioactive, and specific chemical wastes are not included in this type of waste. These leachates generated from landfills can be characterized by four major groups of pollutants, which provide for dissolved organic matter, heavy metals, inorganic macro-components, and xenobiotic organic compounds [25].

A minute quantity of other elements is also included in the leachate generated from the landfill. Some of the elements include boron, arsenic, selenium, lithium, mercury, and cobalt. These are essential secondary elements. Variation in leachate composition depends upon the composition of waste, the quantity of compaction, waste age, hydrology of the site, weather, and the landfill technology [26] [27] [36]. Chemical oxygen demand, total organic carbon, and biological oxygen demand are generally known as the dissolved organic matter components of the landfill leachate [28].

The components of the organic matter are massive ones, and it covers a wide variety of organic degradation products, including methane (CH4), volatile fatty acids, and some refractory compounds such as fulvic and humic-like compounds. The color of the leachate is because of the decomposition of organic matter that gives leachate brown, black or yellow color [29].

Leachate may have a harmful environmental impact because of its toxicity to aquatic life. It also includes plants, freshwater fish, and microorganisms. The movement of leachate to groundwater can cause algal bloom and eutrophication. It is because of a massive concentration of nitrates and phosphates. On many plants, animals, and bacteria, there is a destructive effect of leachate on chromosomal and hereditary materials. It affects the human body and health wellness. The copper and organic chemicals present lead to kidney problems and blood issues, such as anemia [30].

II. MATERIAL AND METHODS

A. STUDY AREA AND POPULATION

Habiba Sial landfill site (HSLFS) was constructed through the Southern Punjab Basic Urban Services Project launched by the Government of Punjab and funded by Asian Development Bank (ADB) and Japan International Cooperation Agency (JICA). The site, which has an area of 13 acres, was approved by City District Government Multan (CDGM) in the year 2005. Before its development, Japanese engineers from JICA demonstrated a model landfill at the site. Figure 1 shows the study area of this research work.

Figure 1: Map of the landfill site

B. DATA COLLECTION

✓ *LANDFILL SITE*

The landfill site for this study was Habiba Sial Landfill Site Multan.

✓ *SAMPLE LOCATION AND SAMPLING DURATION*

The leachate samples were collected from the same location for 6 consecutive months from December 2013 till May 2014 from Multan landfill site.

✓ *ANALYSIS OF LEACHATE SAMPLES*

The leachate samples were taken to the laboratory for analyzing the variations in the physiochemical parameters. The lists of parameters are temperature, pH, color, total suspended solids, total dissolved solids, turbidity, electrical conductivity, chemical oxygen demand, biological oxygen demand, chloride, nitrate, calcium, magnesium, iron, lead, chromium, cadmium, copper, zinc, nickel, arsenic, and total organic carbon.

✓ *SAMPLING TYPE*

Grab sampling was done for the collection of leachate samples. After the collection of the sample, the pH and temperature were noted onsite with the help of pH meter and thermometer. Then the sample was taken to the laboratory for further testing.

✓ *SAMPLE SIZE*

Almost one liter of leachate sample was collected and stored in bottles at a temperature of 4° C (using the ice box) until the analysis of the sample.

✓ *PRIMARY COLLECTION*

Primary collection is a collection of waste from door to door points. Two-wheel hand carts and mini compactors carry

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out the primary collection. The total number of mini compactors and handcarts are 20 and 1600; out of 20 mini compactors, 16 are used at a time. Door-to-door collection of solid waste is carried out in the following colonies: Gulgasht Colony, Officers Colony, Zakariya Town, New Multan, Shah Rukan-e-Alam Colony, Mumtazabad, Wahdat Colony, and Hassan Parwana. Manual sweeping is carried out in all areas of Urban UC's and door-to-door primary collection is also included in the job description of sanitary workers. The average length of road allocated to each sanitary worker for sweeping is 0.5 km. While in the case of mechanical sweeping total kilometers swept mechanically are 61 km (only medians), and the total number of mechanical sweepers are ten, but only six mechanical sweepers are used for this purpose for 13 roads [13].

✓ *SECONDARY COLLECTION*

The secondary collection points are those storage points where the municipal waste is being temporarily stored. The secondary collection is the process of accumulating the waste from collection points to the transfer stations. The tractors, trolleys, arm rolls, hoist trucks, and tractor carriers work for secondary collection from collection points. Details of the containers are shown in Table 1.2 below: [13].)

Type of Container	Total number	Containers in Field	Lifter
$4m^3$	26	9	Tractor Carrier
$7m^3$	150	129	Hoist truck
$10m^3$	150	133	Arm roll

Table 1: Details of containers (Source: [17])

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✓ *TERTIARY COLLECTION*

The tertiary collection is carried out from transfer stations to a final disposal site through dump trucks which are loaded with the help of mini loaders. There are six transfer stations namely [13]. Transfer station Gulshanabad (Lange Khan), transfer station Shaheen Market, transfer station Ali Chowk, transfer station Kirijamanda, transfer station Shah Shams Colony and Jinnah Park/ near 100ft road

III. RESULTS

The results of the analyzed parameters for the leachate samples are shown in Table 2 and the results of the water sample and soil samples are shown in table Figure 2, 3 and 4 respectively. The results of leachate samples are compared with the standards of the Solid Waste Association of North America SWANA [46]. The WHO Standards and National Standards for drinking water along with units of each parameter are also shown. The results of soil samples are compared with the European and Indian standards.

Parameters	Units	Standards (SWANA)	Sample 1 (Dec)	Sample 2 (Jan)	Sample 3 (Feb)	Sample 4 (March)	Sample 5 (April)	Sample 6 (May)
pH	_	5.3-8.5	8.33	6.76	6.7	6	5.78	5.5
Temperature	°C	_	25	21	22	17	20	21
TSS	mg/l	_	1150	1230	1350	1230	1050	900
TDS	mg/l	_	3700	6010	2460	3560	3800	4020
Turbidity	ftu	_	630	548	497	450	225	124
Electrical conductivity	s/m	106	99	87	98	92	95	89
COD	mg/l	3000	902	450	185	890	1020	995
BOD	mg/l	6350	424	238	168	479	580	437
Nitrate	mg/l	5-40	24.17	19	22.36	27	23.56	20.02
Chloride	mg/l	100-3000	355	291	319	255	277	333
Calcium	mg/l	200-3000	2.2	4	8.8	6	10	15.2
Magnesium	mg/l	50-1500	1.33	2.4	5.28	3.	6	9.12
Iron	mg/l	11.5	0.583	2.37	15	8.5	12.4	9.28
CoppeR	mg/l	10	0.2	5.6	1.5	1.8	2	10.6
Chromium	mg/l	0.33	0.153	0.113	2	1	0.5	3
Nickel	mg/l	0.5	0.142	1.71	0.052	0.157	0.1	1.5
Zinc	mg/l	8.3	1.23	2.23	6.66	15	3.13	6.16
Cadmium	mg/l	0.16	0.161	0.032	0.237	0.067	4.4	5.4
Lead	mg/l	0.16	1.36	1.28	0.25	0.51	1.42	1.49
Arsenic	mg/l	0.054	0.038	0.041	0.005	0.079	0.068	0.037
TOC	mg/l	14000		92	98	210	195	99

Table 2: Results of analyzed parameters of leachate

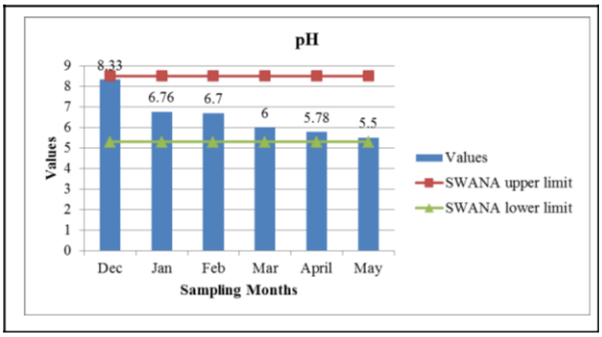

Figure 2: Seasonal variations in pH value

The physiochemical parameters include pH, temperature, color, TDS, TSS, turbidity, electrical conductivity, biological oxygen demand, chemical oxygen demand, chloride, nitrate, calcium, magnesium, copper, iron, lead, arsenic, nickel, zinc, cadmium, chromium, and TOC. Figure 2 shows the seasonal variations in the pH of the leachate sample. The results indicated that the pH remains under the standard value throughout the six months from December till May. The standard value of pH for leachate sample is 8.5 and the values of the leachate samples are below the standard value. The pH values of the leachate samples are acidic in nature. The pH of young leachate is usually less than the older one. The low pH is due to the high amount of volatile fatty acids. The pH of leachate increased with time due to the decrease of the concentration of the partially ionized free volatile fatty acids. Higher pH values of 8.3-9.10 were recorded from the stabilized leachate of semi-aerobic landfill [31, 32]. The pH varied according to the age of landfills. Generally, the pH of a stabilized leachate is higher than that of young leachate [33].

The temperature results explain that the temperature is high in December, and in March, the temperature is low. But the temperature remains from 17 degrees Celsius to 25 degrees Celsius. The leachate samples were dark brown or orange-brown. The dark color of the leachate is also due to the presence of natural organic matter. The leachate has a stinking odor because of the decomposition of organic waste, which comes from the high concentration of organic matter when decomposed [34].

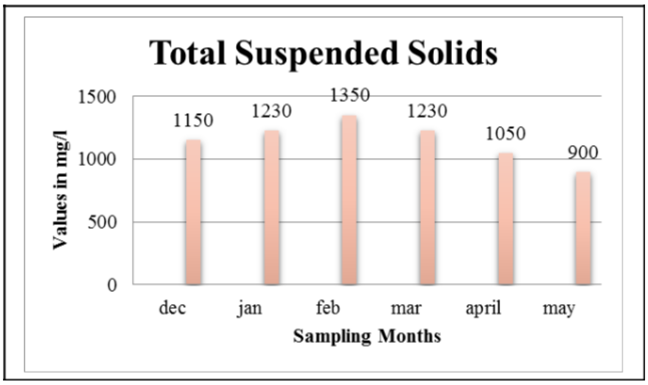

Figure 4: Seasonal variations in TSS values

In figure 3 and 4, the seasonal variation in TDS and TSS has shown. The results indicated that the value of TDS is high in the month of January. The TDS value is 6010 ppm in extremely cold weather, whereas in the moderate weather that is at the end of February the TDS value is low. In the month of February, the TDS value is 2460 ppm. The value of TSS in six months remains almost consistent with a variation of 50 to 100 ppm. The value of TSS in the leachate of Multan landfill site ranges from 900 to 1350 ppm. The change in the values of TDS relates to the age of landfill in leachate [34, 35]. In the initial stages of the landfill (TSS) also contains sodium, calcium, chloride, sulfate, and iron. Afterward, the concentration of inorganic matter will reduce with the increasing age of landfill. TDS comprises mainly of inorganic salts and dissolved organics. The high concentration of TDS is due to the presence of inorganic material in solid waste. A study conducted in Ludhiana India also shows similar results [31, 34]

Parameters	**WHO Standards**	**National standards for Pakistan**	**Drinking water sample**
pH	6.5 – 8.5	6.5 – 8.5	7.36
Chloride (mg/l)	< 250	< 250	248
Nitrate (mg/l)	50	<50	27
Zinc (mg/l)	3	Not specified	0.46
Iron (mg/l)	0.3	Not specified	0.07
Lead (mg/l)	0.01	<0.05	0.45
Arsenic (mg/l)	0.01	<0.05	0.005
Copper (mg/l)	2	Not specified	0
Nickel (mg/l)	0.02	0.02	0
Chromium (mg/l)	0.05	0.05	0

Table 3: Results of analyzed parameters of drinking water

The quality of groundwater depends upon several factors such as the chemical composition of the aquifers – climatic conditions prevailing during formation, the quantum of water available in the aquifer, and the rate of circulation. The analysis of drinking water shows that the pH is within the standard value. Chloride and nitrate content in drinking water is under standard value. The concentration of zinc, arsenic and iron in drinking water is below the normal value, whereas the lead concentration is higher than the drinking water quality standard. There is zero concentration of copper, nickel, and chromium in drinking water. The presence of organic matter content may influence low P.H. value.

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Questions	Options	Responses
Source of drinking water consumption	□ Tube well	4%
	□ Filtered water	16%
	□ Boiled water	4%
	□ Groundwater	64%
	□ Tap water	12%
Quality of drinking water	□ Clean	88%
	□ Dirty	12%
Common waterborne diseases, suffered by people	□ Cholera	7%
	□ Typhoid	10%
	□ Malaria	13%
	□ Hepatitis	7%
	□ Diarrhea	53%
	□ None	10%
Frequency of suffering from diseases	□ Once a week	0 %
	□ Twice a week	4%
	□ Monthly	12%
	□ Twice a month	24%
	□ Yearly	60%
Changes in daily life	□ Experienced no change	60%
	□ Experienced more odor	40%
Condition of the landfill during the rainy season	□ Experienced more odor	48 %
	□ Experienced no change	52%
Condition of vectors in the area (mosquitoes and flies)	□ Less	60%
	□ More	40%

Table 4: Results of the questionnaire survey

IV. DISCUSSIONS

Table 4 shows the overall responses of the participants that were part of this study. For health analysis, the questionnaire survey was conducted. 68 % of males were interviewed and 32 % of females were interviewed. 68 % of people who give response were of 26 to 40 years of age and 20 % were from 41 years to 60 years of age. Most of the people living near the site only pass their matriculation and 16 % of the people were uneducated. Most of the people there were hawkers, shopkeepers, sanitary workers, labors or electricians, etc. 52 % of people's houses were at a distance of 2 to 5 km and 36 % of people live in 5 to 10 km of distance. 50 % of the people living near the landfill site, from more than 5 years and their source of drinking water are groundwater. Furthermore, 88% of people are satisfied with the water quality but still, they suffer from some water-borne diseases yearly and sometimes, on a monthly bases. 60 % of the people feel no change living close to the landfill site and in the rainy condition, they sometimes feel more odor but 52% of the people said that they won't feel any change even in rain conditions. 40 % of people said that because of the landfill site there are more flies and 60% of people said that there are no flies or fewer flies.

The overall results of this study give an insight that the approach of open dumping is still the major waste disposal method in developing countries causing annoyance and environmental problems. With the increase in population size, industrialization, and urbanization, waste generation has also increased. Solid waste is producing a large amount of leachate. The essential possible environmental impacts linked with landfill leachate are groundwater and surface water pollution. Also, leachate can cause soil pollution because of the seepage in the soil. The threat of groundwater pollution happens mostly because dumping sites are built without clay linings and engineered liners. This research helps access groundwater quality, soil quality to determine the physicochemical characteristics of leachate and evaluate the seasonal variations in the leachate of the Multan landfill site. The findings of seasonal variations will help us understand the composition of solid waste being degraded in other months. The results also propose the measures to avoid the contamination of the hazardous substance.

V. CONCLUSION

Based on the results and their discussion, it is concluded that the proper management of solid waste is essential for a clean and tidy environment. The results of leachate samples indicated that the concentrations of few heavy metals are high, and the rest of the parameters are under the standard values. The quality of drinking water and soil is also satisfactory. Only lead content in drinking water is above the standard values, whereas the trace amount of heavy metals are present in soil samples. In short, the people living near the landfill site are satisfied with the drinking water quality, and they have no issues regarding the lousy odor or vector conditions.

VI. RECOMMENDATIONS

Mixing hazardous waste with municipal waste is in practice in the whole city. There is a need for proper planning for the separate collection, transfer, and disposal of hazardous waste and municipal waste. Frequent monitoring of groundwater should be done to check the level of contamination. The landfill caters to only 35 % of the waste generated, and the projections reveal that in the year 2020, the waste generation will be 1367 tons/day. In this situation, there is a need to construct more landfill sites and to look for other disposal methods like waste treatment options through composting, waste to energy, etc. There should be proper monitoring of the landfill gas production and estimation of potential for reuse. Establishing a small-scale material recovery facility at the landfill site is necessary to recover

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valuable recyclables from the waste. Recruitment of waste managers with technical expertise in SWM to work with different authorities to make the city clean and clear is appropriate. Most solid waste management equipment/ vehicles remain out of order. Proper maintenance is needed to avoid a high depreciation rate because the capital, repair, and maintenance cost of machinery is very high.

REFERENCES

[1] Ohwoghere, A.O., and Aweto, K.E., Leachate Characterization and Assessment of Groundwater and Surface Water Qualities near Municipal Solid Waste Dump Site in Effurum, Delta State, Nigeria. Journal of environment and earth science (9): pp. 126-136 (2013).

[2] USEPA, Municipal Solid Waste Generation, Recycling and Disposal in the United States: Facts and Figures for 2006. EPA-530-F-07-030, (2007).

[3] El-Fadel, M., Findikakis, A. N., and Leckie, J. O.: Modelling leachate generation and transport in solid waste landfills, Environ. Technol., 18, pp. 669–686 (1997).

[4] Keenan, J.D., Steiner, R.L., Fungaroli, A.A., Landfill leachate treatment. J. Water Poll.Contr. Fed., 56 (1): pp. 27-33 (2003).

[5] Ahn, Y.M, Kim, J.Y., Nam, K and Yoon, S.P., Enhanced Methane Oxidation Technology by Methanotrophs in Solid Waste Landfills. Processing APLAS Seoul, 2002 the 2nd Asia Pacific Landfill Symposium September 25-28, Seoul, Korea, pp. 482-488 (2002).

[6] Lu J.C.S., et al., Td, Leachate from Municipal Landfills Production and Management, Noyes Publication, Park, Ridge, (2010).

[7] APHA, Standard Methods for the Examination of Water and Waste Water, 21th edition, American Public Health Association, Washington DC, (2005).

[8] Jedrczak, A. Haziak, K. Quantity, chemical composition and treatment of landfill leachate, PUK, Poznan, (2001).

[9] Slack, R.J. Gronow, J.R. Vouvoulis, N. Household hazardous waste in municipal landfills; contaminants in leachate. Science of the Total Environment, 34: pp. 419-425 (2005).

[10] Kjeldsen, P., Andersen, J.S., Grundtvig, Aa., and Winther, P., Characterization of an old municipal landfill (Grindsted, Denmark) as a groundwater pollution source: landfill history and Leachate composition, Waste Manag. Res., (16), 3, (1998).

[11] Assmuth, T., Distribution, and attenuation of hazardous substances in uncontrolled solid waste landfills. Waste Manag. Res., (10), 235, (2007).

[12] Umar, M., Aziz, H. A., and Yusuf, M. S., "Variability of Parameters Involved in Leachate Pollution Index and Determination of LPI from Four Landfills in Malaysia". International Journal of Chemical Engineering. (6 pages), (2010). City District Government Multan

[13] Qasim, S.R., and Chiang, W., Sanitary landfill leachate generation, control, and treatment. Technomic Publishing Co., Inc. Pennsylvania, USA. ISBN 1-56-676129-8, (2004).

[14] Hughes K., Christy A., and Heimlich J., Landfill Types and Liner Systems. Ohio State University Extension Fact Sheet CDFS-138-05 (2008).

[15] Heimlich J., Landfills. [Accessed in May. 2008], Available online: http://ohioline.osu.edu/cd-fact/0111.html. (2000).

[16] Farquhar, G.J., Leachate production and characteristics. Canadian Journal of Civil Engineering, (16): 317-325 (2000).

[17] Tracys V., Research of leachate surface and groundwater pollution near Siauliai landfill. Environmental research, engineering, and management. No.1 (19): pp. 30-33(2002)

[18] Gianni Anreottola & Piero Cannas., Chemical and Biological Characteristics of Landfill Leachate. CISA, Environmental Sanitary Engineering Center, Italy, (1992).

[19] Callander, Ij; Barford, JP. Precipitation, Chelation and the availability of metals as nutrients in anaerobic digestion, I. Methodology Biotechnol. Bioeng. 25: 351368 (2006).

[20] Hayat, S; Hayder, S, Solid Waste Management, Introduction, First edition, Empire Publishers AL- Fazal Market, Urdu Bazar, Lahore, 1 (2011).

[21] Ahmad, H.H, Mohamed, H.R, Assessment of Sanitary Landfill Leachate Characterization and its impacts on the groundwater at Alexandria, The Journal of the Egyptian Public Health Association, vol, 80 (1), (2005).

[22] Harison, J. A. & Hardin, B. O., 'Cracking in clays: Solutions to problems in earth structures', International Journal for Numerical and Analytical Methods in Geomechanics, vol. 18, no. 7, pp. 467-484 (1999).

[23] Sadek, S., Ghanimeh, S. & El-Fadel, M. 'Predicted performance of clay-barrier landfill covers in arid and semi-arid environments', Waste Management, vol. 3 (2007).

[24] Christensen, T. H., Kjeldsen, P., Albrechtsen, H. J., Heron, G., Nielsen, P. H., Bjerg, P. L. & Holm, P. E., 'Attenuation of Landfill Leachate Pollutants in Aquifers', Critical Reviews in Environmental Science and Technology, vol. 24, no. 2, pp. 119-202 (1998).

[25] Al-Yaqout, A. F. &Hamoda, M. F., 'Evaluation of landfill leachate in arid climate-- a case study', Environment International, vol. 29, no. 5, pp. 593-600 (2003).

[26] Bjerg, P. L., Albrechtsen, H. J., Kjeldsen, P., Christensen, T. H., Cozzarelli, I. M. & Heinrich, D. H. a. K. K. T., 'The Groundwater Geochemistry of Waste Disposal Facilities', in (ed.), Treatise on Geochemistry, Pergamon, Oxford, pp. 579-612 (2003).

[27] Kjeldsen, P., Barlaz, M. A., Rooker, A. P., Baun, A., Ledin, & Christensen, 'Present and Long-Term Composition of MSW Landfill Leachate: A Review', Critical Reviews in Environmental Science and Technology, vol. 32, no. 4, pp. 297-336 (2002).

[28] Aziz, H. A., Alias, S., Adlan, M. N., Faridah, Asaari, A. H. &Zahari, M. S., 'Colour removal from landfill leachate by coagulation and flocculation processes', Bioresource Technology, vol. 98, no. 1, pp. 218-220 (2007).

[29] Jones, D. L., Williamson, K. L. & Owen, A. G. 'Phytoremediation of landfill leachate', Waste Management, vol. 26, no. 8, pp. 825-837 (2006).

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[30] Mor S, Ravindra K, Dahiya RP, Chandra A., Leachate characterization and assessment of groundwater pollution near a municipal solid waste landfill site. Environ Monitor Asses 118:435–456 (2006).

[31] M. J. K. Bashir, H. A. Aziz, M. S. Yusoff, and M. N. Adlan, Application of response surface methodology (RSM) for optimization of ammonical nitrogen removal from semi-aerobic landfill leachate using ion exchange resin. Desalination, 254, 154-161 (2010).

[32] D. Kulikowska and E. Klimiuk, The effect of landfill age on municipal leachate composition. Bioresource Technology, 99, 5981-5985 (2008).

[33] L. Koshy, T. Jones and K. BeruBe, Bioreactivity of municipal solid waste landfill leachates-Hormesis and DNA damage, Water Research, 42 (8-9), 2177- 2183 (2008).

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